

Concourse Low Voltage System Upgrade

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IFC Submittal, November 7, 2024

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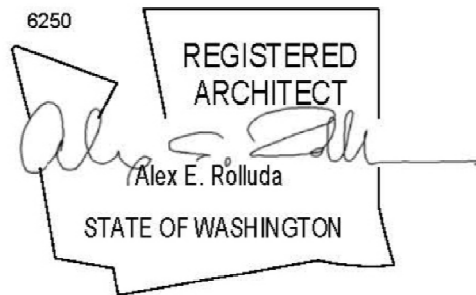
Technical Specifications in this project manual were prepared by the design professionals whose initials appear opposite the Specification Division or Section in the Table of Contents. Stamps, names and initials of the Design Professionals are:

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End of Document

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent of "Removal and Alteration" Work includes the removal and disposal of all items and materials, as indicated on drawings and in the specifications. The Contractor shall provide shoring and protection as necessary to prevent damage to existing structures.

1.02 SUBMITTALS

- A. Submit materials data in accordance with Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.
- B. Submittals shall include the following:
 - 1. Demolition plan and sequence of work.
 - 2. Shut off and rerouting of utility work
 - 3. Proposed Protection Measures: Submit informational report, including Drawings, that indicates the measures proposed for protecting individuals and property, for dust control and, for noise control. Indicate proposed locations and construction of barriers.
 - 4. Method of weather protection.
 - 5. Proposed landfills and recyclers

PART 2 MATERIALS

2.01 MATERIAL REQUIREMENTS

- A. Scrap Material
 - 1. Items not specified for reuse and items not salvage to the Port and items not elsewhere specified for specific disposal are designated as scrap material and become the property of the Contractor.
 - 2. Remove scrap material from the Work area immediately. Transport scrap materials. Storage or sale of removed items on the site will not be permitted.
 - 3. See Section 01 74 19 - Construction Waste Management.

PART 3 EXECUTION

3.01 PROJECT INFORMATION

- A. Occupancy
 - 1. The Port facilities will be occupied for normal operations during the remodel construction operation.
 - 2. Conduct operations in such a manner as to cause the least amount of interference with public and the Port's operations.
 - 3. The area to be altered will be vacated prior to the scheduled start of the Work in that area.
- B. Condition Of Structures

1. The Port assumes no responsibility for the actual condition of the portions of the structures to be removed or altered. The drawings do not show all arrangements and conditions of the structures and appurtenances as they now exist, nor is there any guarantee that fixtures and materials will be in full accord with the drawings. The Contractor shall be responsible for the complete repair of existing construction and equipment affected by the new construction. The Contractor shall inspect the existing construction and the quantity and condition of equipment and materials, and shall assume full responsibility for servicing and repairing of equipment and materials.
2. Repairs to the structure necessitated by the remodeling shall be made using material similar to that of adjacent surfaces. Where finished surfaces, such as paint, tile, wood trim, etc., are disturbed or abraded by remodeling Work, such finished surfaces shall be replaced in kind and color.

C. Alterations Of Existing Construction

1. Dismantling, cutting and removal of a part of the materials or equipment from the existing structures shall be done in such a manner as to prevent unnecessary damage to the remaining structures. Rebuilding or remodeling necessary to produce a completed job necessitated because of removal of the materials or equipment, or because of remodeling of the existing structures, shall become the responsibility of the Contractor, not withstanding that the specific Work may not be shown on the drawings or mentioned in the specifications. The materials and workmanship necessary to accomplish the remodeling Work shall conform to the drawings and to the applicable sections of these specifications.

3.02 DELIVERABLES

- A.** The Contractor shall submit to the Port of Seattle a demolition plan.

3.03 EXECUTION OF WORK

A. Protection

1. Conduct operations to prevent damage by falling debris or other cause to finished area, structures and facilities, as well as persons. Provide shoring, bracing or support to prevent movement or settlement or collapse of portions of the structures to remain.
2. If removal, relocation, or abandonment of utility services will affect adjacent occupied buildings, then provide temporary utilities that bypass buildings and structures to be demolished and that maintain continuity of service to other buildings and structures.
3. Protect exterior from weather intrusion. Maintain all roof drainage systems. Provide temporary services as required.

- B.** Provide temporary services during interruptions to existing utilities, as acceptable to Owner and authorities having jurisdiction.

C. Damages

1. Promptly repair damages caused to adjacent facilities by removal operations as directed by the Engineer and at no additional cost to the Port.

D. Utility Services

1. Do not interrupt existing utilities which service occupied or used facilities, except when authorized by the Engineer. Provide temporary services during interruptions to existing utilities, as acceptable to the Engineer. No less than forty-eight (48) hours' notice shall be given to the Engineer before any intended interruption of services.

E. Barricades

1. Before starting any cutting or removing any part of the existing building, construct barricades where indicated on the drawings and as required for the protection and routing of public and Airport personnel through or around the construction area. Construct barricades as stated in Section 01 50 00 - Temporary Facilities and Controls. Protect all finished areas enclosed within barricades which are not included in the demolition Work. Where necessary, provide suitable hinged access doors, with latch, in barriers. Remove the barriers upon completion of the contract.

F. Removal

1. Removal Operations: Use such methods as required to complete the Work within the limitations of governing regulations and other special requirements as specified.
2. Proceed with removal operations in a systematic manner.
3. Equipment used near all areas of occupancy, including public spaces, shall be of the lowest noise intensity possible.
4. Locate removal equipment and remove materials so as not to impose excessive loads to supporting walls, floors, or framing.
5. Remove existing tile where noted. Prepare floor for new finish.

G. Disposal Of Materials

1. Remove from the site all debris, rubbish and other materials resulting from removal operations. Keep public areas clean at all times.
2. Burning of materials will not be permitted on Port property.
3. Legally dispose of off Port property all scrap and waste materials, and protect the Port from all damages that may arise there from.
4. See Section 01 74 19 - Construction Waste Management.

3.04 QUALITY ASSURANCE

- A. Cleaning: Clean adjacent areas of dust, dirt, and debris caused by demolition operations. Return areas to condition existing before building demolition.

PART 4 MEASUREMENT AND PAYMENT

4.01 PAYMENT

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within

the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontrator (of any tier) or Supplier.

B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

End of Section

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. This section applies to all Work related to removal, transportation and disposal of:
1. Refrigerants and refrigerant containing equipment.
 2. Used Oils, including Hydraulic fluid and other Equipment oils.
 3. Radioactive sources (Exit signs).
 4. Mercury-containing thermostats and switches.
 5. Batteries.
 6. Biological Contaminants.

1.02 SUBMITTALS

- A. Preconstruction Submittals: Provide a site-specific Work Plan that identifies the types of items potentially or expected to be found based on the scope of the project and that demonstrates the methods by which removal, storage, handling and disposal will be performed.
1. To include safe Work practices for removal, handling and storage of each material listed.
 2. Complete list of all materials and equipment proposed for use in the Work.
 3. Qualifications, certifications, training certificates, experience and role of each individual performing or managing the removal Work.
 4. Respirator fit test records for personnel performing the removal Work, as applicable.
 5. Procedures for personnel equipment cleanup and decontamination.
 6. Waste management and disposal section of the Work Plan, including:
 - a. Waste minimization efforts.
 - b. Location of the designated Temporary Waste Storage Area(s).
 - c. Waste container management during the Work.
 - d. Procedures for transfer of off waste containers to the Port for disposal.
 - e. Proposed disposal facilities.
- B. Construction Phase Submittals.
1. 3-Week Look Ahead Schedule.
 - a. Include schedule details related to Work performed under this specification in the 3-Week Look Ahead Schedule.
 2. Daily Work Records: Include the following information in the Engineer Daily when Work is performed.
 - a. Supervisor Daily Inspection Report, including scope of Work completed, engineering controls used, types of materials, hours worked, and equipment and materials used.

- b. If applicable, air and bulk sample data sheets and laboratory analytical results, including chain of custody.
- C. Post-Construction Closeout Submittals.
 - 1. Project Overview: Provide a basic project summary identifying the scope and summarizing the Work performed by the Contractor, a discussion of significant problems encountered during the course of the Work. The written summary shall include a description of all changes or modifications to the Contractor's Pre-Construction Work Plan.
 - 2. Air Monitoring: Submit documentation of all Contractor air monitoring results relative to regulatory compliance. Include copies of all air monitoring data sheets, chain-of-custody documentation and analytical reports for sampling conducted at the site.
 - 3. Project Record Documents: Provide project records including copies of supervisor daily field reports, and documentation of notifications to the Port regarding materials stored in the Temporary Waste Storage Materials Storage Area.
 - 4. Submit copies of inspections or visits by regulatory agencies. Include copies of any citations or notices received by the Contractor from regulatory agencies during the course of the project.
 - 5. All disposal records for any waste disposed of by Contractor.
- 1.03 GOVERNING CODES, STANDARDS, AND REFERENCES
 - A. Contractor must comply with all current Federal, State, and Local rules and requirements in their entirety, even if they are not quoted in this section.
- 1.04 COORDINATION
 - A. Contractor shall properly containerize all waste noted in this specification and coordinate with the Port for disposal of any waste managed under this specification.

PART 2 MATERIALS

2.01 MATERIAL AND EQUIPMENT

- A. Containers
 - 1. All waste and debris shall be placed in DOT approved UN rated containers appropriate for the type of waste being managed.
 - 2. Liquid wastes shall be placed in drums appropriate for the type of waste, but closed top bung drums are preferred.
- B. Enclosure
 - 1. All containerized waste materials are to be placed in a Temporary Waste Materials Storage Area approved by the Port. The Contractor shall install and maintain any containment structures (for liquids only) (i.e., storage pads or berms), gates and fencing as necessary to secure the area.
 - 2. Enclosure materials shall be fire-retardant and conform to applicable local fire codes.

3. The enclosures shall be constructed of materials such that when the enclosure is completed there is limited potential for impact damage to the enclosure and no potential for contaminant release.

PART 3 EXECUTION

3.01 REFRIGERANTS

- A. The following equipment may contain ozone-depleting substances (Chlorinated fluorocarbons (CFCs)): refrigerators, freezers, water coolers, air-conditioning units, spot coolers, and cold rooms.
- B. The Contractor shall properly dispose of equipment scheduled for demolition as part of this contract.
- C. No evacuation of refrigerants shall be done on Port property, unless equipment is being put back in service.
- D. The ozone-depleting refrigerants shall be recovered from equipment in accordance with 40 CFR Part 82 (Protection of Stratospheric Ozone) and State regulations. Contractors performing this activity must use an EPA-certified technician. The equipment may be recycled once the ozone-depleting refrigerants have been removed.
- E. CFCs are to be removed and managed in accordance with the refrigerant reducing requirements of USEPA in Section 608 of the Clean Air Act (CAA), 1990, as amended, including final regulations published May 14, 1993 (58 FR 28660) and the prohibition on venting effective July 1, 1992.
- F. The following documentation shall be provided to the Port: a letter documenting that the refrigerant has been recovered shall be provided in accordance with 40 CFR Part 82.

3.02 MERCURY-CONTAINING THERMOSTATS AND SWITCHES

- A. Mercury-containing thermostats and switches that will be impacted during execution of the Contract will be removed intact and containerized by the Contractor. Intact thermostats and switches will be managed in accordance with Federal (40 CFR 273) and State (WAC 173-303-573) regulations. See also Section 02 84 16 – Light Ballast and Lamp Removal and Management for applicable requirements.
- B. The Contractor shall remove and containerize mercury-containing thermostats and switches from equipment scheduled for demolition as part of this contract. Contractor shall notify the Port within three days of the presence of the containerized waste in the Temporary Waste Materials Storage Area for removal and disposal by the Port.

3.03 BIOLOGICAL CONTAMINANTS

- A. If there are bird droppings and rodent droppings indicated in the Project Work Area, the Contractor shall exercise caution in these areas and wear appropriate personnel protective equipment such as respirators, disposable gloves, and eye shields.
- B. A Work Plan and Health and Safety Plan shall be submitted for review by the Port. The submittals may be submitted and reviewed electronically. Following receipt of review comments from the Port, the Contractor shall submit additional versions

of revised submittals to the Port until each submittal is accepted by the Port. No Work that will impact animal droppings will be permitted prior to submittals being reviewed and accepted by the Port.

- C. At a minimum, dust control techniques (e.g., using water, HEPA vacuums and negative air machines) shall be employed.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.

- B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

End of Section

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The Contractor shall establish, provide, and maintain lead controls for the duration of the work conducted during this Contract. The tasks to be completed under this Contract are generally not considered lead abatement projects. However, the Contractor may encounter lead-containing coatings and lead-containing materials during painting, general construction and demolition.
- B. The intent of this section is to require the Contractor to establish procedures and controls to prevent airborne lead emissions during painting, general construction and demolition; comply with Washington Administrative Code (WAC) 296-155-176; and manage lead waste in accordance with WAC 173-303, Dangerous Waste Regulations. The work may include:
 - 1. Painting on surfaces that have been treated with lead-containing coatings. This includes preparation of the surfaces to accept new paint.
 - 2. Limited demolition of concrete, concrete block, steel, sheetrock, plaster and other items that may consist of lead or be coated with paints that contain lead.
 - 3. Waste designation including samples collected in accordance with ASTM Standard E 1908 and subsequent Toxic Characteristic Leaching Procedure analysis (EPA Method 1311) conducted by a laboratory certified by the Washington State Department of Ecology
 - 4. Disposal of lead waste in accordance with WAC 173-303, Dangerous Waste Regulations
 - 5. Providing personnel that have received training as defined in WAC 296-155-17625

1.02 GOVERNING CODES, STANDARDS, AND REFERENCES

- A. The Contractor is responsible for monitoring work activities and determining conditions that require conformance with specified regulatory requirements and standards. The following rules, requirements, and standards may apply to the work:
 - 1. United States Occupational Safety and Health Administration (OSHA)
 - a. 29 CFR 1910 - Occupational Safety and Health Standards
 - b. 29 CFR 1910.134 - Respiratory Protection
 - c. 29 CFR 1910.1200 - Hazard Communication
 - d. 29 CFR 1926.55 - Gases, Vapors, Fumes, Dusts, and Mists
 - e. 29 CFR 1926.57 - Ventilation
 - f. 29 CFR 1926.62 - Lead in Construction Standard
 - 2. United States Environmental Protection Agency (EPA)
 - a. 40 CFR 260 - Hazardous Waste Management Systems: General
 - b. 40 CFR 261 - Identification and Listing of Hazardous Waste

- c. 40 CFR 262 - Standards Applicable to Generators of Hazardous Waste
 - d. 40 CFR 263 - Standards Applicable to Transporters of Hazardous Waste
 - e. 40 CFR 268 - Land Disposal Restrictions
 - f. 40 CFR Part 745, Subpart L - Lead Based Paint Activities
 - g. 40 CFR Part 745, Subpart E (Ref. 8) - Lead Renovation, Repair, and Painting Program
 - h. EPA Publication SW-846 - *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*
 - i. EPA Publication EPA-740-K-10-001 - *Lead Safe Certified Guide to Renovate Right*
- 3. Department of Transportation
 - a. 49 CFR Subchapter C - Hazardous Materials Regulations
- 4. National Institute for Occupational Safety and Health (NIOSH)
 - a. NIOSH/OSHA Booklet 3142 - *Lead in Construction*
- 5. American Society for Testing and Materials
 - a. Standard E 1908 - *Standard Guide for Sample Selection of Debris Waste from a Building Renovation or Lead Abatement Project for Toxicity Characteristic Leaching Procedure (TCLP) Testing for Leachable Lead (Pb)*
- 6. Washington State Regulations that are codified in the Washington Administrative Code (WAC) and govern lead work and lead waste management include but are not limited to:
 - a. WAC 296-62 - General Occupational Health Standards
 - b. WAC 296-24 - Safety Standards for Construction Work
 - c. WAC 296-155-176 - Lead
 - d. WAC 296-841 - Airborne Contaminants
 - e. WAC 173-303 - Dangerous Waste Regulations
 - f. WAC 365-230 - Accreditation of Firms And Individuals Conducting Lead-Based Paint Activities

1.03 DEFINITIONS

A. Definitions relevant to lead:

- 1. Action Level (Lead): Employee exposure, without regard to the use of respirators, to an airborne concentration of lead of 30 micrograms per cubic meter of air averaged over an 8 hour period.
- 2. Air Monitoring: The process of measuring the concentration of lead in a specific volume of air in a stated period of time. Air samples shall be collected and analyzed in accordance with the methods specified by the

National Institute for Occupational Safety and Health (NIOSH) and as required by WAC-296-155-176.

3. Area Monitoring: Sampling of lead concentrations within the lead control area, inside the physical boundaries, which is representative of the airborne lead concentrations that may reach the breathing zone of personnel potentially exposed to lead.
4. Dangerous Waste: Solid wastes designated as dangerous wastes in accordance with WAC 173-303, Dangerous Waste Regulations. Dangerous waste is the State of Washington equivalent to hazardous waste under the Federal Resource Conservation and Recovery Act (RCRA).
5. DOT: Department of Transportation
6. Eight Hour Time Weighted Average (TWA): Airborne concentration of lead averaged over an 8 hour workday, to which an employee is exposed.
7. Hazardous Waste: Solid waste designated in accordance with 40 CFR Part 261 as hazardous, and regulated as hazardous waste by the United States Environmental Protection Agency.
8. Lead: Metallic lead, inorganic lead compounds, and organic lead compounds
9. Permissible Exposure Limit (PEL - Lead): A lead concentration of 50 micrograms per cubic meter of air as an 8 hour time weighted average.
10. Personal Monitoring: Sampling of lead concentrations within the breathing zone of an employee to determine the 8 hour time weighted average concentration in accordance with WAC 296 155 176 and 296-841. Samples shall be representative of the employee's work tasks. Breathing zone shall be considered an area within a hemisphere, forward of the shoulders, with a radius of 6 to 9 inches and the center at the nose or mouth of an employee.
11. Industrial Hygienist: The Industrial Hygienist shall be subject to approval as specified under Paragraph 1.05 of this section and shall have one of the following certifications:
 - a. Certified Industrial Hygienist certified by the American Board of Industrial Hygiene with prior experience in the health and safety aspects of a lead hazard control work project.
 - b. Professional Engineer or Certified Safety Professional with a minimum of three (3) years prior experience in industrial hygiene relating to lead hazard control work.
12. Waste Designation: The process of determining whether waste is regulated under WAC 173-303, Dangerous Waste Regulations.

1.04 QUALITY ASSURANCE

- A. The Contractor shall submit a Lead Controls Work Plan pursuant to Paragraph 1.05 of this section. The Work Plan shall establish procedures and controls to: prevent airborne lead emissions during general construction and demolition, comply with (WAC) 296-155-176 (Lead) and 296-841 (Airborne Contaminants), and manage waste in accordance with WAC 173-303, Dangerous Waste

Regulations. The Work Plan will be submitted to the Port for review and approval prior to the start of any lead work.

- B. The Port will perform periodic observation of the site work to ensure that it is being performed in a manner consistent with the approved Work Plan and this section. The Port's representative will have the authority to issue a "Stop Work" order for health and safety concerns or non-compliance with regulations or this section.

1.05 SUBMITTALS

- A. The Contractor shall provide complete submittals in accordance with Section 01 33 00 and as specified below.
- B. Preconstruction Submittals: Provide a site-specific Lead Work Plan which demonstrates the methods by which impact, handling and disposal of lead-containing materials will be performed. The Port realizes that this project may or may not involve actual "lead abatement"; instead, the project work may involve demolition, alteration, and/or painting of building components that are coated with paint of varying lead concentrations. Therefore, a statement is required that identifies how the Contractor will be complying with the specifications and regulations as they pertain to lead. At a minimum the Work Plan shall include:
 - 1. A general description of work practices, engineering controls, air monitoring, and decontamination for work involving lead-containing coatings. Describe whether the job will involve removing paint that contains lead (i.e., abatement), or demolition of materials containing or coated with lead.
 - 2. Qualifications, certifications, training certificates and role of each Contractor's personnel
 - 3. Qualifications of the proposed testing laboratory (to perform analysis of air and waste characterization samples)
 - 4. Site inspection process, logs and documents
 - 5. Respirator fit testing records for personnel performing lead work
 - 6. Lead Air Monitoring Program
 - a. The Air Monitoring Program shall include the proposed sampling plan, sampling procedures, and field quality control procedures of the firm conducting the air monitoring.
 - 7. Procedures for personnel and equipment cleanup and decontamination
 - 8. Lead Waste Management and Disposal Plan, including:
 - a. Waste minimization efforts
 - b. Container selection and labeling
 - c. Qualifications and certificates of lead waste transporter
 - d. Qualifications and certifications of lead waste disposal facilities
 - e. Documentation of final lead waste transportation and disposition
- C. Construction Phase Submittals

1. Daily Work Records: Submit the following information to the Engineer daily. This information shall be submitted prior to the start of work on the next scheduled work shift.
 - a. Air and bulk sample data sheets and laboratory analytical results, including chain of custody
 - b. Supervisor daily inspection report, including scope of work completed, engineering controls used, hours worked, and equipment and materials used.
- D. Post-Construction Closeout Submittals
 1. Project Overview: Provide a basic project summary identifying the scope and summarizing the work performed by the Contractor. Provide enough information to have a basic understanding of the project and include project and contact names and ID numbers; Contractor's company name; where, when, and what type of work was completed; and a discussion of significant problems encountered during the course of the work. The written summary shall include a description of all changes or modifications to the Contractor's Pre-Construction Work Plan.
 2. Certification: Provide written certification from the Contractor's Project Manager or Supervisor that the Contractor has fully inspected the work area and completed work in strict accordance with the Specifications.
 3. Air Monitoring: Submit documentation of all Contractor air monitoring results relative to regulatory compliance. Include copies of all air monitoring data sheets, chain-of-custody documentation and analytical reports for sampling conducted at the site.
 4. Project Record Documents: Provide project records including documentation of all contract changes, and copies of work site entry log books, safety logs, sign-in sheets, and supervisor daily field reports. Provide copies of project meetings for pre-construction, construction period, and project closeout meetings.
 5. Disposal Manifests: Submit copies of all lead waste disposal transportation and disposal manifests including signed receipts from the landfill, and chain-of-custody forms. Lead dangerous waste or hazardous waste disposal documentation shall be signed by a representative from Port of Seattle Aviation Environmental Programs.
 6. Submit copies of inspections or visits by regulatory agencies. Include copies of any citations or notices received by the Contractor from regulatory agencies during the course of the project.

PART 2 MATERIALS AND EQUIPMENT

2.01 MATERIAL REQUIREMENTS

- A. Containers
 1. All wastes that designate as Hazardous Waste or Dangerous Waste shall be packaged in sealed containers with appropriate UN Performance Package Ratings.
 2. All drums and containers must be in shipping condition with gaskets intact.

B. Labels

1. All containers holding hazardous wastes will be labeled in accordance with WAC 173-303-190.

PART 3 EXECUTION

3.01 WORK AREA PREPARATION

A. Perform the following preliminary steps to prepare the Work Areas prior to demolition of lead coatings and lead-containing materials.

1. Establish a control area that includes a perimeter sufficient to perform the demolition work around each building or area that contains lead or lead-containing materials and/or renovation work that is expected to disturb lead-containing paint. The control area shall also consist of the pathway for transport of any lead-contaminated material to a stockpile or storage receptacle, if the demolition debris is not immediately transported from the site. Provide and display caution signs, in clearly visible areas, at entrances indicating that hazardous material work is being conducted, that state that unauthorized persons should not enter. Signs shall comply with WAC 296-155-176.
2. Emergency Procedures: Establish and post written emergency procedures within each work area, including emergency contact names and contact phone numbers, plans for medical emergencies, plans for temporary loss of electrical power or water, and procedures for an emergency. The Contractor is responsible for establishing and posting contingency procedures for all workers on site.
3. Health and Safety Briefing: Conduct a health and safety briefing prior to the start of work and weekly to discuss the Health and Safety Plan, hazardous materials, hazardous work and other related items per the specified Health and Safety Plan. More frequent briefings should be performed as required by project activities or changes in the work.
4. Utilities: Request and coordinate the use and shut down of all utilities. Request and coordinate the use and shutdown of electric service to the work area and install temporary electric supply with ground fault interrupt protection.
5. Prepare all storm drains, floor and area drains and drainage routes using the methods described in the approved Work Plan to prevent contaminated runoff.
6. Lead Waste Accumulation Area: Prepare the lead-waste storage area as described in the approved Work Plan.
7. Decontamination Areas: Prepare the decontamination areas for use at all entrances and exits from the Work Area as described in the approved Work Plan.

3.02 WORK PROCEDURE

- A. General Procedures: Perform all work and comply with the safety and health provisions in the site-specific Health and Safety Plan. The work includes all measures necessary to adequately protect workers, authorized personnel, Port

staff and the public from lead exposures during the demolition/renovation process and surface preparation activities.

- B. Coordination of work of all trades: Coordinate the work of all trades to assure that work is performed in accordance with the applicable regulations and that the control limits are maintained at all times both inside and outside the control area.
- C. Access to work Area: Access to work areas shall be through decontamination areas. Only the Contractor, subcontractors, authorized Port personnel, and project consultants shall have access to the Work Area.
- D. Means of Egress: Establish and maintain emergency and fire exits from the work area.
- E. Prevent dust generation at all times to the maximum extent practicable.
- F. The use of water shall be restricted to the smallest quantity necessary to minimize dust and to avoid the potential of contaminant migration through run-off or ponding. In no case shall liquids generated during building demolition/renovation come into contact with uncontaminated soils, drains, surfaces or conduits which may constitute a release to the environment.
- G. Demolition Procedures: Perform demolition in areas of lead-containing paints and lead-containing materials in accordance with the approved Health and Safety Plan. Use procedures and equipment to limit occupational and environmental exposure to lead when lead-containing paint is impacted or when lead-containing building components are demolished. The procedures employed by the Contractor shall not create the potential for contaminating surrounding areas or materials with lead-containing coatings or dust. Dust generation shall be kept to a minimum. Dry scraping, dry sanding, or dry grinding on lead-containing paints or lead contaminated surfaces will not be permitted without a full enclosure.
- H. Personnel and equipment decontamination shall occur whenever workers or equipment leave the work site as described in the approved Work Plan. Decontamination waste shall be packaged, stored, labeled and disposed according to all applicable requirements at the cost of the Contractor.
- I. The Port may inspect the Contractor's operations and work areas daily for job site cleanliness and conformance with the specifications.
- J. While performing the work, the Contractor may be subject to on-site inspection by L&I/DOSH, OSHA, EPA/Ecology inspectors and/or local building or health officials. If found to be in violation of pertinent regulations, the Contractor shall cease all work immediately and may not resume work until the violation is resolved. Standby time required to resolve the violation shall be at the Contractor's expense. Complete sets of equipment (such as respirators and disposable clothing) that may be required for entry to the control area shall be made available at all times by the Contractor to the Port and/or agency inspectors for inspection of the control area. Such requests will only be made during working hours.

3.03 LEAD CONTROLS AND AIR MONITORING

- A. Lead Controls
 - 1. Restrict the spread of dust and debris from being distributed over the work area.

2. Prevent dust generation at all times to the maximum extent practicable. The use of water shall be restricted to the smallest quantity necessary to minimize dust and to avoid potential run-off or ponding.
3. Dry scraping, dry sanding, or dry grinding on lead-containing paints, lead-containing materials or lead-contaminated surfaces will not be permitted without a full enclosure.

B. Air Monitoring

1. Monitoring of airborne concentrations of lead shall be in accordance with WAC 296-155-176, WAC 296-841, and as specified herein. Air monitoring, testing, and reporting shall be performed in accordance with an Air Monitoring Plan prepared and signed by the Contractor's Industrial Hygienist. The Plan shall include personal monitoring in accordance with regulatory requirements and area monitoring outside the lead control area.
 - a. Submit results of air monitoring samples, signed by the Contractor's Industrial Hygienist, within 24 hours after the air samples were taken.
 - b. Notify the Engineer immediately of the corrective action taken if the exposure to lead is at or in excess of the lead action level (30 micrograms per cubic meter) outside of the lead control area.
 - c. If the area air monitoring results are above the lead action level, the Engineer shall have the option of stopping all work until the work procedures and lead hazard controls are revised to the Engineer's satisfaction.

3.04 CLEAN-UP, TESTING AND DISPOSAL

A. Cleanup

1. Maintain surfaces of the lead control area free of accumulation of paint chips and dust. Restrict the spread of dust and debris; keep waste from being distributed over the work area. The use of compressed air to clean up the area is strictly prohibited. At the end of each shift, clean the area of visible lead paint and dust contamination by vacuuming with a HEPA filtered vacuum cleaner, wet mopping the area, or cleanup by other appropriate means.
2. All abated lead waste shall be stored in sealed steel containers with appropriate UN Performance Package Ratings.
3. Demolition debris that is found to designate as Dangerous Waste per WAC 173-303 can be stored in closed top roll off containers. Tops must be closed when not adding waste to the container.

B. Testing of Lead Waste and Demolition Debris

1. The Contractor is responsible for sampling and testing any abated lead waste or lead demolition debris.
2. Sampling of abated lead and lead demolition debris shall be in accordance with the most current version of ASTM Standard E 1908 - Standard Guide for Sample Selection of Debris Waste from a Building Renovation or Lead

Abatement Project for Toxicity Characteristic Leaching Procedure (TCLP) Testing for Leachable Lead (Pb).

3. If any lead waste is found to designate as Dangerous Waste per WAC 173-303, the Contractor must immediately notify the Engineer.

C. Disposal of Lead Demolition Waste

1. Lead-containing waste that does not designate as Dangerous Waste per WAC 173-303 must be managed at a permitted disposal facility.
2. The following requirements shall be met for the disposal of any lead-containing Dangerous Waste:
 - a. The Contractor shall submit the name, address, and EPA Identification Number of the transporter and disposal facility to the Port of Seattle Aviation Environmental Department prior to shipment of any hazardous waste.
 - b. A representative from the Port of Seattle Aviation Environmental Department must be present for any Dangerous Waste shipment and will sign all hazardous waste manifests, waste material profiles, land disposal restriction forms and any other documents requiring generator signature. Contractor shall give notice of any Dangerous Waste shipments to the Port of Aviation Environmental Department at (206) 787-5525 at least 2 business days prior to shipment.
 - c. Any lead-containing Dangerous Waste for disposal must be packaged in appropriate UN performance packages or roll off containers according to all DOT specifications.

PART 4 MEASUREMENT AND PAYMENT

4.01 PAYMENT

A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.

B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

DIVISION 2 - EXISTING CONDITIONS

Section 02 83 19 – Lead Controls in Construction and Demolition

End of Section

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The Contractor shall supply all labor, materials, vehicles, services, insurance and equipment necessary to remove, transport, recycle and dispose universal waste lamps, and non-PCB ballasts in accordance with all applicable federal and state regulations and these specifications.
- B. The Contractor shall supply all labor, materials, vehicles, services, insurance and equipment necessary to remove, containerize and transfer to the Port all Polychlorinated Biphenyls (PCB) containing light ballasts (PCB ballasts) or other PCB containing equipment regulated by 40 CFR 761 or WAC 173-303.
- C. This project involves complete removal of light fixtures in areas of new construction and/or demolition.
- D. Refer to the design drawings for specific information about location of lamps and/or ballast removal. The Work includes the following:
 - 1. Dismantling of light fixtures and separation of ballasts and lamps.
 - 2. Determination whether ballasts are PCB ballasts or non-PCB ballasts. Unmarked ballasts shall be considered PCB ballasts.
 - 3. Package, label and store lamps in accordance with WAC-173-303-573, Standards for Universal Waste Management.
 - 4. Immediate identification and notification to the Engineer of any leaking PCB ballasts.
 - 5. Package, mark, label and store all PCB or PCB containing/contaminated waste generated as a result of work activities in accordance with 40 CFR 761.
 - 6. Collection and containerization of all non-PCB ballasts.
 - 7. Coordinating transfer of all PCB ballasts or other PCB containing / PCB contaminated waste to the Port of Seattle within 30 days of generation of waste.
 - 8. Coordinate proper recycling of all non-PCB ballasts to approved recycling facility.
 - 9. Coordinate transportation and recycling of lamps in accordance with WAC-173-303-573, Standards for Universal Waste Management.
 - 10. Provide disposal documentation for all ballasts and lamps removed during the Project.

1.02 GOVERNING CODES, STANDARDS, AND REFERENCES

- A. The applicable sections, latest editions and addenda of the following government regulations, codes, industry standards and recommended practices, form a part of these specifications.
 - 1. U.S. EPA - Environmental Protection Agency, Toxic Substances Control Act, Title 40, Code of Federal Regulations, Part 761 (40 CFR 761)
 - 2. U.S. EPA - Environmental Protection Agency, Standards for Universal Waste Management (40 CFR 273)

DIVISION 2 – EXISTING CONDITIONS

Section 02 84 16 – Light Ballast and Lamp Removal and Management

3. U.S. DOT - Department of Transportation, Title 49 Code of Federal Regulations
4. DOE - Washington State Department of Ecology, Dangerous Waste Regulations, Washington Administrative Code 173-303 (WAC 173-303)
5. Washington State Department of Labor and Industries (L&I) WISHA - Washington State Industrial Safety & Health Act, Chapter 296-800 Washington Administrative Code (WAC), Safety and Health Core Rules
 - a. WAC 296-800-170 Hazard Communication Standard
6. L&I Chapter 296 -24 WAC, General Safety and Health Standards
 - a. L&I Chapter 296-62 WAC, Occupational Health Standards including: WAC 296-842 Respiratory Protection
7. L&I Chapter 296-155 WAC, Construction Standards
8. All other applicable Federal, State, county and city standards codes

1.03 DEFINITIONS

- A. ASTM: American Society for Testing and Materials
- B. Certified Industrial Hygienist (CIH): An industrial hygienist certified in the Comprehensive Practice of Industrial Hygiene by the American Board of Industrial Hygiene
- C. Contractor: The individual or business with whom the Port has contracted to perform the work as specified herein
- D. DOE: Washington State Department of Ecology
- E. Engineer: The Port of Seattle's designated contact person.
- F. EPA: United States Environmental Protection Agency
- G. L&I: Washington State Department of Labor & Industries
- H. NIOSH: The National Institute for Occupational Safety and Health
- I. OSHA: The Occupational Safety and Health Administration
- J. Universal Waste Lamps: Any light bulb, lamp or tube that contain constituents, such as mercury or lead, that could otherwise cause a Dangerous Waste designation when discarded, but can be managed as universal waste. The following lamps must be considered universal waste lamps and managed accordingly:
 1. Fluorescent tubes
 2. High intensity discharge lamps (including mercury vapor, metal halide, and high pressure sodium)
 3. Compact fluorescent lamps
 4. Incandescent bulbs
 5. Any other lights or lamps that are Dangerous Waste
- K. WAC: Washington Administrative Code

- L. WISHA: Washington Industrial Safety and Health Act as enforced by the Washington State Department of Labor & Industries

1.04 COORDINATION

- A. Contractor shall coordinate ballast removal with the following Port of Seattle Departments:
 - 1. Port of Seattle Aviation Maintenance, Electrical Department:
 - a. The Contractor must coordinate with the Electrical Department for disconnection and lockout of electrical service. This coordination will be communicated through the Engineer
 - 2. Port of Seattle Aviation Environmental Programs:
 - a. The Contractor must coordinate with Aviation Environmental Programs to coordinate transfer of any PCB ballasts or other PCB containing materials to the Port of Seattle.

1.05 QUALITY CONTROL

- A. Use properly trained and experienced workers to perform the removal and containerization of PCB ballasts and universal waste lights and lamps.

PART 2 MATERIALS AND EQUIPMENT

2.01 MATERIAL REQUIREMENTS

- A. Containers
 - 1. All PCB ballasts (or PCB contaminated material) and non-PCB ballasts shall be packaged in sealed steel drums with appropriate UN Performance Package Ratings.
 - 2. All drums must be in shipping condition and water tight with gaskets intact.
- B. Labels
 - 1. All containers holding PCB ballasts or PCB contaminated material shall be labeled with the Large PCB Mark (M_L) in accordance with 49 CFR 761.40 marking requirements.
 - 2. All containers holding non-PCB ballasts shall be labeled with the words "Non-PCB Ballasts".
 - 3. All containers that contain universal waste lamps shall be labeled with the words "Universal Waste".
 - 4. All containers designated for disposal shall be marked with the project number.

2.02 EQUIPMENT

- A. Personal Protective Equipment
 - 1. Provide proper and appropriate personal protective equipment, as necessary for the performance of this Work.
- B. Removal Equipment
 - 1. A sufficient supply of scaffolds, ladders, lifts and hand tools shall be provided as needed.

2. Additional support equipment as needed.

PART 3 EXECUTION

3.01 WASTE STREAM DETERMINATION, PACKAGING, AND MARKING

A. Waste Stream Determination – Ballasts

1. Before removing the ballast from the fixture, the Contractor shall distinguish PCB ballasts from non-PCB ballasts by looking for the words “No PCBs” on the ballast. If the words “No PCBs” do not appear on the ballast, the ballast must be considered PCB Equipment as defined in 40 CFR 761.3. If the words “No PCBs” do appear on the ballast, the ballasts shall be considered non-PCB. Contractor will also determine if the ballast is leaking.
2. The determinations made by the Contractor will result in the following three possible waste streams that must be segregated:
 - a. PCB ballasts
 - b. Leaking PCB ballasts and PCB contaminated materials
 - c. Non-PCB ballasts (leaking non-PCB ballasts can be packaged with the non-leaking, non-PCB ballasts).
3. Any leaking PCB ballasts must be reported to the Engineer immediately.

B. Waste Stream Determination – Universal Waste Lamps

1. All lamps removed from the site shall be considered universal waste lamps as defined by 40 CFR 273.5 and WAC 173-303-040, provided the lamps are managed accordingly.
2. Any accidentally broken lamps are fully regulated under Federal Resource Conservation and Recovery Act (40 CFR 261) and Washington State Dangerous Waste Regulations (WAC 173-303).
3. Any onsite disposal of universal waste lamps constitutes improper disposal of fully regulated Dangerous Waste and would be considered a violation of the Federal Resource Conservation and Recovery Act and the Washington State Dangerous Waste Regulations.

C. Containerization and Marking

1. All non-leaking PCB ballasts shall be packaged in steel drums marked or labeled with the Large M_L PCB Mark. The “taken out of service” date shall be marked on the drum as the date the first ballast is removed and placed in the drum.
2. All leaking PCB ballasts shall be double bagged, packed in steel drums and marked or labeled with the Large M_L PCB Mark. The “taken out of service” date and “Leaking PCB Ballasts” shall be marked on the drum. Upon notification to Port of Seattle Aviation Environmental Programs, leaking PCB ballasts will be removed from the site immediately by the Port.
3. Any PCB contaminated material generated as a result of the Work shall be packaged in steel drums marked or labeled with the Large M_L PCB Mark. The accumulation start date shall be indicated on the drum as the date the first piece of contaminated material is placed in the drum.

4. All non-PCB ballasts shall be packaged in steel drums and marked with the words “Non-PCB Ballasts for Recycling”.
5. Lamps shall be removed and containerized in a manner to prevent breakage. If a lamp breaks, the Contractor shall immediately clean-up debris, place debris in double plastic taped bags, and place the bagged debris in a container specified for broken lamps and labeled and managed in accordance with 40 CFR 261.

3.02 CLEANUP PROCEDURES

- A. All leaking PCB ballasts shall be addressed immediately. Upon discovery of leaking PCB ballasts, the Contractor shall commence with cleanup as follows:
 1. Clear the area and prohibit those not involved with cleanup from entering the area. Ventilate area if possible.
 2. Contact the Engineer immediately.
 3. Don appropriate personal protection equipment for handling organic liquids as specified in the site specific safety plan.
 4. Ensure that the light fixture is turned off and disconnect electricity at the fuse or breaker box. Follow all lockout/tagout procedures.
 5. Remove the fluorescent lamp if it is still affixed and manage according to this Section.
 6. Remove the ballast and immediately double-bag in plastic.
 7. Place ballast in steel drum, seal the drum, and mark the drum as indicated in 3.01.
 8. If there are any uncontained liquids or other material on a surface other than the ballast, contact the Engineer immediately and prevent the area from being disturbed.
 9. Arrangements will be made by Port of Seattle Aviation Environmental Programs to remove the drums containing leaking PCB ballasts from the site within 30 days for storage in accordance with 49 CFR 761.65(b).
- B. Clean-up Procedures for Broken Lamps
 1. The Contractor shall have a cleanup kit on site prior to removing or dismantling universal waste lamp fixtures.
 2. Avoid breathing dust created by broken lamps. Allow vapor to dissipate.
 3. Do not vacuum the broken lamps.
 4. Ventilate area and leave area for 5 minutes prior to returning to clean up broken glass. Keep people from the site.
 5. Use approved and appropriate cleanup solvents and neutralizers.
 6. Place all broken glass and phosphor powder in double plastic taped bags, place the bagged debris in sealed containers, and label as specified in this Section.

3.03 TEMPORARY STORAGE, TRANSPORTATION AND DISPOSAL

- A. Temporary Storage

DIVISION 2 – EXISTING CONDITIONS

Section 02 84 16 – Light Ballast and Lamp Removal and Management

1. The Contractor may temporarily store non-leaking PCB ballasts onsite for a maximum of 30 days. Contractor must arrange for transfer to the Port of Seattle within 30 days. Contractor cannot store PCB ballasts onsite for more than 30 days.
 2. Leaking PCB ballasts cannot be temporarily stored onsite. If leaking PCB ballasts are discovered, immediately contact the Engineer.
 3. Universal waste lamps that have been removed, properly packaged, and are awaiting disposal must be stored in a manner consistent with WAC-173-303-573 and the Contractor's Pollution Prevention Plan.
 4. Under no circumstances shall universal waste be stored onsite for longer than 1 year.
- B. Transportation and Recycling
1. PCB Containing Ballasts
 - a. The Port will take possession of and remove from the project site, all non-leaking PCB containing ballasts at a minimum of every 30 days.
 - b. The Contractor is responsible for scheduling transfer of drums to the Port. The Contractor must notify the Engineer at least 48 hours in advance to coordinate pickup of drums by the Port.
 2. Non-PCB Containing Ballasts
 - a. The Contractor is responsible for soliciting a waste service provider and any cost negotiations regarding disposal.
 - b. The Port of Seattle requires that all non-PCB ballasts are recycled. Landfill of any light ballast is not allowed under this contract. The Contractor must ensure that the disposal/recycling facility will separate metal components from the ballast for recovery.
- C. Universal Waste Lamps
1. Universal waste lamps shall be packaged, labeled and transported to the Port approved recycling facility. Include documentation in the form of log, invoice, manifest, bill of lading or other shipping documents. This documentation shall include the name and address of the generator, address of the site where the waste was generated, quantity, date of shipment, name and address of hauler and name and address of waste facility receiving waste.
 2. These boxes shall be shipped to the following Port approved recycling facility:

Ecolights Northwest
1915 South Corgiat Drive
Seattle, WA 98108
Facility Phone: (206) 343-1247
 3. If an alternate permitted facility has been identified by the Contractor, the facility must be approved by the Port.

DIVISION 2 – EXISTING CONDITIONS

Section 02 84 16 – Light Ballast and Lamp Removal and Management

4. The Port of Seattle shall be listed as the Generator of the universal waste lamps on all shipping papers.
5. The Contractor shall provide a shipping record to the Port at the time of shipment.
6. The Contractor shall arrange for all certificates of recycle to be mailed to the Port at the following address:

Aviation Environmental Programs
Port of Seattle AV/ENV
PO Box 68727
Seattle, WA 98168-0727

PART 4 MEASUREMENT AND PAYMENT

4.01 PAYMENT

A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.

B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

End of Section

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The Contractor shall furnish all labor, materials, facilities, equipment, services, employee training and testing, and agreements necessary to perform the work required for potential silica dust control activities in accordance with these specifications and the latest worker protection regulations from the Washington State Department of Labor and Industries Division of Occupational Safety and Health (DOSH), and for fugitive dust control in accordance with these specifications and the latest regulations from the Puget Sound Clean Air Agency (PSCAA) and any other applicable federal, state, and local government regulations. Whenever there is a conflict or overlap of the above references, the most stringent provisions are applicable.
- B. The work specified herein shall be performed by competent persons, trained, knowledgeable and qualified in both fugitive and silica dust evaluation and control methods.
- C. Activities with potential for exposure include, but are not limited to:
 - 1. Activities where exposure to airborne concentrations of respirable crystalline silica exceeds, or can reasonably be expected to exceed, the permissible exposure limit (PEL) or action level (AL), and
 - 2. Activities listed in WAC 296-840, Safety Standards for Respirable Silica, Table 1: Specified Exposure Control Methods When Working With Materials Containing Crystalline Silica.
- D. If visible fugitive dust emissions are observed or respirable crystalline silica concentrations exceed the applicable PEL and AL beyond the perimeter of the work area, the Port is authorized to stop work. The Contractor shall perform all necessary corrective actions to eliminate visible dust and reduce respirable crystalline silica concentrations to less than 25 $\mu\text{g}/\text{m}^3$ before resuming work. The Port may visually monitor for fugitive dust and collect air samples for silica at any time.

1.02 DEFINITIONS

- A. Definitions relevant to silica:
 - 1. Action Level (AL): A concentration of airborne respirable silica of 25 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$), calculated as an 8-hour time-weighted average (TWA_8).
 - 2. Competent person: An individual who is capable of identifying existing and foreseeable respirable crystalline silica hazards in the workplace and who has authorization to take prompt corrective measures to eliminate or minimize them. The competent person must have the knowledge and ability necessary to fulfill the responsibilities set forth in the Contractor's written Silica Exposure Control Plan.
 - 3. Engineer: The Port of Seattle Resident Engineer.
 - 4. Permissible Exposure Limit (PEL): A concentration of airborne respirable silica of 50 $\mu\text{g}/\text{m}^3$, calculated as an 8-hour time-weighted average (TWA_8).

5. Regulated area: An area, demarcated by the Contractor, where exposure to airborne concentrations of respirable crystalline silica exceeds, or can reasonably be expected to exceed, the PEL or AL.
6. WAC Silica Table 1: WAC 296-840, Safety Standards for Respirable Crystalline Silica, Table 1: Specified Exposure Control Methods When Working with Materials Containing Crystalline Silica.

1.03 GOVERNING CODES, STANDARDS, AND REFERENCES

- A. Washington State Department of Labor and Industries
 1. WAC 296-840 – Safety Standards for Respirable Crystalline Silica
 2. WAC 296-62-136 – Ventilation
 3. WAC 296-901 – Global Harmonized System for Hazard Communication
- B. Puget Sound Clean Air Agency
 1. Regulation I, Article 9, Section 9.15 – Fugitive Dust Control Measures
- C. U.S. Occupational Safety and Health Administration
 1. 29 CFR 1926.1153 – Respirable Crystalline Silica
 2. 29 CFR 1926.57 – Ventilation
- D. Associated General Contractors of Washington Education Foundation
 1. Guide to Handling Fugitive Dust from Construction Projects, Seattle, Washington, 1997

1.04 SCOPE OF WORK

- A. Fugitive Dust: All Construction work will potentially generate fugitive dust. It is the responsibility of the Contractor to control the release of fugitive dust by using a combination of reasonable precautions and best work practices.
- B. Silica: Construction work that requires control of silica shall include but not be limited to general demolition, chipping, sanding, tuck-point grinding, scabbling/scarifying, surface grinding, sawing, jackhammering on concrete building materials, cement mixing, dry sweeping of concrete dust, significant disturbance of and/or removal of non-asbestos fireproofing, and the activities listed in WAC 296-840, Safety Standards for Respirable Crystalline Silica, Table 1: Specified Exposure Control Methods When Working With Materials Containing Crystalline Silica.
- C. Work activities shall include the following, as applicable:
 1. Provision of site security to assure that no member of the public is able to gain access to the construction work area at any time. The Contractor shall maintain access and egress routes at all times.
 2. In accordance with WAC 296-840, the Contractor is responsible for determining if the activities being performed may reasonably be expected to release respirable silica at or above the PEL and AL. The Contractor shall use, but not be limited to, the following criteria to determine if the work being performed may reach or exceed the PEL or AL:
 - a. Determine if the activity is listed in WAC 296-840, Safety Standards

- for Respirable Silica, Table 1: Specified Exposure Control Methods When Working With Materials Containing Crystalline Silica.
- b. Type of work being performed.
 - c. Duration of work.
 - d. Work practices and engineering controls being used.
 - e. Previous air monitoring data from within the last 12 months on projects that were “essentially identical”.
 - f. Standard or site-specific written operating procedures.
 - g. Citation history regarding silica.
3. In the case of work that may generate silica dust at or above the PEL or AL, or that is listed in WAC Silica Table 1, the Contractor shall designate a Competent Person who shall:
 - a. Provide a written Silica Exposure Control Plan. The Plan shall be made available to the Port if requested.
 - b. Establish a regulated area.
 - c. Provide personal protective equipment and engineering controls as required by WAC 296-840.
 - d. If the activity is not listed in WAC Silica Table 1, conduct exposure evaluations to determine employee exposure to silica and implement feasible exposure controls to reduce employee exposure below the PEL. This may include the revision of work practices and engineering controls, and provision of personal protective equipment.
 - e. Ensure that exposure controls are being put in place and evaluated for effectiveness.
 4. Provision of best work practices to prevent the release of fugitive and silica dust outside of the work area, as described in the execution portion of this section, Part 3.
 5. Provisions for worker and equipment decontamination. Worker decontamination and equipment areas shall be cleaned daily or as required more frequently to prevent fugitive dust emissions.
 6. Protection of security, life safety, and energy management systems, including associated wiring, which shall remain operational throughout the work activities.
 7. Decontamination of work area(s). Concrete dust shall be cleaned from the work area using wet methods and HEPA vacuuming equipment at the completion of demolition activities, before barriers are removed.
 8. Water used for dust suppression or decontamination (provided it does not contain additional chemical contaminants) shall be controlled and disposed of as follows:
 - a. Slurry and residual dust shall be vacuumed during dust-generating operations.

- b. Slurry and residual dust shall not remain on permanent concrete or asphalt pavement overnight.
- c. Slurry and residual dust shall not drain to Storm Drain System (SDS), Industrial Waste System (IWS), or any other natural or constructed drainage conveyance.
- d. Collected slurry residual dust and debris are the responsibility of the Contractor and shall be disposed of off-site in a manner that does not violate groundwater or surface water quality standards.

1.05 PERSONAL PROTECTION

A. Respiratory Protection

- 1. Where activities with exposures to respirable crystalline silica are listed in WAC Silica Table 1, and the Table indicates that respiratory protection is required, workers shall be provided, at a minimum, with personally issued respirators equipped with high efficiency particulate air (HEPA) filters approved by NIOSH (99.97% efficient) that meet the assigned protection factor (APR) specified in the Table. Sufficient filters shall be provided for replacement as required by the workers or applicable regulations. Disposable respirators shall not be used.
- 2. Where activities with exposures to respirable crystalline silica are not listed in WAC Silica Table 1, and exposures may exceed the PEL or AL, workers shall be provided, at a minimum, with personally issued respirators equipped with HEPA filters approved by NIOSH (99.97% efficient) to be worn in the regulated work area. Sufficient filters shall be provided for replacement as required by the workers or applicable regulations. Disposable respirators shall not be used.
- 3. The Contractor shall comply with OSHA 29 CFR Part 1910.134 (Respiratory Protection), WAC 296-841-200 (Evaluate and control employee exposures to Airborne Contaminants), WAC 296-842 (Respirators), and ANSI/NIHA/ASSE Z88 (Respirator Package).
- 4. Worker exposure to respirable crystalline silica shall not exceed the PEL or AL. Worker exposure shall be determined by WAC Silica Table 1, the protection factor of the respirator worn, or an exposure assessment.
- 5. A sufficient supply of replacement parts and HEPA filter cartridges shall be provided to the workers.
- 6. The Contractor shall maintain daily inspection(s) of all respirators to verify cleanliness and to replace damaged, worn or missing parts.
- 7. Where respirators are used (in most cases a half-face respirator equipped with HEPA filters), a complete Respirator Program must be put in place in accordance with WAC 296-842. Such a program includes proper selection, fit-testing, cleaning and maintenance, supervision, training, and a written procedure.

B. Protective Clothing:

- 1. Workers shall be provided with sufficient sets of protective full-body clothing to be worn in the regulated work area whenever a potential exposure to respirable crystalline silica concentrations above the PEL or

- AL exists. Such clothing shall include, but not be limited to, coveralls and eye protection.
2. Protective clothing shall not be worn outside the work area. Non-disposable-type protective clothing and footwear shall be left in the work area.
 3. Eye protection shall be provided and worn as required by applicable safety regulations. Equipment shall conform to ANSI Z87.1-2015.
 4. Head Protection: Hard hats or other head protection shall be provided as required by applicable safety regulations. Hard hats shall conform to ANSI Z89.1-2014, Type I or Type II.
 5. Foot Protection: Nonskid footwear shall be provided to all workers. Footwear shall conform to ANSI F2412/2413-05.
 6. Workers shall not eat, drink, smoke, or chew gum or tobacco in or near the respirable silica work areas.

1.06 SUBMITTALS

- A. The Contractor shall provide complete submittals in accordance with Section 01 33 00 - Submittals and as specified below.
- B. Preconstruction Submittals: Prior to conducting any work which is listed in WAC Silica Table 1 or may result in any exposure to silica above the PEL or AL, provide a site-specific Silica Exposure Control Plan which demonstrates the methods by which this work will be performed. At a minimum, the Silica Exposure Control Plan shall include:
 1. A description of the tasks in the workplace that involve exposure to respirable crystalline silica.
 2. A description of the engineering controls, work practices, and respiratory protection used to limit employee exposure to respirable crystalline silica for each task.
 3. A description of the housekeeping measures used to limit employee exposure to respirable crystalline silica.
 4. A written description of the annual review of the Silica Exposure Control Plan.
 5. A description of the procedures used to restrict access to work areas, when necessary, to minimize the number of employees exposed to respirable crystalline silica and their level of exposure, including exposures generated by other employers or sole proprietors.
 6. If exposure monitoring will be conducted, a description of the exposure monitoring procedures.
 - a. The exposure monitoring procedures shall include the proposed sampling plan, sampling procedures, and field quality control procedures of the firm conducting the air monitoring.
- C. Construction Phase Submittals
 1. Air sample data sheets and laboratory analytical results, including chain of custody.

2. Supervisor daily inspection report, including scope of work completed, engineering controls used, hours worked, and equipment and materials used.

D. Post-Construction Closeout Submittals

1. **Project Overview:** Provide a basic project summary identifying the scope and summarizing the work performed by the Contractor. Provide enough information to have a basic understanding of the project and include project and contact names and ID numbers; Contractor's company name; where, when, and what type of work was completed; and a discussion of significant problems encountered during the course of the work.
2. **Certification:** Provide written certification from the Contractor's Project Manager or Supervisor that the Contractor has fully inspected the work area and completed work in strict accordance with the Specifications.
3. **Air Monitoring:** Submit documentation of all Contractor air monitoring results relative to regulatory compliance. Include copies of all air monitoring data sheets, chain-of-custody documentation and analytical reports for sampling conducted at the site.
4. **Project Record Documents:** Provide project records including documentation of all contract changes, and copies of work site entry log books, safety logs, sign-in sheets, and supervisor daily field reports. Provide copies of project meetings for pre-construction, construction period, and project closeout meetings.
5. Submit copies of inspections or visits by regulatory agencies. Include copies of any citations or notices received by the Contractor from regulatory agencies during the course of the project.

1.07 SILICA AIR SAMPLING EVALUATION BY CONTRACTOR

- A.** If the Contractor determines that activities being performed are not listed in WAC Silica Table 1 and may reasonably be expected to release respirable silica at or above the PEL or AL, the following shall apply:
1. The Contractor shall conduct air sampling of workers and subcontractors for respirable crystalline silica. The Contractor shall submit a description of their exposure monitoring procedures as part of its Silica Exposure Control Work Plan.
 2. The Contractor shall conduct personal air sampling for respirable silica in accordance with National Institute for Occupational Safety and Health (NIOSH) Method 7500 or equivalent. Sample volume shall be sufficient to determine if worker exposure to respirable crystalline silica is below the PEL. If analysis of the samples indicates concentrations are above the PEL, the Contractor shall determine the cause of the overexposure and revise work practices and engineering controls to reduce exposures to below the PEL. The Contractor is required to conduct re-sampling and analysis at no expense to the Port of Seattle.
 3. Results of air samples collected by the Contractor shall be submitted to the Engineer within 48 hours following receipt of analytical results.

PART 2 MATERIALS AND EQUIPMENT

2.01 EQUIPMENT

- A. Provide suitable tools for dust collection and water-jet dust suppression systems.
- B. Provide sufficient number of HEPA-filtered vacuum cleaners to clean-up visible dust residues.
- C. Air filtration devices shall utilize high efficiency particulate absolute (HEPA) filtration systems bearing a UL 586 label indicating its ability to perform under specified conditions. Provide filters marked with the name of the manufacturer, serial number, airflow rating, efficiency and resistance, and the direction of the test airflow. Units shall have two stages of pre-filtering, as follows:
 - 1. The first stage pre-filter shall be a low efficiency type for particle sizes 100 micrometers and larger.
 - 2. The second stage pre-filter shall be a medium efficiency type effective for particle sizes down to 5 micrometers.
 - 3. Pre-filters shall be installed either on or in the intake grid to the exhaust unit and shall be held in place with special housings or clamps provided by the manufacturer.
- D. Air filtration devices shall also include:
 - 1. An elapsed time meter showing the total accumulated hours of operation.
 - 2. An electrical interlock preventing operation of the unit without a HEPA filter.
 - 3. An automatic shutdown system to stop the fan in case of a rupture in the HEPA filter or a blocked air discharge.
 - 4. Warning lights to indicate normal operation (green); moderately high pressure drop across the filters, such as due to filter overloading (yellow); and too high of a pressure drop due to an overloaded or ruptured HEPA filter or obstructed discharge (red).
 - 5. An audible alarm if the unit shuts down due to operation of the safety systems.
 - 6. Electrical components approved by the National Electrical Manufacturers Association (NEMA) and the Underwriter's Laboratories (UL). Each unit shall be equipped with overload protection sized for the equipment. The motor, fan, fan housing, and cabinet shall be properly grounded.

PART 3 EXECUTION

3.01 CONTROL METHODS

- A. Options for the control of fugitive and silica concentrations are given in the following paragraphs. The specific method(s) used shall be detailed in the submittals and approved by the Engineer.
- B. Wet Method
 - 1. Use best management practices for the control of fugitive dust. This may include but is not limited to the following:

- a. The use of control equipment, enclosures, and wet (or chemical) suppression techniques, as practical, and curtailment during high winds.
 - b. Treating temporary, low-traffic areas (e.g., construction sites) with water or chemical stabilizers, reducing vehicle speeds, constructing pavement or rip rap exit aprons, and cleaning vehicle undercarriages before they exit to prevent the track-out of mud or dirt onto paved public roadways.
 - c. Covering or wetting truck loads or allowing adequate freeboard to prevent the escape of dust-bearing materials.
 2. For activities that may generate airborne silica or fugitive dust, use “wet” systems that eliminate or reduce dust generated and tools that include dust control features where possible. Clean up sludge and/or waste immediately following its generation.
- C. Enclosure Method
1. Use enclosures as listed in Section 01 50 00 - Temporary Facilities and Controls in conjunction with air filtration devices, as described in paragraph 2.01.D. Air shall be moved through the filtration unit at a minimum of 1,500 cubic feet per minute (CFM). Provide HEPA filtered vacuum units to control dust at the point of dust generation, and use tools that include dust control features where possible.
- D. Negative Air Pressure Systems
1. If visible levels of dust emissions are observed outside the work area, provide differential air pressure systems for each work area.
 2. Construct an enclosure that encompasses the work area.
 3. Exhaust air shall only be vented to locations approved by the Port. The Contractor shall provide on-site certification of the negative pressure units to document adequate filtration efficiency for all units exhausting internally within the building or as otherwise required by the Port. Testing may need to be repeated if the unit(s) or their filtration systems have been repaired or replaced during the course of the work, following movement between zones, or if damage has occurred since the units were previously tested. Certification shall be by DOP or Portacount testing and signed by an independent tester or the Contractor's trained Health and Safety personnel. DOP testing shall verify an in-situ efficiency of 99.97% or greater. Portacount testing shall verify an in-situ efficiency of 99.3% or better. The tester(s) shall show knowledge of the testing procedures and limitations to the satisfaction of the Port, including but not limited to knowledge of test modes, variability of results, calibration techniques, and equipment operating procedure. Where knowledge or testing procedures are deemed inadequate, a Professional Engineer or Certified Industrial Hygienist shall sign test results.

3.02 OVERSIGHT

- A. An environmental consultant (Consultant) may be retained to advise the Engineer in all matters pertaining to the work performed in accordance with these specifications and requirements. Where an outside consultant is not hired, Port

personnel will serve as this Consultant. References to the Consultant herein shall include the outside Consultant or Port personnel.

- B. The Consultant will act as the Engineer's liaison in technical matters involving the fugitive dust and silica-related work.
- C. The Consultant is authorized by the Engineer to have free access to work areas where silica and fugitive dust may be generated, to assist in interpretation of procedures, and to advise on all provisions of the contract documents pertaining to the control of dust.
- D. The Consultant will advise the Engineer to stop work if in the course of performing their monitoring duties, they observe an instance of substantial nonconformance with the Contract Documents and/or a situation presenting a nuisance to the public or a health hazard to workers, Port employees, or the public. Work shall not resume until corrective measures have been enforced. Instances of substantial non-conformance shall include but not be limited to the following:
 - 1. Visible dust emissions outside of the work area barriers.
 - 2. Loss of negative pressurization (where negative pressure is used).
 - 3. Activities or misconduct affecting worker or building occupant safety.
 - 4. Breaches of containment that could substantially damage building life safety systems.
- E. If poor work practices are observed, the Consultant/Port shall direct the Contractor to make the necessary corrections. If appropriate corrections are not made, or if an immediate threat that silica or fugitive dust could be released outside the work area exists, work shall be stopped. The decision to stop work shall be made by the Engineer.
- F. The Consultant may perform air sampling for silica inside and outside the work area during the Project. The Contractor shall cooperate fully with the Consultant and ensure the cooperation of his workers during collection of air samples and work area inspections.
- G. The Consultant's role in advising the port on environmental health matters does not relieve the Contractor's obligation to comply with all applicable health and safety regulations promulgated by the federal, state, or local governments. Air monitoring results generated by the Consultant shall not be used by the Contractor to represent compliance with regulatory agency requirements for monitoring of workers exposure to airborne silica, nor shall any other activity on the part of the Consultant represent the Contractor's compliance with applicable health and safety regulations.

3.03 WORK AREA ISOLATION AND CLEANUP

- A. The Contractor shall continuously endeavor to eliminate the release of fugitive dust and silica into adjacent building spaces.
- B. Work areas where fugitive dust and silica-containing materials will be disturbed shall be isolated from other parts of the building with 6 mil polyethylene critical barriers on all doors, windows, and work area penetrations. Other methods may be approved upon written requests. Coordinate with Section 01 50 00 - Temporary Facilities and Controls for additional information regarding barriers to the public.

- C. The work areas will be considered clean when all visible dust and debris has been removed.

3.04 RECORD KEEPING

- A. The Contractor shall maintain, for at least 30 years, a record of the Project. Furnish one copy to the Engineer in an electronic format as part of the post-construction closeout submittals. The record shall include the following information:
 - 1. The starting and completion dates of the project.
 - 2. A copy of all analytical results.
 - 3. Copies of negative pressure documentation records (as required).
 - 4. The name and address of the analytical laboratory used for silica analyses.
 - 5. The name, address, and social security number (last 4 digits only) of all persons who were engaged in activities that may generate airborne silica or fugitive dust.

PART 4 MEASUREMENT AND PAYMENT

4.01 PAYMENT

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.
- B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

End of Section

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of "Concrete Form" Work is shown in the Contract Documents.

1.02 GOVERNING CODES, STANDARDS, AND REFERENCES

- A. American Concrete Institute (ACI)
 - 1. ACI 347 – Guide to Formwork for Concrete (current edition)
- B. National Institute of Standards and Technology (NIST)
 - 1. U.S. Voluntary Product Standard PS-1 Structural Plywood (current edition)

1.03 SUBMITTALS

- A. Submit materials data in accordance with Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.
- B. Submittals shall include the following:
 - 1. Formwork and Falsework:
 - a. Drawings indicating the proposed formwork, falsework, and shoring construction in detail, including:
 - (1) Size of the members
 - (2) Spacing of supports, studs, walers, stringers, collars, wedges, bolts, bracing
 - (3) Designed rates of pour.
 - b. Manufacturer's recommended safe working loads for form ties, column clamps, she bolts and associated equipment.
 - c. Manufacturer's recommendation on method and rate of application of form releasing agents.
 - d. In the event that a patented form system is to be used for concrete forms, submit the complete concrete forming details for approval.
 - e. Formwork, falsework, and shoring calculations stamped by a Professional Engineer licensed in the State of Washington.
 - 2. Formwork and Falsework Sequence:
 - a. Method of formwork removal
 - b. Expected formwork removal timeline
 - c. Sequence of falsework and shoring removal, including any reshoring
- C. Do not construct falsework and forms until the drawings have been approved by the Engineer. Approval by the Engineer will not relieve the Contractor of responsibility for the sufficiency of the falsework and forms.

PART 2 MATERIALS

2.01 PROJECT INFORMATION

2.02 PREPARATION FOR MATERIALS

2.03 FABRICATION, PRODUCTION, & SUPPLY OF MATERIALS

- A. Materials for concrete forms may be new or used. The quality of the materials, not the age or previous usage, will be the determining factor as to their suitability.
- B. Construct all concrete forms and falsework of stress-gradable materials.

2.04 MATERIAL REQUIREMENTS

A. Job-Built Forms

1. Wood Forms:

- a. Framing lumber shall be of standard dimensions and of size and quality to meet the requirements of the stresses applied.
- b. Use Medium Density Overlay, Plywood U.S. Product Standard PS-1, for all exposed concrete forms.
 - (1) The plywood shall be exterior type without splits or knotholes and sanded smooth. The face grain of the plywood shall run perpendicular to the studs or joists.
 - (2) Plywood shall not be less than 1/2 inch thick except where curved areas require the use of 1/4 inch thick material. When 1/4-inch thick material is used, it shall be backed with heavier material.
- c. Shiplap, square-edged boards, or tongue-and-groove sheathing may be used for forming unexposed concrete surfaces.
- d. Where indicated on the drawings, metal, fiberglass, or other special form lining must be used to create the desired surface texture.

2. Steel Forms:

- a. Steel forms to be fabricated at the site shall be approved by the Engineer prior to construction.
- b. Forms for round columns or shafts shall consist of self-supporting metal shell or tube which will give a smooth, even surface.
- c. Forms which produce a spiral appearance or those made of wood shall not be used except as approved by the Engineer.

3. Miscellaneous Forms:

- a. Aluminum, fiberglass, paper, fiberglass, micarta, asphalt-impregnated fiber and other miscellaneous form materials shall be approved prior to construction.

B. Prefabricated Forms

- 1. All prefabricated forms, whether they are part of a patented system or custom-fabricated, shall be approved by the Engineer prior to assembly.

C. Form Liners and Coatings

1. Line, coat, or treat forms with a suitable form-releasing agent to ensure their timely removal with minimum damage to the concrete.
2. Form releasing agents shall be commercial formulations that will not bond with, stain or adversely affect concrete surfaces.
3. Agents shall not impair subsequent treatment of concrete surfaces depending upon bond or adhesion nor impede the wetting of surfaces to be cured with water or curing compounds.
4. If special form liners are to be used, follow the recommendation of the form coating manufacturer.

D. Form Ties and Accessories

1. Form ties shall be manufactured items with stress values published.
2. Form ties shall have a pre-measured, break-back, weakened area so that ties can be removed within 3/4-inch of the concrete surface.
3. Tie rods for use with she bolts shall be set back 1-1/2 inches from the concrete surface. Tie-rod steel shall have published stress values.
4. Wire ties and wood spacers will not be allowed.
5. Corner brackets, column clamps and other specialized accessories shall be utilized in accordance with the manufacturer's recommendations.
6. Quick-release mechanisms, wedges, screw jacks, blocking, eccentric toggle levers, or other equipment shall be according to the approved drawings.

E. Shoring and Falsework

1. General: Materials for shoring, falsework, mudsills, or structural staging shall be sized according to the approved drawings. The use of steel scaffold-type falsework, when approved by the Engineer, shall be furnished, erected and braced in strict accordance with the manufacturer's recommendations.
2. Friction Collars and Clamps: The capacity of friction-supported forms shall be established by tests that are guaranteed by the manufacturer. Tests shall be conducted with the same material and the same configuration as will be used on the Project. Satisfactory use of the friction collar or clamp on previous projects of similar design will be considered sufficient test data.

2.05 MATERIAL HANDLING, DELIVERY, & STORAGE

2.06 DELIVERABLES

2.07 QUALITY ASSURANCE

A. Design Criteria:

1. The design, engineering, and construction of the formwork is the responsibility of the Contractor.
2. Design concrete forms, falsework, and shoring in accordance with methodology of ACI 347 for anticipated construction loads, vibration, lateral pressures, stresses, sequence of placement, and schedule resulting from placement and vibration of concrete in the Project's conditions.

3. For calculating the strength required of falsework and forms, 1 cubic foot of standard weight concrete is assumed to weigh 160 pounds.
 4. Unless noted otherwise, the maximum allowable design deflection shall be 1/500th of the span for walls exposed to public view, 1/360th of the span for exposed beams or slabs and 1/270th of the span for all other concrete.
- B. All form and falsework drawings shall bear the seal of a Professional Engineer licensed in the State of Washington.
- C. Where provisions of pertinent codes and standards conflict with these specifications, the more stringent provisions shall govern.

PART 3 EXECUTION

3.01 PROJECT INFORMATION

3.02 PREPARATION FOR EXECUTION OF WORK

3.03 EXECUTION OF WORK

A. General

1. Set falsework and forms to allow for structural camber plus an allowance for shrinkage and settlement. The finished concrete shall conform to the lines and grades indicated on the drawings.
2. Provide wedges, jacks, or similar devices to ensure uniform take-up or release of the forms and falsework. Do not place wedges where they will be subject to undue bearing stress.

B. Form Installation

1. Replace any forms that exhibit evidence of defects that would impair the quality of the resulting concrete surface.
2. All forms shall be mortar-tight.
3. All joints in surfaces of forms used on exposed surfaces shall be vertical or horizontal unless specifically noted otherwise.
4. Prior to final setting or placing of reinforcing steel, forms for exposed concrete surfaces shall be treated with a bond-breaker or parting compound. Apply the compound at a rate recommended by the manufacturer to provide a smooth surface free of dusting action caused by the chemical reaction of the compound.
5. Forms may be set with a slight bevel or draft for easy removal, where approved by the Engineer. Use 3/4-inch chamfer strips on exposed inside and outside corners unless noted otherwise.
6. Standing water in the forms will not be permitted.
7. Clean the forms immediately prior to placing of concrete.

C. Tolerances for Formed Surfaces

1. Variation from the plumb:

a. In the lines and surfaces of columns, piers, walls and in arises	1/4 inch in any 10 feet of length
b. For exposed corner columns, control-joint grooves, and other conspicuous lines	1/4 inch in any 20 feet of length
2. Variation from the level or from the grades indicated on the drawings:	
a. In slab soffits, ceilings beam soffits, and in arises, measured before removal of supporting shores	1/4 inch in any 10 feet of length 3/8 inch in any bay or in any 20 feet of length
b. In exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines	1/4 inch in any bay or in any 20 feet of length Maximum for entire length: 1/2 inch
3. Variation of the linear building lines from established position in plan	1/2 inch in any 10 feet
4. Variation of distance between walls, columns, partitions	1/4 inch per 10 feet of distance, but not more than 1/2 inch in any one bay, and not more than 1 inch total variation
5. Variation in the sizes and locations of sleeves, floor openings, and wall openings	Minus 1/4 inch, plus 1/2 inch
6. Variation in cross-sectional dimensions of columns and beams and in the thickness of slabs and walls	Minus 1/4 inch, plus 1/2 inch
7. Footings:	
a. Variation of dimensions in plan	Minus 1/2 inch, plus 2 inches when formed or plus 3 inches when placed against unformed excavation
b. Misplacement of eccentricity	2 percent of the footing width in the direction of misplacement but not more than 2 inches
c. Reduction in thickness	Minus 5 percent of the specified thickness
8. Variation in steps:	
a. In a flight of stairs	Riser: 1/8 inch
b. In consecutive steps	Riser: 1/16 inch

D. Form Removal

1. The minimal time required for concrete to reach a strength adequate for removal of formwork without risking the safety of workers or the quality of the concrete depends on a number of factors including, but not limited to, ambient temperature, concrete lift heights, type and amount of concrete admixture, and type and amount of cementitious material in the concrete. It is the responsibility of the Contractor to consider all applicable factors and leave the forms in place until it is safe to remove them. In any case forms shall not be removed unless the criteria of this section have been met.
2. Do not remove or release forms without the approval of the Engineer.
3. Provided that the average temperature remains 50°F or higher, forms and falsework shall remain in place in accordance with the time specified in the following table:

STRUCTURE COMPONENT	TYPE I CEMENT	TYPE III CEMENT
Footing side forms	24 hrs. **	
Wall faces & columns (not yet supporting loads)	3 days	
Mass pier or abutment face forms (not yet supporting loads)	3 days	
Beam or pile cap side forms	3 days	24 hrs.
Supporting falsework or soffit forms for slabs, spandrel beams, cross beams and T-beam girders	14 days	5 days*
Supporting falsework or soffit forms for pile caps or beams	14 days	64 hrs.

*Or 80% of design strength if no loads are to be applied.

**Provided that a curing compound is applied immediately. Do not apply the curing compound to a construction joint surface area between footing and column or wall or to any reinforcing steel. Wet-curing may be utilized in lieu of curing compound; however, at no time during the removal of the forms and the subsequent curing period shall the surfaces of the concrete be allowed to become dry.

4. Do not release forms from under concrete that has been cured at a temperature under 50°F without first determining if the concrete has gained adequate strength, without regard to the time cure time.
5. In areas where the surface of the concrete will be exposed to sea water or soil, do not remove the forms for a period of 30 days for Type 1 cement, seven days for Type III cement, or longer if required by the Engineer.

6. In multi-storied structures, remove the column forms prior to constructing forms for the next lift.
- E. Falsework and Shoring:
1. Do not use beams or slabs as a portion of the falsework or shoring in a manner that will create higher stresses than the design load will.
 2. Do not use beams or slabs as support for the falsework or shoring prior to their attainment of full concrete strength.
 3. When placed against the ground, support falsework on driven piling or mudsills and posts.
 - a. If approved by the Engineer, place mudsills on undisturbed soil or on soil compacted to 95% of maximum density as determined by compaction control tests.
 - b. Do not use mudsills in areas where the resulting soil pressures will exceed 3,000 pounds per square foot nor the allowable bearing pressure stated in the applicable geotechnical report, if available.
 4. Cribbing or stacking of blocking will not be allowed.
 5. Reshoring shall be accomplished in conformance with the Engineer-approved plan.
 6. Do not remove or release falsework without the approval of the Engineer.
 7. Do not release falsework or shoring under beams and slabs until the concrete has reached its design strength when the beam or slab is utilized as a portion of the falsework.

3.04 DELIVERABLES

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.

B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the

Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

End of Section

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of "Concrete Reinforcement" Work is shown in the Contract Documents. .

1.02 GOVERNING CODES, STANDARDS, AND REFERENCES

- A. American Concrete Institute (ACI)
 - 1. ACI 315 - Manual of Standard Practice for Detailing Reinforced Concrete Structures (current edition)
 - 2. ACI 318 - Building Code Requirements for Structural Concrete (current edition) (current edition)
 - 3. ACI SP-66 – ACI Detailing Manual
- B. American Society for Testing and Materials (ASTM)
 - 1. ASTM A82 - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement (current edition)
 - 2. ASTM A185 - Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete (current edition)
 - 3. ASTM A416 - Standard Specification for Steel Strand, Uncoated Seven Wire for Prestressed Concrete (current edition)
 - 4. ASTM A615 - Standard Specification for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement (current edition)
 - 5. ASTM A706 - Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement (current edition)
 - 6. ASTM A775 - Standard Specification for Epoxy-Coated Steel Reinforcing Bars (current edition)
- C. International Code Council (ICC)
 - 1. International Building Code (IBC) as adopted by the Seattle-Tacoma International Airport Building Department.
- D. Concrete Reinforcing Steel Institute (CRSI)
 - 1. Manual of Standard Practice (current edition)

1.03 SUBMITTALS

- A. Submit materials data in accordance with Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.
- B. Submittals shall include the following:
 - 1. Material Testing and Inspection:
 - a. Submit certified tests reports of reinforcement steel showing that the steel complies with the applicable specifications for each steel shipment and identified with specific lots prior to placement. Tests to be submitted include

- (1) Tension tests
 - (2) Chemical analyses
 - b. Submit testing agency reports for radiographic examination of welds.
- 2. Reinforcement Shop Drawing:
 - a. Layout of all pretensioning, posttensioning, and mild reinforcement, including:
 - (1) Reinforcement types
 - (2) Reinforcement sizes and lengths
 - (3) Clear distances as necessary
 - (4) Reinforcement bend diagrams
 - b. Mill certifications for each type of reinforcement
- 3. Installation Inspection Report:
 - a. Provide reports per Section 01 45 29 - Quality Control; Testing Laboratory Services and Section 01 45 16.13 - Contractor's Quality Control Program as applicable.
- C. Do not deliver concrete reinforcement to the job site until receipt of shop drawings approval from the Engineer.

PART 2 MATERIALS

2.01 PROJECT INFORMATION

2.02 PREPARATION FOR MATERIALS

2.03 FABRICATION, PRODUCTION, & SUPPLY OF MATERIALS

2.04 MATERIAL REQUIREMENTS

A. General

- 1. All concrete reinforcement materials shall be new and free from rust.

B. Deformed bars

- 1. Bars for reinforcement shall comply with the requirements of ASTM A615, Grade 60 deformed.
- 2. Where in-field bending of partially embedded reinforcing is specifically noted in the drawings or where otherwise specified, reinforcement shall comply with the requirements of ASTM A706, Grade 60 deformed.
- 3. Epoxy-coated rebar shall be coated according to ASTM A775, including written certifications for coating material and coated bars,

C. Spiral Reinforcement

- 1. Wire for spiral reinforcement shall be hot-rolled ASTM 615, Grade 60.

D. Wire for Reinforcement

- 1. Wire for reinforcement shall comply with the requirements of ASTM A82.

- E. Welded Wire Fabric
 - 1. Wire fabric shall comply with the requirements of ASTM A185.
 - 2. For wire with a specified yield strength (f_y) exceeding 400 MPa 60,000 psi, f_y shall be the stress corresponding to a strain of 0.35 percent.
- F. Wire ties
 - 1. Wire ties shall be 16 gauge or heavier black annealed steel wire.
- G. Synthetic Fiber Reinforcement
 - 1. Synthetic fiber shall be polypropylene with a denier less than 100 and a nominal fiber length of 50 mm 2 inches.
- H. Other Materials
 - 1. All other materials not specifically described but required for a complete and proper installation of reinforcement, shall be selected by the Contractor, subject to the approval of the Engineer.
 - 2. Supports
 - a. Bar supports for formed surfaces shall be designed and fabricated in accordance with CRSI Manual of Standard Practice and shall be steel or precast concrete blocks.
 - b. Precast concrete blocks shall have wire ties and shall be not less than 4 inches square when supporting reinforcement on ground.
 - c. Precast concrete block shall have compressive strength equal to that of the surrounding concrete.
 - d. Where concrete formed surfaces will be exposed to weather or where surfaces are to be painted, steel supports within 1/2 inch of concrete surface shall be galvanized, plastic protected or of stainless steel.
 - e. Concrete supports used in concrete exposed to view shall have the same color and texture as the finish surface.
 - f. For slabs on grade, supports shall be precast concrete blocks, plastic coated steel fabricated with bearing plates, or specifically designed wire-fabric supports fabricated of plastic.
 - g. Precast concrete supports shall be wedged-shaped, not larger than 3-1/2 by 3-1/2 inches, of thickness equal to that indicated for concrete cover and have an embedded hooked tie-wire for anchorage.
 - h. Supports for bars in concrete with formed surfaces exposed to view or to be painted shall be plastic-coated wire, stainless steel or precast concrete supports.
 - i. Bar supports shall comply with the requirements of ACI SP-66.
 - j. Bar supports used in precast concrete with formed surfaces exposed to view shall be the same quality, texture and color as the finish surfaces.

2.05 MATERIAL HANDLING, DELIVERY, & STORAGE

A. Protection:

1. Protect reinforcement before, during and after installation and protect the installed Work and materials of other trades. Handle and protect all reinforcement per the applicable ASTM material standard.
2. Store in a manner to prevent fouling with dirt, grease and other bond-breaking coatings.
3. Use all necessary precautions to maintain identification after the bundles are broken.

B. Replacements:

1. In the event of damage, immediately make all repairs and replacements necessary to the approval of the Engineer at no additional cost to the Port.

2.06 DELIVERABLES

2.07 QUALITY ASSURANCE

A. General

1. Perform material tests, specified and required by applicable standards, by an approved laboratory and certified to demonstrate that the materials are in conformance with the specifications.
2. Tests, inspections, and verifications shall be performed and certified at the Contractor's expense.

B. Reinforcement Steel Tests

1. Mechanical testing of steel shall be in accordance with ASTM A370 except as otherwise specified or required by the material specifications.
2. Tension tests shall be performed on full cross-section specimens using a gage length that spans the extremities of specimens with welds or sleeves included.
3. Chemical analyses of steel heats shall show the percentages of carbon, phosphorous, manganese, sulphur and silicon present in the steel.

C. Radiographic Examination of Welds

1. Radiographic examination of welds shall be in accordance with ASTM E94 and shall be performed and evaluated by an approved testing agency adequately equipped to perform such services.

PART 3 EXECUTION

3.01 PROJECT INFORMATION

3.02 PREPARATION FOR EXECUTION OF WORK

A. Inspection:

1. Prior to installation of this section, carefully inspect the installed Work of other trades and verify that such Work is complete to the point where this installation may properly commence.

B. Order Lists:

1. Before ordering material, furnish all submittals for approval by the Engineer. Do not order material until such lists and bending diagrams have been approved. The approval of order lists and bending diagrams by the Engineer shall in no way relieve the Contractor of responsibility for the correctness of such lists and diagrams.

3.03 EXECUTION OF WORK

A. Reinforcing Steel Bars

1. Fabrication:
 - a. Bend all bars cold to the shapes indicated on the drawings unless otherwise approved by the Engineer.
 - b. Zinc-coated and epoxy-coated bars shall be mill-bent prior to coating.
 - c. Do not field-bend bars partially embedded in concrete except as indicated on the drawings or as approved by the Engineer.
 - d. Make bends and hooks in accordance with the applicable portions of the International Building Code and the CRSI Manual of Standard Practice.
2. Placing and Fastening:
 - a. Place all steel reinforcement accurately and hold firmly in the position indicated on the drawing during the placing and setting of concrete.
 - b. Tie bars at all intersections, except where spacing is less than one foot in each direction, and then tie alternate intersections.
 - c. Wire tie ends shall face away from the forms.
 - d. Provide the following minimum concrete covering of reinforcement:
 - (1) Concrete below ground deposited against forms: 2 inches
 - (2) Concrete deposited against earth: 3 inches
 - (3) Concrete elsewhere: As indicated on the drawings, or as required by ACI 318 where specific information is not provided.
 - e. Maintain the minimum distance from the forms by means of stays, blocks, ties, hangers, or other approved supports.
 - (1) Blocks for holding reinforcement from contact with the forms, shall be precast mortar blocks of compressive strength not less than 3750 psi of approved shape and dimensions, or approved metal chairs. Blocks are not permitted in pile caps or other structures exposed on the underside of a dock.
 - (2) Metal chairs which are in contact with the exterior surface of the concrete shall be plastic-coated or galvanized.
 - (3) Separate layers of bars by plastic chairs, by precast mortar blocks of compressive strength not less than 3750 psi, or by

other equally suitable devices. The use of pebbles, pieces of broken stone, brick, metal pipe, and wooden blocks will not be permitted.

- (4) The minimum spacing between bars shall be one bar diameter or one inch minimum, but not less than 1-1/3 times the maximum size of coarse aggregate.
- f. Place reinforcement, inspect, and obtain approval of the Engineer before placing concrete. Concrete placed in violation of this provision may be rejected and removal required, to be followed by placing of new reinforcing steel and concrete by the Contractor at no additional cost to the Port.
- g. In the event that conduits, piping, inserts, sleeves, or other items interfere with placing reinforcement as indicated on the drawings or as otherwise required, immediately consult the Engineer and obtain approval of new procedure before placing concrete.
- 3. Splicing:
 - a. Furnish all reinforcement in the full lengths indicated on the drawings. Splicing of bars, except when indicated on the drawings, will not be permitted without written approval of the Engineer. When approved, stagger splices as far as possible.
 - b. Unless shown otherwise, lap splice for with lengths as dictated by ACI 318, but no less than 18 inches.
 - (1) If bars are epoxy-coated, multiply minimum lap splice length by 1.5.
 - (2) Lapped bars shall be placed in contact and securely tied or spaced transversely apart to permit the embedment of the entire surface of each bar in concrete.
 - (3) Lapped bars shall not be spaced farther apart than one-fifth the required length of lap or 6 inches
 - c. Weld reinforcing steel only as indicated on the drawings unless authorized otherwise, in writing, by the Engineer.
 - (1) Welding shall be performed in accordance with Section 05 05 23 – Welding.
 - (2) When welding reinforcing bar splices, use low-hydrogen electrodes with preheat and interpass temperatures of not less than 200°F Clean welds of all slag.
 - d. Bar couplers shall be used only as indicated on the drawings unless authorized otherwise, in writing, by the Engineer.

B. Cleaning Reinforcement

- 1. Steel reinforcement, at the time concrete is placed around it, shall be free from loose rust or mill scale, oil, paint and all other coatings that will destroy or reduce the bond between steel and concrete.

3.04 DELIVERABLES

3.05 QUALITY ASSURANCE

A. Qualifications of Workers:

1. Provide at least one person who shall be present at all times during execution of this portion of the Work. This person shall be thoroughly trained and experienced in placing the types of concrete specified and shall direct all Work performed under this section.
2. Thoroughly trained and experienced journeyman concrete finishers shall be responsible for finishing of exposed surfaces.

B. Codes and Standards:

1. In addition to complying with all pertinent codes and regulations, comply with all pertinent recommendations contained in ACI 315.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by a Subcontractor (of any tier) or Supplier.

B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

End of Section

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of "Cast-In-Place Concrete" Work is shown in the Contract Documents.

1.02 GOVERNING CODES, STANDARDS, AND REFERENCES

- A. American Concrete Institute (ACI)
 - 1. ACI 211.1 - Recommended Practice for Selecting Proportions for Concrete (current edition)
 - 2. ACI 301.1 – Specification for Hot Weather Concreting (current edition)
 - 3. ACI 318 - Building Code Requirements for Structural Concrete (current edition)
- B. American Society for Testing and Materials (ASTM)
 - 1. ASTM C33 - Standard Specification for Concrete Aggregates (current edition)
 - 2. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens (current edition)
 - 3. ASTM C94 - Standard Specification for Ready-Mixed Concrete (current edition)
 - 4. ASTM C143 - Standard Test Method for Slump of Hydraulic Cement Concrete (current edition)
 - 5. ASTM C150 - Standard Specification for Portland Cement (current edition)
 - 6. ASTM C171 - Standard Specification for Sheet Materials for Curing Concrete (current edition)
 - 7. ASTM C187 - Standard Test Method for Amount of Water Required for Normal Consistency of Hydraulic Cement Paste (current edition)
 - 8. ASTM C260 - Standard Specification for Air Entraining Admixtures for Concrete (current edition)
 - 9. ASTM C494 - Standard Specification for Chemical Admixtures for Concrete (current edition)
 - 10. ASTM C827 - Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures (current edition)
 - 11. ASTM C989 - Standard Specification for Slag Cement for Use in Concrete and Mortars (current edition)
 - 12. ASTM C1107 - Standard Specification for Packaged Dry, Hydraulic Cement Grout (Nonshrink) (current edition)
 - 13. ASTM C1582 - Standard Specification for Admixtures to Inhibit Chloride-Induced Corrosion of Reinforcing Steel in Concrete (current edition)
- C. International Code Council (ICC)
 - 1. International Building Code (IBC) as adopted by Seattle-Tacoma International Airport Building Department (current edition).

- D. National Ready Mix Concrete Association (NRMCA);
 - 1. NRMCA Certification of Ready Mixed Concrete Production Facilities. Quality Control (QC) Manual (current edition)
 - 2. NRMCA Truck Mixer Manufacturer's Bureau (TMMB) 100 – Concrete Carrier Standards (current edition)
- E. Washington State Department of Transportation (WSDOT)
 - 1. WSDOT Standard Specifications for Road, Bridge, and Municipal Construction; and Amendments (current edition)
 - a. WSDOT 9-03 Aggregates
 - b. WSDOT 6-02.3(6)A Weather and Temperature Limits to Protect Concrete
 - c. WSDOT 9-25.1 Water for Concrete

1.03 SUBMITTALS

- A. Submit materials data in accordance with Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.
- B. Submittals shall include the following:
 - 1. Mix Design:
 - a. Proposed design mix for each class of concrete required for this portion of the Work, including admixture proportions
 - b. Expected mix design results, including compressive strength, air entrainment, and slump. If test data from previous usages of the same mix design is available, include previous test results.
 - c. Name and address of the proposed concrete supplier
 - d. Grading of coarse and fine aggregate
 - e. Type and specification of cement
 - f. Component manufacturer's name and product name or catalog number
 - g. Component manufacturer's certification of ASTM compliance, where applicable
 - h. Admixture manufacturer's recommended usage and guidelines
 - i. For plant-mix concrete, a supplier-provided certificate showing proportions and the seven-day strength of the concrete mix being furnished
 - 2. Non-Shrink Grout:
 - a. Manufacturer name and product name or catalog number
 - b. Manufacturer's certification of ASTM compliance
 - c. Manufacturer's recommended usage and installation guidelines
 - 3. Membrane:

- a. Manufacturer name and product name or catalog number
 - b. Manufacturer's recommended usage and guidelines
- 4. Quality Control Testing and Inspection: The Contractor shall coordinate the following inspection and tests described below with the Port of Seattle and in accordance to sections Section 01 45 29 - Quality Control; Testing Laboratory Services and Section 01 45 16.13 - Contractor's Quality Control Program. The results of these inspections and tests shall be submitted to the Engineer and the contractor shall take the action required by the Engineer.
 - a. Sampling and Testing of Materials:
 - b. Scales, Batching, and Recording:
 - c. Batch Plant Control:
 - d. Concrete Mixture:
 - e. Inspection Before Placing
 - f. Vibrators:
 - g. Curing Inspection:
 - h. Water Protection:
 - i. Mixer Uniformity:
 - j. Reports:
- 5. Inspection and Testing Report:
 - a. Reports per Section 01 45 29 - Quality Control; Testing Laboratory Services and Section 01 45 16.13 - Contractor's Quality Control Program.
- 6. Concrete Batch Ticket:
 - a. Approved batch tickets for each load of ready-mixed concreteb. Placement sequence when multiple pours are required
- 7. Concrete Placement:
 - a. Placement diagram showing extents of each class of concreteb. Placement sequence when multiple pours are required
- 8. Finishing Procedure:
 - a. List of materials and tools
 - b. Written procedure

PART 2 MATERIALS

2.01 PROJECT INFORMATION

2.02 PREPARATION FOR MATERIALS

- A. All associated formwork and reinforcing bars shall be properly placed, inspected, and approved as required by specification Section 03 11 00 – Concrete Forms and Section 03 21 00 – Concrete Reinforcement, respectively, prior to placement of concrete.

2.03 FABRICATION, PRODUCTION, & SUPPLY OF MATERIALS

2.04 MATERIAL REQUIREMENTS

A. General

1. All concrete shall meet the requirements of the current edition of the International Building Code. Where provisions of pertinent codes and standards conflict with this specification, the more stringent provisions shall govern.
2. All concrete is reinforced, unless stated otherwise. The amount of reinforcing shall not be less than the minimum required by the Code.

B. Concrete

1. Properties:
 - a. Concrete of the tabulated classes shall have the following properties unless specifically approved otherwise.

Class:	Minimum Compressive Strength	Minimum Sacks of Cement/C.Y.:^b	Maximum Water-Cement Ratio	Slump Limits:	Additional Requirements
E	$f'_c = 4000$ psi	6	0.47	3 1/2" max	

^a The minimum compressive strengths tabulated are the strength at 28 days for ordinary concrete, or the strength at seven days for high-early-strength concrete.

^b Mixes utilizing less cement may be approved upon submittal of compression test reports

^c Determined by mix design

- b. General intended placement types for each class uses are described in section 3.03.A.3
2. Cement:
 - a. All cement shall be Portland cement conforming to ASTM C150, Type I or III.
 - b. All cement shall be the product of one manufacturer.
 - c. Type III cement shall be used for all concrete unless the use of Type I cement is specifically authorized in writing by the Engineer. The use of Type I cement will be authorized only if the Contractor can demonstrate, by preparation of and adherence to a construction schedule approved by the Engineer, that the project will be completed within the stipulated contract time using the Type I cement.
 - d. The maximum water-cement ratios required in subparagraph Water-Cement Ratio will be the equivalent water-cement ratio as determined by conversion from the weight ratio of water to cement

plus pozzolan, silica fume, and ground granulated blast furnace slag (GGBF slag) by the weight equivalency method as described in ACI 211.1.

- e. Concrete made with coarse aggregate of "Grading No. 5" as described in WSDOT Standard Specification, paragraph 9-03.1(3)C, shall have an extra one-half sack of cement added to the minimum indicated in the table in section 2.04.A.1.
 - f. All classes of concrete may contain an appropriate amount of Fly Ash as a pozzolanic material.
 - (1) Concrete mix designs including Fly Ash, shall be prepared by a certified laboratory and have the approval of the Engineer prior to use.
 - (2) Pozzolan shall conform to ASTM C618, Class C or F, including low alkali, multiple factor, drying shrinkage, uniformity, and moderate sulfate resistance requirements in Table 3 of ASTM C618.
 - (3) If pozzolan is used in the concrete mixture, the minimum pozzolan content shall be 15 percent by weight of the total cementitious material, and the maximum shall be 35 percent.
 - g. If specifically approved by the Engineer or noted in the drawings and specifications, concrete may include ground granulated blast-furnace (GGBF) slag.
 - (1) GGBF slag shall comply with ASTM C989, Grade 120.
 - (2) If used, GGBF slag shall be as a 1:1 replacement of Portland cement, with not less than 15% nor more than 60% replacement.
 - h. If specifically approved by the Engineer or noted in the drawings and specifications, concrete may include silica fume.
 - (1) Silica fume shall conform to ASTM C1240. Available alkalis shall conform to the optimal limit given in Table 2 of ASTM C1240.
 - (2) Silica fume may be furnished as a dry, densified material or as a slurry.
 - (3) If used, provide at no cost to the Port the services of a manufacturer's technical representative experienced in mixing, proportioning, placement procedures, and curing of concrete containing silica fume.
3. Aggregates:
- a. Aggregates for standard Portland cement concrete shall conform to the quality requirements of the WSDOT Standard Specifications.
 - b. Aggregate for lightweight concrete shall be approved prior to the mix design. Lightweight aggregate shall have a maximum dry loose weight of 70 pounds per cubic foot.

- c. See section 2.04.A.2.d for requirements associated with WSDOT Standard Specification "Grading No. 5."
 - d. Maximum aggregate size for a given mix should not exceed:
 - (1) 1/5 the dimension of non-reinforced members.
 - (2) 3/4 the clear spacing between reinforcing bars or between reinforcing bars and forms.
 - (3) 1/3 the depth of nonreinforced slabs on the ground.
- 4. Water:
 - a. Water used for mixing concrete shall conform to the quality requirements of WSDOT Standard Specifications, paragraph 9-25.1
- 5. Admixtures:
 - a. All admixtures shall be supplied by one manufacturer and approved by the Engineer.
 - b. Use all admixtures in strict accordance with the manufacturer's recommendations, including proportioning and procedures.
 - c. Air-Entraining Agents shall be BASF MB VR, MB AE-10, W.R. Grace product, Or Approved Equal, conforming to ASTM C260. Where guidance is not provided by the manufacturer, added to obtain 4-1/2% entrained air.
 - d. Water-Reducing Agents shall conform to ASTM C494, Type A for water-reducing, Type D for water-reducing and retarding, and Type E for water-reducing and accelerating.
 - e. Set Retarding Agents shall be BASF "Pozzolith 300R," W. R. Grace "Daratard," Or Approved Equal set-retarding admixture compliant with ASTM C494 at three to five fluid ounces per 100 pounds of cement as recommended by the manufacturer.
 - f. Accelerators shall be approved by the Engineer and shall comply with ASTM C494, Type C or E, except that calcium chloride or admixtures containing calcium chloride shall not be used.
- C. Non-Shrink Grout
 - 1. Use premixed and packaged, non-metallic grout conforming to ASTM C1107. The use of powdered aluminum will not be permitted without written permission of the Engineer.
 - 2. Grout shall be tested to comply with ASTM C827 for volume change, ASTM C187 and C143 for workability, and ASTM C39 for compressive strength.
- D. Moisture Retaining Membranes
 - 1. All curing membrane shall conform to ASTM C171, and may be white polyethylene film, a combination sheet polyethylene and paper, Or Approved Equal, approved in advance by the Engineer.
 - 2. All cement or tape used for sealing membrane joints shall be only as recommended by the manufacturer of the membrane being joined.

E. Other Materials

1. All other materials not specifically described but required for a complete and proper installation of cast-in-place concrete shall be as selected by the Contractor subject to the approval of the Engineer.

2.05 MATERIAL HANDLING, DELIVERY, & STORAGE

A. Protection:

1. Use all means necessary to protect cast-in-place concrete materials before, during, and after installation and to protect the installed Work and materials of all other trades.

B. Replacement:

1. In the event of damage, immediately make all repairs and replacements necessary to the approval of the Engineer and at no additional cost to the Port.

2.06 DELIVERABLES

2.07 QUALITY ASSURANCE

A. Independent Inspection and Testing:

1. The Port of Seattle will provide field or plant inspection and testing services to the satisfaction of the Engineer. Sampling and testing to assure compliance with the contract provisions shall be in accordance with Section 01 45 29 - Quality Control; Testing Laboratory Services.
2. The Contractor may obtain copies of results of tests performed by the Port of Seattle from the office of the Resident Engineer at no cost.
3. Tests conducted for the sole benefit of the Contractor shall be at the Contractor's expense.

B. Qualifications of Manufacturer:

1. Ready-mixed concrete plants shall be approved and certified by the Port Building Department.
2. Ready-mixed concrete shall be batched in accordance with the applicable portions of ASTM C94.

C. Control of Concrete Production:

1. All concrete, unless otherwise specifically permitted by the Engineer, shall be batched and mixed at an approved plant.
2. Concrete production shall be under supervision of the Port of Seattle Engineering Department.

D. Qualifications of Workers:

1. Provide at least one person who shall be present at all times during execution of this portion of the Work. This person shall be thoroughly trained and experienced in placing the types of concrete specified and shall direct all Work performed under this section.
2. Thoroughly trained and experienced journeyman concrete finishers shall be responsible for finishing of exposed surfaces.

PART 3 EXECUTION

3.01 PROJECT INFORMATION

3.02 PREPARATION FOR EXECUTION OF WORK

A. Inspection:

1. Prior to all Work of this section, carefully inspect the installed Work of all other trades and verify that all such Work is complete to the point where this installation may properly commence.
2. Verify that concrete may be placed to the lines and elevations indicated on the drawings with all required clearances for reinforcement. Where concrete clear cover is not shown on the drawings, ensure minimum clearances based on ACI 318 requirements.
3. Embedded Items
 - a. Before placement of concrete, determine that all embedded items are firmly and securely fastened in place in the location and orientation indicated on the drawings or required.
 - b. Conduit and other embedded items shall be clean and free of oil and other foreign matter such as loose coatings or rust, paint, and scale.
 - c. The embedding of wood in concrete will be permitted only when specifically authorized or directed.
 - d. Voids in sleeves, inserts, and anchor slots shall be filled temporarily with readily removable materials to prevent the entry of concrete into voids.
4. Verify completion and acceptance of all inspections required by the Engineer and/or Independent Testing Agency.

B. Cleaning:

1. Thoroughly clean all areas in which concrete is to be placed. Clean and roughen existing concrete or concrete from a previous pour to provide a bondable surface. Thoroughly wet down concrete forms which have not been treated with oils, waxes, or other bond breakers prior to placing concrete.
2. Clean all transporting and handling equipment of all hardened concrete.

C. Preparation of Previously Placed Concrete for Bonded Joints

1. Concrete surfaces to which additional concrete is to be bonded shall be prepared for receiving the next horizontal lift by cleaning the Construction joint surface with either air-water cutting, sandblasting, high-pressure water jet, or other approved method. Keep the surface of horizontal construction joints continuously wet for the first 12 hours during the 24-hour period prior to placing fresh concrete.
2. Prepare concrete at the side of vertical construction joints as approved by the Engineer.

3. Air-water cutting shall not be used on formed surfaces or surfaces congested with reinforcing steel.
 4. Regardless of the method used, the resulting surfaces shall be free from all laitance and inferior concrete so that clean surfaces of well bonded coarse aggregate are exposed and make up at least 10-percent of the surface area, distributed uniformly throughout the surface.
 5. The surface shall be washed completely clean as the last operation prior to placing the next lift.
 6. The edges of the coarse aggregate shall not be undercut.
- D. Discrepancies:
1. In the event of discrepancy, immediately notify the Engineer. Do not proceed with installation until all discrepancies have been fully resolved.
- E. Notification:
1. Notify the Engineer at least 48 hours in advance of concrete pour.

3.03 EXECUTION OF WORK

- A. Placing Concrete:
1. General:
 - a. Place concrete as soon as possible after mixing. Concrete shall be plastic and readily workable when placed in the forms. Concrete that does not reach its final position in the forms within 1-1/2 hours after the addition of cement shall not be used.
 - b. The method and manner of placing concrete shall not allow segregation of the aggregates or displacement of reinforcement.
 - c. Conveyor belts, when used, shall be limited to approximately 300 feet in length to prevent segregation and shall be covered to protect the concrete from sun or rain.
 - d. Do not use aluminum conduits or tremis for pumping or placing concrete.
 - e. Place concrete in continuous horizontal layers and compact so that there will be no line of separation between layers. Carefully fill each part of the forms by depositing concrete directly at or as near as possible to the final position.
 - f. When concrete must be dropped more than five feet into the forms, it shall be deposited through approved conduit. Approved conduit shall also be used to place concrete in sloping forms or in other locations, as directed, to prevent concrete from sliding around reinforcing or other embedments.
 - g. In general, the method of depositing and compacting concrete shall be conducted to form a compact, dense, impervious concrete with the required surface and a minimum of segregation. Remove defective concrete as directed by the Engineer at no additional cost to the Port. "Plastering" will not be permitted.

- h. Do not place concrete where other Work in the area, such as the driving of piling or sheets, or other vibratory action, will adversely affect the initial set or strength of the concrete.
- 2. Ready-Mixed Concrete
 - a. Ready-mix plant equipment and facilities shall be certified in accordance with NRMCA QC Section 3.
 - b. Ready-mixed concrete shall be batched, mixed, and transported in accordance with ASTM C94, except as otherwise specified.
 - c. Truck mixers, agitators, and nonagitating transporting units shall comply with NRMCA TMMB 100.
 - d. Ready-mixed concrete shall be placed in its final position within 1-1/2 hours after the addition of cement.
 - e. Mix concrete only in such quantities as are required for immediate use and use while fresh before initial set has taken place. Concrete which has developed initial set shall not be used. Concrete which has partially hardened shall not be re-tempered or remixed.
- 3. Placement by Classification:
 - a. Class A concrete is to be used as precast-prestressed or post-tensioned concrete, for uses such as piling, deck, wall, or roof panels and other high-stress, heavily reinforced structures.
 - b. Class B concrete is to be used in the same type of structures as Class A except that the units will not be prestressed or post-tensioned.
 - c. Class C concrete is to be used for heavily reinforced structural members, such as pile caps, steel pile bulkhead caps, bull rails, etc.
 - d. Class D concrete is to be used for reinforced structural members, but only those which require placement in such a way or location that proper vibration or consolidation is questionable. The additional strength is required to overcome the doubtful placement technique.
 - e. Class E concrete is to be used in all other reinforced members or sections.
 - f. Class F concrete is to be used only in un-reinforced sections, such as footing blocks, mass pours, fence anchors, etc.
 - g. Class P or R concrete is to be used for paving runways, taxiways, ramps, etc.
 - h. Class X concrete is to be used for cast-in-place closure between the ends of deck panels or other areas which are highly reinforced or under extreme stresses.
 - i. Class Y concrete is to be used for cast-in-place shear keys between adjacent deck panels or similar locations.
- 4. Cold Weather Placement

- a. Do not place concrete on frozen ground or against frosted reinforcing steel or forms.
- b. Do not mix or place concrete while the atmospheric temperature is below 40°F.
- 5. Hot Weather Placement:
 - a. When job-site conditions are present or anticipated that accelerate the rate of moisture loss or rate of cement hydration of freshly mixed concrete, including an ambient temperature of 80 degrees F or higher, and an evaporation rate that exceeds 0.2 lb/ft²/h, concrete Work shall conform to all requirements of ACI 305.1.
- 6. Underwater Placement:
 - a. In no case place concrete in running water or in water with a temperature below 35 degrees F.
 - b. Whenever permission is given to place concrete under water, place concrete within the confines of a compartment, such as a cofferdam, tube, or caisson.
 - c. Method of placement, forms, confining structure, special concrete mix and all equipment shall have prior approval of the Engineer.
- 7. Vibration of Concrete:
 - a. Provide suitable internal vibrating tampers for use in placing and compacting all concrete except that which is placed under water. The vibrators shall be of the type designed to be placed directly in the concrete, and their frequency of vibration shall be not less than 7,000 impulses per minute when in actual operation. The type of vibrator and its method of use shall be subject to the approval of the Engineer.
 - b. Vibration shall be such that the concrete becomes uniformly plastic. Insert vibrators to a depth sufficient to vibrate the bottom of each layer effectively, but do not penetrate partially hardened concrete. Do not apply the vibrators directly to steel which extends into partially hardened concrete.
 - c. Do not continue vibration in any one spot until pools of grout are formed. In vibrating and finishing top surfaces which are exposed to weather or wear, extreme care shall be exercised to avoid drawing water or laitance to the surface. In relatively high lifts, the top layer shall be comparatively shallow and the concrete mix shall be as stiff as can be effectively vibrated into place and properly finished. Do not use vibrators to transport or move concrete inside the form.
 - d. Supply a sufficient number of vibrating tampers to effectively vibrate all of the concrete placed. Hand-tamping shall be required wherever necessary to secure a smooth and dense concrete on the outside surfaces.

B. Finishing Concrete Surfaces

1. Finish concrete surfaces in accordance with the procedure specified for each type of surface.
2. Unformed Surfaces:
 - a. Finish U-1: the top surface of footings, piers, columns, walls and other formed concrete which will ultimately receive additional concrete. The surface may contain shear keys, reinforcing steel, anchor bolts, or other embedments as indicated on the drawings.
 - (1) The surface shall be rodded across the grade strip or forms such that the resulting surface will have no irregularities, except shear keys, greater than the maximum-size aggregate. Grade strips, if used, are considered forms, and the accuracy of setting and the exposed appearance shall fall within the appropriate finish designation tolerances.
 - (2) Clean the surface of laitance, dirt, foul water, or other deleterious material to the satisfaction of the Engineer prior to placing additional concrete. If "green cutting" air and water jets are used to remove laitance, sufficient time shall have elapsed after the pour so as not to weaken the joint by loosening the top aggregate.
 - b. Finish U-2: the top surface of unexposed slabs, beams, buttresses, corbels, etc., which will not receive additional concrete and will not be exposed to view.
 - (1) The surface shall be rodded across the top of the forms or screeds and smoothed with a wood float to remove irregularities greater than 3/8 inch in depth or variations from a grade of more than 1/2 inch in ten feet.
 - c. Finish U-3: the top surface of exposed exterior slabs, such as sidewalks, porch decks, stair treads, driveways, approaches, etc.
 - (1) The surface shall be rodded across the screeds and smoothed with a "bull float" light steel trowel and broom-finished. The general surface shall have no irregularities greater than 3/16 inch in depth or variations in grade of more than 3/8 inch in ten feet. The broom stria shall be approximately 1/8 inch in depth. The slab shall be edged or patterned with a two-inch-wide edging tool having a 3/4-inch corner radius.
 - d. Finish U-4: the same as U-3 except that the maximum irregularity shall be 1/8 inch in depth and the broom stria shall be approximately 1/16 inch.
 - e. Finish U-5: the top surface of interior slabs or other shapes, exposed to public view or to receive a subsequent surface coating, treatment, or material. The ultimate use of this surface is for foot traffic, machinery, or furniture.
 - (1) The surface shall be rodded across the screeds and smoothed with a "bull float," the larger aggregate shall be depressed with a "jitter bug" or similar device; and the

surface shall be hand- or power-steel-troweled to a finish that has no irregularities greater than 1/32 inch in depth and shall not vary from a true plane by more than 1/8 inch in ten feet.

3. Formed Surfaces:

- a. Finish F-1: The formed surface created by boards, plywood, or steel sheets which may ultimately serve as a form for an additional concrete pour or as an unexposed side of a bulkhead, pier, or foundation wall. The surface may contain shear key, keyways, reinforcing steel, anchor bolts, or other embedments as indicated on the drawings.
 - (1) The surface shall have no treatment except for repair of rock pockets in excess of 3/4 inch deep and filling tie or she-bolt holes. The surface plane dimensions shall be within a tolerance of minus 1/2 inch or plus 1-1/2 inch of design dimensions.
 - (2) The surface shall be cleaned of laitance, dirt, or other deleterious material to the satisfaction of the Engineer prior to placement of additional concrete or special coating.
- b. Finish F-2: The formed surface created by boards, plywood, steel, or other sheets which may be exposed to industrial view.
 - (1) The surface shall have no treatment except for the repair of rock pockets greater than 1/2 inch in depth, the filling of tie or the bolt holes, and the removal of fins or other protrusions in excess of 3/8 inch.
 - (2) The surface plane dimensions shall be within a tolerance of minus 1/4 inch or plus 3/4 inch of design dimensions.
 - (3) The surface shall be cleaned of laitance, dirt, or other deleterious material to the satisfaction of the Engineer prior to placement of any coating or surface treatment.
- c. Finish F-3: The formed surface created by plywood, steel, or other sheets which may be exposed to public view.
 - (1) The surface shall be ground smooth to remove all fins and protrusions, all rock pockets and tie holes, and shall be repaired by dry-packing. All depressions shall be filled with a one-to-one sand cement grout and sack- or carpet-rubbed with a one-to-one sand/cement dry mix.
 - (2) The surface plane dimension shall be within a tolerance of plus or minus 1/4 inch of design dimensions, and the surface shall be free of irregularities greater than 3/16 inch in ten feet in any direction.

C. Curing Concrete

1. General

- a. Keep all concrete surfaces, except those on retaining walls, roadway slabs, sidewalk slabs and rail bases, continuously wet with water for not less than three days after the concrete is placed. This curing may be done by covering the surface with sand, cotton mats, burlap, or moisture-retaining membrane, or by wetting the outside surfaces of the forms.
 - b. Keep all other concrete continuously wet with water for not less than ten days when Type I cement is used and not less than three days when Type III cement is used.
 - c. Retaining walls may be cured by wetting the outside surfaces of the forms or covering the outside surfaces with white polyethylene sheeting.
2. Curing Compound Covered with Curing Sheet
- a. Application:
 - (1) Apply an epoxy-chlorinated, rubber-type curing compound to the fresh concrete immediately after finishing the concrete on roadway slabs, sidewalk slabs and roof slabs and as soon as the visible bleed water has evaporated or at such time as directed by the Engineer.
 - (2) The rate of coverage shall be at least one gallon per 100 square feet and sufficient to effectively obscure the original color of the concrete.
 - (3) Apply the curing compound in two applications to ensure full coverage of the concrete, with the second coat applied in a direction perpendicular to that of the first application.
 - (4) Care shall be taken to avoid getting any curing compound on construction joints or on exposed reinforcing steel. Curing compound on construction joints or reinforcing steel shall be completely removed before the following concrete pour.
 - (5) Use white-pigmented-type curing compound, except that when bonding other materials to the concrete surface is required, the clear-type curing material shall be used. Thoroughly agitate the white-pigmented-type curing compound immediately before and during application.
 - (6) Supply a separate work bridge, backup spray equipment and sufficient workmen to properly apply the curing compound.
 - b. Not later than ten-hours following the application of the curing compound, the top surfaces shall be covered with cotton mats, two-inches of clean sand, an approved vapor-proof curing paper, or white polyethylene sheeting. If the covering used is sand or cotton mats, it shall be kept continuously wet day and night for the period of time specified above, and if curing paper or plastic film is used, it shall be left in place for the same length of time.

- c. Curing paper and white polyethylene sheeting must be kept tightly in place by taping and weighting joints, or other methods as the Contractor may devise, for the prescribed length of time.
- d. Sprinkling, ponding, or covering with material other than clean sand, cotton mats, curing paper, or white polyethylene sheeting will not be allowed.
- e. Membrane curing compounds which leave a waxy film on the concrete will not be allowed.
- f. After the concrete has cured for the required time, the sand covering, if used, shall be removed and the slabs shall be swept clean.

3.04 DELIVERABLES

3.05 QUALITY ASSURANCE

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.

B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

End of Section

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of the "Concrete Unit Masonry" Work is indicated in the Contract Documents.

1.02 GOVERNING CODES, STANDARDS, AND REFERENCES

A. Governing Codes, Standards, and References:

1. Building Code Requirements and Specification for Masonry Structures (MSJC)
2. American Society for Testing and Materials (ASTM)
 - a. ASTM A82, Standard Specification for Steel Wire
 - b. ASTM A116, Standard Specification for Metallic-Coated, Steel Woven Wire Fence Fabric
 - c. ASTM A153, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
 - d. ASTM A615, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
 - e. ASTM B227, Standard Specification for Hard-Drawn Copper-Clad Steel Wire
 - f. ASTM C55, Standard Specification for Concrete Building Brick
 - g. ASTM C90, Standard Specification for Loadbearing Concrete Masonry Units
 - h. ASTM C129, Standard Specification for Nonloadbearing Concrete Masonry Units
 - i. ASTM C140, Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units
 - j. ASTM C270, Standard Specification for Mortar for Unit Masonry
 - k. ASTM C426, Standard Test Method for Linear Drying Shrinkage of Concrete Masonry Units
 - l. ASTM C476, Standard Specification for Grout for Masonry
 - m. ASTM C516, Standard Specification for Vermiculite Loose Fill Thermal Insulation
 - n. ASTM C549, Standard Specification for Perlite Loose Fill Insulation
 - o. ASTM C578, Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
 - p. ASTM C612, Standard Specification for Mineral Fiber Block and Board Thermal Insulation
 - q. ASTM D2240, Standard Test Method for Rubber Property—Durometer Hardness

- r. ASTM E72, Standard Specification Methods for Conducting Strength Tests of Panels for Building Construction
 - s. ASTM E90, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
 - t. ASTM E119, Standard Test Methods of Fire Tests of Building Construction and Materials
- 3. American Society of Heating, Refrigerating, and Air-Conditioning Engineers
 - a. ASHRAE, Fundamentals Handbook
- B. All Work shall comply with the applicable provisions of the 2018 International Building Code.

1.03 SUBMITTALS

- A. Submit materials data in accordance with Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.
- B. Submittals shall include the following:
 - 1. Mix Design and Test Results
 - a. One of the following for each mortar mix:
 - (1) Mix designs indicating type and proportions of ingredients in compliance with the proportion specification of ASTM C270, or
 - (2) Mix designs and mortar tests performed in accordance with the property specification of ASTM C270
 - b. One of the following for each grout mix:
 - (1) Mix designs indicating type and proportions of the ingredients according to the proportion requirements of ASTM C476, or
 - (2) Mix designs and grout strength test performed in accordance with ASTM C476, or
 - (3) Compressive strength tests performed in accordance with ASTM C1019, and slump flow and visual stability index (VSI) as determined by ASTM C1611/C1611M.
 - c. Material certificates for the following, certifying that each material is in compliance:
 - (1) Reinforcement
 - (2) Anchors, ties, fasteners, and metal accessories
 - (3) Masonry units
 - (4) Mortar, thin-bed mortar for AAC, and grout materials
 - (5) Self-consolidating grout
 - d. Construction procedures

- (1) Cold weather construction procedures
- (2) Hot weather construction procedures

PART 2 MATERIALS

2.01 PREPARATION FOR MATERIALS

2.02 MATERIAL REQUIREMENTS

A. Concrete Masonry Units

- 1. Use hollow load-bearing units conforming to the requirements of ASTM C90, Type I, Grade N, with nominal face dimensions of 8 inches x 16 inches.
- 2. Use hollow non-load-bearing units conforming to the requirements of ASTM C129 normal weight aggregate, Type I, with nominal face dimensions of 8 inches x 16 inches.

B. Mortar and Grout

- 1. Use mortar, for non-reinforced unit masonry, conforming to the property or proportion requirements of ASTM C270. Use Type S; fc 1800 psi.
- 2. Use mortar, for reinforced unit masonry, conforming to the requirements of ASTM C270. Use Type S; fc 1800 psi.
- 3. Use grout, for reinforced unit masonry, conforming to the requirements of ASTM C476, "Fine Grout" for filling voids with dimensions of less than 1-1/2 inches, "Coarse Grout" for filling voids with dimensions of 1-1/2 inches or larger. Grout shall have a minimum compressive strength of 2,000 psi.
- 4. As grout for filling cavities in reinforced unit masonry walls, lintels, bond beams, pilasters, or columns, use "Pea Gravel" Concrete, compressive strength of 2500 psi. Add water in the field to maintain a maximum slump of approximately 10 inches, but place no grout which has been mixed longer than 1-1/2 hours.

C. Reinforcement, Anchors, and Ties

- 1. Use masonry joint reinforcement that is factory-fabricated from zinc-coated, cold-drawn steel wire, ASTM A82. Use reinforcement consisting of two or more deformed longitudinal wires, minimum size No. 9 gage, weld-connected with minimum size No. 9 gage cross wires, forming a truss or ladder design. Zinc coating: ASTM A116, Class 1, except that cross wires used for cavity wall ties shall be Class 3. Arrange out-to-out spacing of longitudinal wires approximately one inch less than the nominal width of the block or wythe in which it is placed. Do not allow the distance between welded contacts of cross wires with each longitudinal wire to exceed 16 inches.
 - a. Furnish joint reinforcement in flat sections 10 to 20 feet in length, except that factory-formed corner reinforcements and other special shapes may be less.
- 2. Use steel bar reinforcement conforming to ASTM A615, Grade 60.

3. Use anchors and ties of zinc-coated ferrous metal of the types specified. Zinc coating shall be ASTM A153, Class B-1, B-2, or B-3, as applicable. Copper cladding of steel wire shall conform to the requirements as specified for Grade 30 HS wire in ASTM B227.
 - a. Wire Mesh Ties: 1/2-inch mesh of steel wire, minimum of 16 gage, minimum of 12 inches in length, and one inch less in width than wall in which placed.
 - b. Rigid-Steel Anchors: 1-1/2 inches by 1/4 inch with ends turned up minimum of two inches, not less than 24 inches long.
 - c. Cavity-Wall Ties: 3/16-inch diameter, formed in a rectangular shape four inches wide for hollow units laid with cells vertical and formed in a U or Z shape for solid units.
 - d. Dovetail Anchors: Minimum of 16 gauge, one inch wide, turned up 1/4 inch at outer end.
 - e. Corrugated or Crimped Metal Ties: Sheet steel not less than 7/8 inch wide, 22 gage in thickness.
 - f. Wire Ties Joint Reinforcement: 1/2-inch mesh of steel wire, minimum of 16 gauges, lengths as required.
 - g. Length of Ties: two inches shorter than combined thickness of cavity and walls but not less than six inches.
- D. Control Joint Resilient Keys
 1. Use a factory-fabricated solid section of natural or synthetic rubber, a combination thereof, plastic, or other rubber-like material. Durometer hardness shall be not less than 70 when tested in conformance with ASTM D2240. The key shall be shape indicated and of dimensions to completely fill and fit neatly, but without forcing, in masonry-unit jamb or sash grooves, and to provide a control joint width of 3/8 inch with a tolerance of 1/16 inch. The shear section shall be of a 5/8 inch minimum thickness.
- E. Insulation
 1. Water-Repellent Loose-Fill Masonry Insulation:
 - a. Perlite: ASTM C549, Type II (surface-treated for water repellency and limited moisture absorption).
 - b. Vermiculite: ASTM C516, Type II (surface-treated for water repellency and limited moisture absorption), Grade 3 (Fine), complying with 29 CFR 1926 by containing less than 0.1 percent by weight of asbestos and then demonstration shows will not release asbestos fibers in excess of 0.1 fibers per cubic centimeter.
- F. Dampproofing
 1. Siloxane penetrating, water repellent, "Euco weather-Guard" as manufactured by Euclid Chemical Company, "Klere-Seal 908-SX as manufactured by Pecora Corp., "Weatherseal Siloxane" as manufactured by ProSoCo, Inc. or approved equivalent.
- G. Certification

1. Furnish certificates, test reports, or other acceptable evidence that the masonry materials comply with specification requirements. Furnish certificates for the following materials:
 - a. Concrete Masonry Blocks
 - b. Grout
 - c. Mortar
 - H. Fire-Resistance Classification
 1. Concrete masonry walls and partitions shall have the fire-resistance ratings indicated on the drawings. Units shall be of the minimum equivalent thickness specified for the fire rating and corresponding aggregate type.
- 2.03 FABRICATION & SUPPLY OF MATERIALS
- 2.04 MATERIAL HANDLING & STORAGE
- A. Store masonry units above ground on level platforms which allow air circulation under stacked units.
 - B. Cover and protect against wetting prior to use.
 - C. Handle units on pallets or flatbed barrows.
 - D. Do not permit free discharge from conveyor units or transporting in mortar trays.
- 2.05 QUALITY ASSURANCE & INSPECTIONS

PART 3 EXECUTION

3.01 PROJECT INFORMATION

3.02 PREPARATION FOR EXECUTION

- A. Job Conditions
 1. Cold Weather Conditions:
 - a. Do not place concrete masonry units when the air temperature is below 40°F.
 - b. Protect in-place masonry construction from freezing by the use of enclosures, covers, or supplemental heat, or by a combination of the above, until the danger of temperature effect has passed.
 2. Hot Weather Conditions: Protect masonry construction from direct exposure to wind and sun when erected in an ambient air temperature of above 90°F in the shade with relative humidity of less than 50%.
 3. Dust Control: Use masonry saws equipped to collect masonry dust while cutting the units.
 4. Adhesives: Labeled pint container of each type.
 5. Resilient Key Material: six-inch length of each type.

3.03 EXECUTION OF WORK

- A. General

1. Lay only dry Type I masonry units. Type II units need not be dry where installed underground or below the water table.
 2. Use masonry saws to cut masonry units for proper fit.
 3. Run bond with vertical joints located at center of masonry units in alternate course below, unless indicated otherwise.
 4. Set units plumb, true to line and with level courses accurately spaced.
 5. Adjust masonry unit to final position while mortar is soft and plastic.
 6. If units are displaced after mortar has stiffened, remove them, clean the joints and units of mortar, and re-lay the units with fresh mortar.
 7. Adjust shelf angles to keep masonry level and at proper elevation.
 8. Provide pressure-relieving joints by placing a continuous 1/8-inch foam neoprene pad under the shelf angle and seal joint with sealant specified in Section 07 92 00 - Joint Sealers, of these specifications.
 9. When joining fresh masonry to set or partially set masonry construction, clean the exposed surface of set masonry and remove loose mortar prior to laying fresh masonry.
 10. If necessary to stop off a horizontal run of masonry, rack back one-half block length in each course.
 11. Do not use toothing to join new masonry to set or partially set masonry when continuing a horizontal run.
 12. Keep chases and raked-out joints free from mortar or debris.
 13. Solidly fill spaces around metal door frames and other built-in items with mortar or grout.
 14. Install anchors, wall plugs, accessories, flashings and other items to be built in as the masonry Work progresses.
- B. Protection of Work
1. Protect sills, ledges and offsets from mortar drippings or other damage during construction.
 2. Remove misplaced mortar or grout immediately.
 3. Cover the top of walls with non-staining, waterproof, protective coverings when Work is not in progress.
 4. Provide a minimum 2-foot overhang of protective covering on each side of each wall, and securely anchor, when Work is not in progress.
 5. Protect face materials against staining.
- C. Mortar Beds
1. Hollow Units:
 - a. Lay with full mortar coverage on horizontal and vertical face shells.
 - b. Provide full mortar coverage on horizontal and vertical face shells and webs in all courses of the following:

- (1) Piers, columns and pilasters.
 - (2) Starting course on footings and solid foundation walls.
 - (3) Where adjacent to cells or cavities to be filled with grout or concrete.
 2. Solid Units: Lay with full mortar coverage on horizontal and vertical joints.
- D. Reinforcing
1. General: Accurately cut to length all reinforcement and bend by methods that will prevent damage to the material. Before placing bars in the masonry, straighten, without damage to the material, all kinks or bends in the bars caused by handling incidental to delivery.
 2. Joint Reinforcement: Place masonry joint reinforcement so that longitudinal wires are located over face-shell mortar beds and are fully embedded in mortar for their entire length with a minimum mortar cover of 5/8 inch on the exterior side of walls and 1/2 inch at other locations. Extend joint reinforcement at openings no less than 24 inches beyond the end of sills or lintels or to the end of the panel if the distance to the end of the panel is less than 24 inches. Joint reinforcement shall not be continuous through a control joint or an expansion joint. Lap joint reinforcement six inches or more. Install factory-fabricated sections at corners and wall intersections.
 3. Placing Reinforcement:
 - a. Minimum Bar Spacing: The minimum clear distance between parallel bars, except in columns, shall be equal to the nominal diameter of the bar.
 - b. Splices in Reinforcement: Make splices only at such points and in such a manner that the structural strength of the member will not be reduced. Provide sufficient lap using lapped splices to transfer the working stress of the reinforcement by bond and shear. The minimum lap shall be 30-bar diameters. Develop the strength of the reinforcement with welded or Splices in Reinforcement: Make splices only at such points and in such a manner mechanical connections.
 - c. Protection for Reinforcement: Completely embed all bars in mortar or grout. Provide all reinforcement with a coverage of masonry not less than the following:
 - (1) Three inches for bottom of footings.
 - (2) Two inches on vertical members where masonry is exposed to action of weather or soil for bars larger than 5/8 inch, and 1-1/2 inches for bars 5/8 inch or less.
 - (3) 1-1/2 inches for all reinforcement in columns.
 - (4) 1-1/2 inches on bottom and sides of beams or girders.
 - (5) 3/4 inch from faces of all walls not exposed to action of weather or soil.

- (6) One-bar diameter over all bars, but not less than 3/4 inch at upper faces of any member, except where exposed to weather or soil, in which cases minimum coverage shall be two inches or three inches, respectively.
- (7) 5/8 inch at exposed face of wall for reinforcement consisting of bars or wire 1/4 inch or less in diameter embedded in the horizontal mortar joints.
- (8) 1/4 inch between masonry units and reinforcement, except that 1/4-inch bars may be laid in 1/2-inch horizontal mortar joints, and No. 6 gage or smaller wires may be laid in 3/8-inch horizontal joints. Vertical joints containing both horizontal and vertical reinforcement shall be not less than 1/2 inch larger than the sum of the diameters of the horizontal and vertical reinforcement contained therein.

E. Joints

- 1. Horizontal and Vertical Face Joints:
 - a. Nominal thickness: 3/8 inch.
 - b. Construct uniform joints.
 - c. Shove vertical joints tight.
 - d. Cut joints flush in surfaces to be plastered, stuccoed, or covered with other masonry or other surface-applied finish other than paint.
 - e. Point joints tight in masonry below ground.
 - f. Tool joints in exposed or to-be-painted surfaces when thumb-print hard with round jointer.
 - g. Remove mortar protruding more than 1/2 inch into cells of cavities to be reinforced or filled.
 - h. Fill horizontal joints with mortar between the top of masonry partitions and the underside of concrete slabs or beams.
- 2. Collar Joints: Except in cavity walls, fill with mortar by back-parging either facing or backing wythe and shoving, or by grouting.

F. Grouting

- 1. Do no grouting until hollow masonry walls have been constructed for a minimum of four hours; fill vertical cells full of grout, where indicated, making no lifts or pours more than 48 inches in height. Puddle or vibrate grout to ensure that voids are filled as required. Clean and wet the surface of the preceding pour before making new pours; if grouting is stopped for more than one hour, form a horizontal construction joint by stopping the pour 1-1/2 inches below the top of the uppermost masonry unit.

G. Bonding

- 1. Bond the facing and backing of multiple-wythe masonry walls, load-bearing and non-load-bearing, in accordance with the following methods:

- a. **Bonding with Metal Ties:** Bond the facing and backing (adjacent wythes) of masonry walls with cavity wall ties or metal wire of equivalent stiffness embedded in the horizontal mortar joints. Provide a minimum of one 3/16 wire tie for not more than each 4-1/2 square feet of wall area, or one corrugated tie for not more than each two square feet of wall area. Stagger ties to alternate courses embed them in the face shell of hollow units. The maximum vertical distance between ties shall not exceed 24 inches, and the maximum horizontal distance shall not exceed 36 inches. Use rods or ties bent to rectangular shape with hollow masonry units laid with the cells vertical. In other walls, bend the ends of ties to 90 degree angles to provide hooks not less than two inches long. Provide additional bonding ties at all openings, spaced not more than three feet apart around the perimeter and within 12 inches of the opening.
 - b. **Bonding with Prefabricated Joint Reinforcement:** Bond the facing and backing (adjacent wythes) of masonry walls with prefabricated joint reinforcement. There shall be one cross wire serving as a tie for not more than each two square feet of wall face area. The vertical spacing of the reinforcement shall not exceed 16 inches. Thoroughly embed the longitudinal wires in the mortar.
 2. **Bonding Faced or Composite Walls:** Bond faced or composite walls as provided, or where the facing and backing are bonded by means of masonry headers, extend such headers not less than three inches into a hollow masonry backup unit designed to receive and provide mortar bedding for the header. The thickness of masonry units used as facing shall be not less than two inches and in no case less than 1/8 the height of the unit.
 3. **Bonding Hollow Units in Cavity Walls:** Bond the facing and backing of cavity walls as required in subparagraph A.1. or subparagraph A.2. above.
 4. **Masonry Laid in Stack Bond:** Provide masonry units laid in stack bond with continuous prefabricated joint reinforcement or other steel bar or wire reinforcement embedded in the horizontal mortar beds at vertical intervals not to exceed 16 inches.
- H. **Weepholes**
1. Provide in mortar joints of exterior wythes of cavity walls.
 2. Install along bottoms of cavities over foundations, bond beams, and other waterstops in the wall.
 3. Space 32 inches o.c.
 4. Keep free of mortar and other obstructions.
 5. Cover the cavity side of weepholes with copper or plastic insect screen cloth before placing loose-fill masonry insulation between wythes.
- I. **Anchorage**
1. **General:** Securely anchor all structural elements depending upon one another for continuity or support.

2. Intersection of Walls and Partitions: Securely anchor or bond masonry walls and partitions, at points where they meet or intersect, by one of the following methods:
 - a. Bonding: Bond walls by:
 - (1) Laying at least 50% of the units at the intersection in a masonry bond, with alternate units having a bearing of not less than three inches upon the unit below; or,
 - (2) Metal ties, joint reinforcement, or anchors, as indicated.
 - b. Interior Non-Load-Bearing Walls: Anchor interior non-load-bearing walls at their intersections, at vertical intervals of not more than two feet in centers, with metal ties extending at least four inches into the masonry, or with other ties which provide an equivalent method of anchorage.
 3. Walls Carried Up Separately: Where the courses of meeting or intersecting walls are carried up separately, make corner intersections by regularly tothing or blocking with eight-inch maximum offsets and provide the joint with rigid steel anchors. The maximum vertical spacing of such anchors shall be four feet. Space other metal ties, joint reinforcement or anchors, if used, to provide equivalent anchorage at the intersection to that required by this section. Similarly bond other intersections, except that the masonry bond may be omitted.
 4. Walls Adjoining or Intersecting Structural Framing: Anchor curtain walls, panel walls, or other walls dependent upon the structural frame for lateral support, to the structural members with flexible metal anchors, or otherwise key to the structural members.
 5. Anchorage of Furring: Anchor masonry furring to the backing with hardware cloth ties extending at least 1-1/4 inches into the facing and backing or by an equivalent means of anchorage. Space ties not farther apart than 24 inches vertically and 36 inches horizontally. Powder-actuated fasteners may be used in accordance with Department of Labor and Industry standards.
- J. Built-in Work
1. Install bolts, anchors, nailing blocks, inserts, frames, vents, flashings, conduit and other built-in items as masonry Work progresses.
 2. Solidly grout spaces around built-in items.
 3. Unless noted otherwise on the drawings, provide outside joint around exterior door and window frames and other framed wall openings as follows:
 - a. Width: 1/4 inch to 3/16 inch.
 - b. Rake (and tool smooth) to a uniform depth as required by the sealant manufacturer.
- K. Control Joints
1. Provide control joints in accordance with the locations and details indicated on the drawings and construct the joints by using special control-joint units,

open-end stretcher units, or metal-sash-jamb units and control-joint key. Extend control joints through bond beams, unless otherwise indicated. On the exposed-to-view faces of interior walls, rake control joints to a depth of 3/8 inch and neatly tool square and smooth and caulk as indicated.

L. Insulated Masonry Walls

1. General: Insulate exterior cavity walls, where indicated, by completely filling the cells of the inner wythe with loose-fill insulation or by installing board-type insulation on the cavity side of the inner wythe as indicated on drawings. Completely bring up insulation to the elevations indicated for the underside of door and window sills, bond beams, lintels, through-wall flashing, and similar interruptions through the cavity before installing these items.
 - a. Loose-Fill Insulation: Pour the insulation from the top of each height of wall section completed and allowed it to assume its natural density. Do not tamp loose-fill insulation.
 - b. Board-Type Insulation: Apply directly to the masonry with adhesive. Neatly fit insulation between obstructions without impaling the insulation on cavity-wall ties or anchors. Apply the insulation in parallel courses with joints breaking midway over the course below, apply in moderate contact with adjoining units without forcing, and cut to fit neatly against adjoining surfaces.

M. Masonry and Precast Concrete Sills and Coping

1. Set with faces plumb and true in a full bed of mortar; except, for precast concrete sills with lugs, provide mortar beds under the ends of the sills only until completion of the walls, at which time solidly fill the remainder of the bed joint under the sill with mortar and tool it smooth on the exposed face. Use dowels to attach coping to masonry walls. Build in flashing, as specified elsewhere, or provide for its installation later in accordance with the details. Make dowel holes and other openings in flashing watertight with mastic waterproofing compound. Provide expansion joints and caulking where indicated.

N. Lintels

1. Furnish and place precast concrete or concrete masonry lintels of the type and dimensions shown and of the quality specified herein. Extend lintels at least eight inches beyond edge of openings and firmly bed them at bearings in mortar of the same quality as used in laying the wall. Where ends of lintels are at control joints, level the bed joint at such ends and cover it with a sheet of 16-ounce smooth copper with edges cut back 1/2 inch from face of wall, and rake out the bed and end joint for caulking.

O. Bond Beams

1. Bond beams shall consist of load-bearing units filled with concrete or grout and reinforced as indicated. Reinforcement shall be continuous except through expansion joints. Where the bond beam is not broken at the control joint, form a dummy control joint in the bond beam.

P. Bearing Plates

1. Set bearing plates for beams, joists, joist girders and similar structural members to the proper line and elevation with damp-pack bedding mortar, except where non-shrink grout is indicated.

Q. Chases

1. Build chases in; do not cut.
2. Minimum installation distance from jambs of openings: one concrete masonry unit length.

R. Pointing and Cleaning

1. At final completion of unit masonry Work, fill holes in joints and tool.
2. Do not fill weepholes.
3. Cut out and repoint defective joints.
4. Dry-brush masonry surface after mortar has set at the end of each day's Work and after final pointing.
5. Leave Work and surrounding surfaces clean and free of mortar spots and droppings.

S. Tolerances

1. Bed Joint: Thickness $\pm 1/8$ inch, level $\pm 1/4$ inch in 10 feet with $1/2$ inch maximum.
2. Head Joint: Thickness $\pm 1/8$ inch, vertical alignment $\pm 1/4$ inch in 10 feet with $1/2$ inch maximum.
3. Vertical Wall Alignment: $\pm 1/4$ inch in 10 feet with $1/2$ inch maximum per floor and 1 inch maximum for total height.
4. Horizontal Wall Alignment: $\pm 1/4$ inch in 10 feet with $1/2$ inch maximum.

T. Dampproofing

1. Verify that surfaces are dry, clean, free from all dirt, rust and other foreign matter and ready to receive treatment.
2. Mask surfaces to receive caulking or sealants specified elsewhere.
3. Apply dampproofing material in strict accordance with the manufacturer's recommendations for the conditions of the application, but not less than 600 square feet per gallon for the first coat and 200 square feet per gallon for the second coat.
4. When painting is specified, apply the second coat of dampproofing after painting.
5. Allow dampproofing to dry for twenty-four hours before proceeding with other Work.

3.04 QUALITY ASSURANCE

- A.** Inspection and Testing: Sampling and testing to assure compliance with the contract provisions shall be in accordance with Section 01 45 29 - Quality Control; Testing Laboratory Services of these specifications. The Contractor may obtain copies of results of tests performed by the Port of Seattle from the office of the

Resident Engineer at no cost. Tests conducted for the sole benefit of the Contractor shall be at the Contractor's expense

- B. Testing and Inspection for Contractor Quality Control: The Contractor shall perform the inspection and tests described below and, based upon the results of these inspections and tests, shall take the action required and shall submit specified reports.
1. Field Testing of Mortar:
 2. Field Testing of Grout:
 3. Efflorescence Test:
 4. Prism Test:
 5. Reports:

3.05 DELIVERABLES

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

- A. For incidental work:
- No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by a Subcontractor (of any tier) or Supplier.
- B. For Work separately paid:
- The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

End of Section

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of the “Post-Installed Concrete Anchor” Work is indicated in the Contract Documents. The post-installed anchors in concrete includes drilled and bonded dowels, expansion anchors, drop-in anchors, and other epoxy-based and mechanical anchors.

1.02 GOVERNING CODES, STANDARDS, AND REFERENCES

- A. American Concrete Institute (ACI)
 - 1. ACI 301 - Specifications for Structural Concrete, latest edition (current edition)
 - 2. ACI 315 - Manual of Standard Practice for Detailing Reinforced Concrete Structures (current edition)
 - 3. ACI 318 - Building Code Requirements for Structural Concrete (current edition)
 - 4. ACI 355.2 – Qualification of Post-Installed Mechanical Anchors in Concrete (current edition)
- B. American Society of Testing and Materials (ASTM)
 - 1. ASTM-C881 “Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete” (current edition)
- C. International Code Council (ICC)
 - 1. International Building Code (IBC) as adopted by the Seattle-Tacoma International Airport Building Department (current edition)
 - 2. ICC Evaluation Services (ICC-ES) Report for the selected systems

1.03 SUBMITTALS

- A. Submit materials data in accordance with Section 01 33 00 - Submittals. Furnish manufacturers’ technical literature, standard details, product specifications, and installation instructions for all products.
- B. Submittals shall include the following:
 - 1. Manufacturer’s Literature
 - a. Manufacturer’s name
 - b. ICC-ES Report
 - c. Complete material specifications
 - d. Requirements for storage, handling and mixing of the product
 - e. Manufacturer’s installation instructions, including specifications for this particular Work regarding surface preparation, installation, curing and any other requirement.
 - f. Installer Qualifications & Procedures:
 - (1) Installer qualifications and certifications.

- (2) Letter of procedure stating method of drilling, the product proposed for use, the complete installation procedure, manufacturer training date, and a list of the personnel trained on anchor installation.
2. Installer Qualifications
 - a. List of certified installers for drilled and bonded dowels, including documentation of certification for type of installation Work found on the project
3. Inspection and Testing Reports
 - a. As noted in Section 3.05.

PART 2 MATERIALS

2.01 PROJECT INFORMATION

- A. SEE DRAWINGS FOR REQUIREMENTS.

2.02 PREPARATION FOR MATERIALS

- A. Prepare per Manufacturer's requirements.

2.03 FABRICATION, PRODUCTION, & SUPPLY OF MATERIALS

2.04 MATERIAL REQUIREMENTS

- A. Material
 1. Bolts and Studs: ASTM A307; ASTM A449 where "high strength" is indicated on the Drawings.
 2. Carbon and Alloy Steel Nuts: ASTM A563.
 3. Carbon Steel Washers: ASTM F436.
 4. Carbon Steel Threaded Rod: ASTM A36
 5. Wedge Anchors: ASTM A510; or ASTM A108.
 6. Stainless Steel Bolts, Hex Cap Screws, and Studs: ASTM F593.
 7. Stainless Steel Nuts: ASTM F594.
 8. Zinc Plating: ASTM B633.
 9. Hot-Dip Galvanizing: ASTM A153.
 10. Reinforcing Dowels: ASTM A615, Grade 60
- B. Screw Anchors: Unless noted otherwise, screw anchors shall comply with the following:
 1. Material: Carbon steel, heat treated.
 2. Finish: Zinc plated or mechanical galvanized.
 3. Provide anchors with a diameter and anchor length marking on the head.
 4. Provide one of the following: Hilti "HUS-H", Simpson "TITEN HD", Dewalt "Screw-Bolt" Or Approved Equal.

- C. Mechanical anchors: Unless noted otherwise, expansion anchors shall comply with the following:
 - 1. Compliant with ACI 355.2 and ICC-ES approved, with confirming evaluation report.
 - 2. ICC-ES approved for use in cracked concrete, unless otherwise approved by the Engineer.
 - 3. ICC-ES approved for use in seismic conditions, unless otherwise approved by the Engineer.
 - 4. Provide anchors with length identification markings conforming to ICC ES AC01 or ICC ES AC193.
 - 5. Interior Use: Unless otherwise indicated on the Drawings, provide carbon steel anchors with zinc plating in accordance with ASTM B633, Type III Fe/Zn 5 (SC1).
 - 6. Exterior Use:
 - a. Provide stainless steel anchors. Stainless steel anchors shall be AISI Type 304 stainless steel provided with stainless steel nuts and washers of matching alloy group and minimum proof stress equal to or greater than the specified minimum full-size tensile strength of the externally threaded fastener.
 - b. Stainless steel nuts shall conform to ASTM F594 unless otherwise specified.
 - c. Avoid installing stainless steel anchors in contact with galvanically dissimilar metals.
 - 7.
- D. Drilled and Bonded Dowels and Anchors:
 - 1. Dowels shall conform to the requirements for concrete reinforcement as specified in Section 03 21 00 – Concrete Reinforcement.
 - 2. Anchors shall be ICC-ES approved, with confirming evaluation report.
 - 3. Epoxy adhesive for bonding dowels and anchors to concrete shall conform to ASTM-C881, "Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete." Type, grade and class of the system shall be as selected by the Contractor for the specific application and ambient temperature conditions.
 - 4. Epoxy adhesive for bonding dowels and anchors to concrete shall have ICC-ES approval for compliance with the IBC using the selected dowel or anchor in the following conditions:
 - a. Shear and tensile loads
 - b. Cracked and uncracked normal-weight concrete
 - 5. Interior Use:
 - a. Unless otherwise indicated on the Drawings, provide carbon steel threaded rods conforming to ASTM A36.

6. Exterior Use:
 - a. Provide stainless steel anchors. Stainless steel anchors shall be AISI Type 304 stainless steel provided with stainless steel nuts and washers of matching alloy group and minimum proof stress equal to or greater than the specified minimum full-size tensile strength of the externally threaded fastener.
 - b. All nuts shall conform to ASTM F594 unless otherwise specified.
 - c. Avoid installing stainless steel anchors in contact with galvanically dissimilar metals.
7. Reinforcing dowels shall be A615 Grade 60.

2.05 MATERIAL HANDLING, DELIVERY, & STORAGE

- A. Materials shall be handled and stored in strict accordance with the Manufacturer's recommendations, including humidity and temperature conditions.
- B. Epoxy adhesives used shall be within their shelf-life as noted on the packaging.

2.06 DELIVERABLES

2.07 QUALITY ASSURANCE

- A. Certifications: Unless otherwise authorized by the Engineer, anchors shall have one of the following certifications:
 1. ICC ES Evaluation Report indicating conformance with current applicable ICC ES Acceptance Criteria.

PART 3 EXECUTION

3.01 PROJECT INFORMATION

3.02 PREPARATION FOR EXECUTION OF WORK

- A. All Work shall be conducted in strict accordance with the manufacturer's recommendations and ICC-ES Evaluation Report requirements. If those recommendations are in conflict with this Specification, the Contractor shall bring it to the attention of the Engineer for resolution prior to beginning this portion of the Work.
- B. Prior to start of dowel installation, carefully inspect the Work area. Verify that the conditions indicated on the drawings exist in the field. Immediately bring conflicts or changes to the attention of the Engineer, who shall resolve such conflicts.
- C. If reinforcing bars to be installed are epoxy-coated, embedment portion of bars shall be thoroughly cleaned of epoxy prior to installation. Bars may be sand-blasted or cleaned by other means that does not damage the reinforcing, but thoroughly removes all epoxy from the surface of the reinforcing bar.

3.03 EXECUTION OF WORK

- A. Drilling Of Holes:
 1. Drill holes using a percussion-type drill. Provide the drill with an automatic device to stop at the required depth. In the absence of manufacturer-recommended criteria, use the following criteria:

- a. Do not allow the diameter of the drill hole to exceed the diameter of the dowel by less than 1/4 inch or more than 1/2.
 - b. Ensure that the depth of the hole is within +1/2 inch and -0 inch of the depth indicated on the drawings.
 2. Core drilling will not be permitted.
 3. Locate holes to miss existing reinforcing steel as needed. If reinforcing steel is encountered such that specified embedment depth cannot be achieved, locate a new hole not closer than 3 inches away, or the minimum allowed anchor spacing as noted in the ICC-ES Evaluation Report, whichever is greater. Grout failed location solid with cementitious grout. Prior to re-drill, get approval of the proposed new location by the Engineer.
- B. Dowel And Anchor Installation
1. Thoroughly clean and prepare drill holes per the epoxy manufacturers specifications. Remove loose or cracked pieces of concrete. Blow holes clear with oil-free compressed air to remove all dust, debris and water.
 2. Place and apply epoxy adhesive and dowel strictly per the epoxy manufacturer's specifications. Strictly adhere to the manufacturer's instructions regarding handling, mixing, pot life, and placement.
- C. Repair Of Defective Work
1. Remove and replace misplaced or malfunctioning anchors.
 2. Fill empty anchor holes and patch failed anchor locations with high-strength non-shrink, nonmetallic grout per Section 03 30 00 – Cast-in-Place Concrete.
 3. Anchors that fail to meet proof load or installation torque requirements shall be regarded as malfunctioning.

3.04 DELIVERABLES

3.05 QUALITY ASSURANCE

- A. Conflicting Requirements
1. In the event of conflict between pertinent codes and regulations and the requirements of the referenced standards or these specifications, the Engineer shall be notified and shall render a decision as to which requirements govern. The Contractor shall comply with the requirements selected by the Engineer as if they were the sole requirements of the contract. The Contractor shall not receive additional compensation for the requirements selected.
- B. Qualification of Workers
1. Provide at least one (1) person who shall be present at all times during execution of this portion of the Work and who shall be thoroughly trained and with at least three years of experience in the use of post-installed anchors and who shall direct all Work performed under this section.
 2. For drilled and bonded dowels, installers shall be shall have successfully completed the ACI Adhesive Anchor Certification Program.

- C. Installer Training
 - 1. Conduct a thorough training with the manufacturer or the manufacturer's representative for the installer on the project.
 - 2. Training to consist of a review of the complete installation process for drilled-in anchors, to include but not limited to:
 - a. Hole drilling procedure.
 - b. Hole preparation & cleaning technique.
 - c. Adhesive injection technique & dispenser training / maintenance.
 - d. Rebar dowel preparation and installation.
 - e. Proof loading/torqueing.
- D. Inspection and Testing
 - 1. See Special Inspection Requirements on the Drawings.
 - 2. At a minimum, periodic special inspection shall be conducted in accordance with Chapter 17 of the IBC Continuous special inspection shall be conducted if required by the selected product's ICC-ES Evaluation.
 - 3. Contractor shall coordinate all inspections with the Port of Seattle to provide field or plant inspection and testing service to the satisfaction of the Engineer. Sampling and testing to assure compliance with the contract provisions shall be in accordance with Reports per Section 01 45 29 - Quality Control; Testing Laboratory Services and Section 01 45 16.13 - Contractor's Quality Control Program as applicable.
 - 4. The Contractor may obtain copies of results of tests performed by the Port of Seattle from the office of the Engineer at no cost.
 - 5. Tests conducted for the sole benefit of the Contractor shall be at the Contractor's expense.
 - 6. Inspection and tests described below shall be completed with the reports submitted to the Engineer. Contractor shall take the action required by the Engineer.
 - a. Sampling and Testing of Materials:
 - b. Scales, Batching, and Recording:
 - c. Batch Plant Control:
 - d. Concrete Mixture:
 - e. Inspection Before Placing
 - f. Vibrators:
 - g. Curing Inspection:
 - h. Cold Water Protection:
 - i. Mixer Uniformity:
 - j. Reports:

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.

B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

End of Section

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of the "Welding" Work is indicated in the Contract Documents. Terms
 - 1. The terms, "welding," "weld," "joining," and other similar variations of these terms used in the context of this section generally refer to the joining of metals, using approved materials and procedures.

1.02 GOVERNING CODES, STANDARDS, AND REFERENCES

- 1. American Institute of Steel Construction (AISC)
 - a. AISC 360, Specification for Structural Steel Buildings
 - b. AISC 303, Code of Standard Practice for Steel Buildings and Bridges
 - c. AISC 325, Steel Construction Manual
- 2. American Welding Society (AWS)
 - a. AWS A2.4, Standard Symbols for Welding, Brazing, and Nondestructive Examination
 - b. AWS A3.0, Standard Welding Terms and Definitions
 - c. AWS D3.6, Underwater Welding
 - d. AWS D1.1, Structural Welding Code – Steel
 - e. AWS D1.3, Structural Welding Code – Sheet Steel
 - f. AWS D1.4, Structural Welding Code – Reinforcing Steel
 - g. AWS D14.4, Specification for Welding Joints for Machinery and Equipment
- 3. American Society for Testing and Materials (ASTM)
 - a. ASTM E165, Standard Practice for Liquid Penetrant Examination for General Industry
 - b. ASTM E709, Standard Guide for Magnetic Particle Examination
- 4. International Building Code (IBC)
 - a. International Building Code as adopted and amended by the Seattle-Tacoma International Airport Building Department.

1.03 SUBMITTALS

- A. Submit materials data in accordance with Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.
- B. Submittals shall include the following:
 - 1. Shop Drawings
 - a. Manufacturer shall submit shop drawings detailing the following information at a minimum in addition to shop drawing requirements:

- (1) Elements in shop drawings shall be shown with respect to grid or bent locations as shown on contract documents.
 - (2) Show all shop and erection details, including cuts, copes, splices, weld preparations, cambers, holes, fasteners, and welds (etc.).
 - (3) Show all welds, both shop and field, using AWS A2.4 standard notation.
2. Filler Material Specifications
 - a. Material specifications shall be provided and presented as a direct comparison with the material requirements listed in this specification section.
 - b. Each comparison shall be labeled with a 'Pass' or a 'Fail.'
 - c. Generic or incomplete manufacturer-supplied data may be rejected.
3. Weld Qualifications
 - a. Submit qualification documents (WPS, PQR, WPQ, WPQT) in accordance with:
 - (1) AWS D1.1 for structural component thickness 1/8" and greater.
 - (2) AWS D1.3 for structural component thickness of 1/8" and smaller.
 - (3) AWS D1.3 for reinforcing steel.
 - (4) AWS D14.4 for machinery.
4. Testing and Inspection Plan
 - a. Locations of planned weld testing and inspection
 - b. Schedule of planned weld testing and inspection, including inspection frequency
 - c. Name(s) of testing and inspection agency or agencies
5. Testing and Inspection Results
 - a. Inspector name, company, date
 - b. Project name
 - c. Test location, using design drawings
 - d. Welding Process
 - e. Code Standard
 - f. NDT Type
 - g. Inspection Standard
 - h. Acceptance Standard
 - i. Pass/Fail
 - j. Inspector remarks, photos, and measurements

6. Qualifications of Welding Supervisor
 - a. Name of welding supervisor(s)
7. Installer Performance Qualifications
 - a. Submit WABO performance qualifications for each welder, showing approval for each of the following at a minimum.
 - (1) Name of welder
 - (2) Weld positions
 - (3) Welding processes
 - (4) Plate thicknesses
 - (5) Dates of qualification
8. Weld Inspection Work Schedules

PART 2 MATERIALS

2.01 PROJECT INFORMATION

- A. As detailed in the provided drawings.

2.02 PREPARATION FOR MATERIALS

2.03 FABRICATION, PRODUCTION, AND SUPPLY OF MATERIALS

2.04 MATERIAL REQUIREMENTS

A. All Materials

1. Unless noted or specified otherwise, all products shall be new, free from defects, and of the best quality for the intended use.
2. Materials shall be within specification tolerances throughout the duration of the project, including at the time of installation.
3. When proprietary systems are required, Contractor shall generally conform to manufacturers' specifications, for best performance in the use of each of their products.
 - a. If manufacturer instructions are at variance with these specifications, report the discrepancy to the Port of Seattle before proceeding.
4. All materials not specified but required for a complete and proper installation shall be selected by the Contractor but are subject to the approval of the Engineer.

B. Filler Material

1. Filler materials for underwater welding Work shall be in compliance with the standards stated or referenced in AWS D3.6.
2. Only low hydrogen weld filler material shall be used.
3. Weld filler metal shall meet the following minimum mechanical property requirements:

PROPERTY	ACCEPTANCE REQUIREMENTS
Charpy V-Notch (CVN)	20 ft-lb @ 40°F
Charpy V-Notch (CVN)	40 ft-lb @ 70°F
Yield Strength	58 ksi min.
Tensile Strength	70 ksi min.
Elongation	22%, minimum

4. Filler materials for underwater welding Work shall be in compliance with the standards stated or referenced in AWS D3.6M, latest edition.

C. Base Metals

1. Weld filler metal shall comply with matching filler metal/base metal combinations of AWS D1.1/D1.4.
2. Materials with welds in undesignated locations will not be accepted unless the welding is approved by the Engineer.

2.05 MATERIAL HANDLING, DELIVERY, AND STORAGE

A. Storage

1. Welding electrodes shall be packaged, stored, and used in a manner consistent with AWS D1.1/D1.4, and electrode manufacturer specifications.

B. Damage & Replacements

1. In the event of damage, immediately make all repairs and replacements necessary at no additional cost to the Port of Seattle in accordance with AWS D1.1/1.4.

2.06 QUALITY ASSURANCE

A. Inspection and Testing

1. Any testing and inspection shall be in accordance with Section 01 45 23 - Independent Testing and Inspection Service.
2. The Port of Seattle retains the right to inspect and test all materials at all phases of construction.

PART 3 EXECUTION

3.01 PROJECT NOTES

3.02 PREPARATION FOR EXECUTION OF WORK

A. Prequalified Welding Procedure Specifications (WPS)

1. All welds shall be prequalified by AWS D1.1/1.4 unless otherwise approved by the Engineer.

2. Use prequalified WPS's in accordance with AWS D1.1/D1.4.
 - a. Use prequalified base metal/ filler metal combinations.
 - b. Use prequalified partial and complete joint penetration details.
 - c. Use prequalified minimum preheat and interpass temperatures.
 - B. Weld Qualifications
 1. All welds shall be qualified per AWS D1.1/D1.4.
 2. Previously qualified welds are allowable at the sole discretion of the approval of the Engineer.
 3. Welds with qualification tests are allowable at the sole discretion of the approval of the Engineer.
 4. Approval of any procedure does not relieve the Contractor of the sole responsibility for producing a finished structure meeting all specified strength and serviceability requirements.
 - C. Base Metals
 1. Where weld is intended for application to steel with surface coatings such as paint or galvanizing, remove surface coatings within 1" clear of weld.
- 3.03 EXECUTION OF WORK
- A. Fit-Up
 1. Fit-up tolerances, per AWS D1.1/D1.4, shall be measured and reported as a component of Periodic and Continuous Inspections.
 2. Root thickness tolerances shall be observed as described in AWS D1.1/D1.4.
 3. The Contractor shall not build-up out-of-tolerance roots using weld material unless approved by the Engineer.
 - a. Approval of root build-up at one location shall not be considered to be tacit approval at other locations.
 - B. Preheat and Interpass
 1. Use a maximum preheat and maximum interpass temperature of 550 deg. F, measured at a distance of 1 in. from the point of arc initiation.
 - a. This maximum temperature may not be increased by the WPS, regardless of qualification testing.
 - C. Minimum Welds
 1. Use minimum prequalified partial joint penetration (PJP) weld sizes in accordance the more stringent of the project specifications, drawings, and AWS D1.1/D1.4.
 - a. Use PJP welds larger than the minimum allowable where shown on the plans.
 2. Where fillet weld size is not shown on the drawings, use minimum fillet weld sizes in accordance with the more stringent of the project specifications, drawings, and AWS D1.1/ D1.4.

D. Welding

1. Welding materials, procedures, and equipment shall comply with AWS D1.1/D1.4.
2. Conform the design of welded connections to AISC 360 unless otherwise indicated or specified.
3. Do not commence welding until welding procedures, inspectors, nondestructive testing personnel, welders, welding operators, and tackers have been qualified and the submittals approved by the Port.
4. Metals shall be joined as indicated on drawings.
5. Members in tubular structures shall be joined under the AWS D1.1 design requirements for cyclically loaded tubular structures.

E. Field Welding

1. Field welding shall comply with AWS D1.1/D1.4.
2. Underwater welding Work shall be in compliance with the standards stated or referenced in AWS D3.6.
3. Contactor shall shield welding operations from wind, rain, dirt, and other environmental weld detriments as directed by the Engineer.
4. If light produced by welding arcs hinder the ongoing operations of tenants or the public, the Contractor shall make arrangements to move the weld location or screen the welding operations from view as directed.

F. Finishing

1. Where detailed, each weld shall be ground or otherwise mechanically finished to smooth condition without pits, edges, and sharp corners.
2. Where coatings such as paint or galvanizing is to be applied, welds shall be prepared to compliance.
3. All welds shall be completed to be smooth and free of burs, protrusions, edges, and other sharp discontinuities.
4. Where applicable, weld must retain required throat thickness after finishing operations are completed.
5. No weld shall be finished to allow for pits or cause pooling water when the finished structure is oriented as shown on plan.
6. Weld contours shall be completed as required by AWS D1.1 reference.
7. All finished welds shall remain within allowable sizes and tolerances throughout and after all finishing operations.

G. Warping

1. Fabricator shall use jigs, templates, strategic application of welds, and other means necessary to protect members from warping.
2. Fabrications with excessive distortion due to welding may be rejected by the Engineer.

H. Repair

1. Repairs shall be performed in accordance with AWS requirements.
2. Heat generated from weld may have a deleterious effect on surface conditioning, causing cracks, debonding, delamination, and other types of distress.
 - a. Remove and repair surface coatings damaged by welding operations with like materials to the approval of the Engineer.
 - b. Galvanizing shall be repaired by zinc solder or as approved by the Engineer.

3.04 QUALITY ASSURANCE

A. Testing and Inspection

1. All Testing and Inspection
 - a. All inspection procedures, techniques, methods, acceptance criteria, and inspector qualifications shall be completed in accordance with AWS D1.1/D1.4 and D3.6 as applicable.
 - b. All Special Inspections shall be completed in compliance with the more stringent of IBC Chapter 17 or the adopted building code.
 - c. Special Inspection or other Testing and Inspection of welding will be performed by the Special Inspector or agent of the Port in accordance with Section 01 45 23 - Independent Testing and Inspection Service, subject to the limitations of this section.
 - d. Costs associated with the Independent Testing and Inspection Service inspecting replacement materials, products, welds, and other installations due to Contractor error shall be deducted from monies due to the Contractor.
 - e. Testing and Inspection shall be completed at or near the Work site.
 - f. The Port of Seattle and the Inspector shall be given the option to be present to view all fit-up and welding operations.
2. Off-site Testing and Inspection
 - a. The Airport Building Department accepts Washington Association of Building Officials (WABO) registered steel fabrication facilities. Fabricators must provide WABO registration to the Airport Building Department for review and approval.
 - b. It is not the Airport Building Department's intent to prevent any fabricator who is not registered with WABO to manufacture structural steel components for building construction. Those fabricators, however, would be subject to special inspection at the fabrication facility by a WABO certified structural steel and welding special inspector.
 - c. Upon completion of fabrication, the approved fabricator shall submit a certificate of compliance to the Airport Building Department stating that the work was performed in accordance with the approved construction documents.

- d. In accordance with Section 01 45 29 – Independent Testing and Inspection Service, the Contractor shall provide and pay for off-site inspection and testing service required to confirm the quality of materials used.
- 3. Minimum Testing and Inspection Requirements
 - a. Test Methods and Acceptance Criteria
 - (1) Test methods and acceptance criteria shall be determined by location in accordance with AWS D1.1/D1.4 and adopted building codes for all Testing and Inspection requirements.
 - (2) The extent of Testing and Inspection required shall be continuously determined by the Engineer.
 - b. Visual Inspection
 - (1) The Contractor shall sequence Work or otherwise schedule welding operations to accommodate the scheduling of 75% minimum required visual weld inspections to occur during normal business hours.
 - (2) Visual Inspection shall be performed by the Inspector before, during, and after welding to the extent determined by the Port.
 - (3) All root openings shall be inspected prior to welding.
 - (a) Out-of-tolerance root openings must be approved by the Engineer prior to welding.
 - (4) Inspector shall visually inspect 100% of installed welds after welding and prior to coating application.
 - c. Nondestructive Testing (NDT)
 - (1) The Contractor shall sequence Work or otherwise schedule welding operations to accommodate the scheduling of 100% minimum required nondestructive weld inspections to occur during normal business hours.
 - (2) Magnetic Particle Testing
 - (a) The following shall be tested by the magnetic particle method in accordance with AWS D1.1/D1.4. Locations to be determined by the Port.
 - (i) 30% of fillet welds
 - (ii) 50% of all partial penetration welds
 - (iii) All complete penetration welds not tested by ultrasonic testing.
 - (3) Ultrasonic Testing
 - (a) The following shall be tested by the ultrasonic method in accordance with AWS D1.1/D1.4.
 - (i) 100% of complete penetration welds.

- (ii) All complete penetration welds in which, in the opinion of the inspector, ultrasonic testing is more conclusive than magnetic particle testing.
- 4. Testing and Inspection Results
 - a. Inspection results shall be made available to the Port and the Contractor within 2 business days of testing.
 - b. Each weld designated for testing shall be inspected, located on design drawings, compared with acceptance standards, and assigned a "PASS" or "FAIL" grade.
- B. Qualifications
 - 1. Qualifications of Welding Supervisor(s)
 - a. Provide at least one person who shall be present at all times during execution of this portion of the Work who shall be thoroughly trained and experienced in placing the types of welding specified and who shall direct all Work performed under this section.
 - 2. Installer Performance Qualifications
 - a. All welders shall be currently certified by AWS or Washington Association of Building Officials (WABO) for structural welding.
 - (1) If the welder has not been engaged in the welding process for three or more months, re-qualify the welder before permitting structural welding Work.
 - b. All welders performing underwater welding Work shall be in compliance with the standards stated or referenced in AWS D3.6M, latest edition.
- C. Weld Inspection Work Schedules
 - 1. The Contractor shall notify the Port of Seattle and the Independent Testing Agency 14 days prior to beginning welding operations.
 - 2. The Contractor shall notify the Port of Seattle and the Independent Testing Agency 3 business days prior to fit-up and welding operations for all structural welds requiring Periodic or Continuous Inspection in accordance with adopted building codes.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the

scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.

B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

End of Section

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of the "Structural Steel" Work is indicated in the Contract Documents.
- B. Terms
 - 1. The terms, "steel," "structural steel," "channel," "angles," "pipe," "tube," "plate," and other similar variations of these terms used in the context of this section generally refer to structural steel materials and shapes.

1.02 GOVERNING CODES, STANDARDS, AND REFERENCES

- A. American Institute of Steel Construction (AISC)
 - 1. AISC 303, Code of Standard Practice for Steel Buildings and Bridges
 - 2. AISC 325, Steel Construction Manual
 - 3. AISC 326, Detailing for Steel Construction
 - 4. AISC 341, Seismic Provisions for Structural Steel Buildings
 - 5. AISC 360, Specification for Structural Steel Buildings
 - 6. AISC DG1-26, Design Guides (as applicable)
- B. American Society for Testing and Materials (ASTM)
 - 1. A6, Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
 - 2. A36, Specification for Carbon Structural Steel
 - 3. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
 - 4. A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
 - 5. A193, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
 - 6. A240, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
 - 7. A242, Standard Specification for High-Strength Low-Alloy Structural Steel
 - 8. A276, Standard Specification for Stainless Steel Bars and Shapes
 - 9. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
 - 10. A325, Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
 - 11. A449, Standard Specification for Quenched and Tempered Steel Bolts and Studs

12. A490, Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength
13. A489, Specification for Carbon Steel Lifting Eyes.
14. A493, Standard Specification for Stainless Steel Wire and Wire Rods for Cold Heading and Cold Forging
15. A500, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural tubing in Rounds and Shapes
16. A501, Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
17. A514, Standard Specification for High Yield Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding
18. A529, Standard Specification for High-Strength Carbon-Manganese Steel of Structural Quality
19. A563, Standard Specification for Carbon and Alloy Steel Nuts
20. A572, Standard Specification for High-Strength Low Alloy Columbium-Vanadium Structural Steel
21. A588, Standard Specification for High-Strength Low-Alloy Structural Steel with 50ksi Minimum Yield Point, with Atmospheric Corrosion Resistance
22. A618, Standard Specification for Hot-Formed Welded and Seamless High-Strength Low-Alloy Structural Tubing
23. A666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
24. A668, Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use
25. A709, Standard Specification for Structural Steel for Bridges
26. A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
27. A786, Standard Specifications for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates.
28. A992, Standard Specification for Structural Steel Shapes
29. D4894, Standard Specification for Polytetrafluoroethylene (PTFE) Granular Molding and Ram Extrusion Materials
30. D4895, Standard Specification for Polytetrafluoroethylene (PTFE) Resin Produced From Dispersion
31. F436, Specification for Hardened Steel Washers.
32. F593, Standard Specification for stainless Steel Bolts, Hex Cap Screws, and Studs
33. F594, Standard Specification for Stainless Steel Nuts
34. F844, Specification for Washers, Steel, Plain (Flat), Unhardened for General Use.

- 35. F959, Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners
- 36. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
- C. American Society for Mechanical Engineers (ASME) International
 - 1. ASME B46.1, Surface Texture, Surface Roughness, Waviness, and Lay
 - 2. ANSI/AWS A2.4, Standard Symbols for Welding, Brazing, and Nondestructive Testing, Structural Welding Code
 - 3. ANSI/AWS D1.1, Structural Welding Code - Steel
 - 4. ANSI/AWS D1.6, Structural Welding Code – Stainless Steel
- D. International Building Code (IBC)
 - 1. International Building Code as adopted by the Seattle-Tacoma International Airport Building Department.
- E. Research Council on Structural Connections (RCSC)
 - 1. Specification for Structural Joints Using High-Strength Bolts.
 - 2. Educational Bulletin No. 4, Recommended Erection and Field Inspection Procedures for High-Strength Bolts in Structural Steel Assemblies.
- F. Society for Protective Coatings (SSPC)
 - 1. SSPC -A 1, Shop, Field, and Maintenance Painting of Steel
 - 2. SSPC PS-13.01, Epoxy Polyamide Painting System
 - 3. SSPC Paint 25, Zinc Oxide, Alkyd, Linseed, Oil Primer for Use Over Cleaned Steel, Type I and Type II.
 - 4. SSPC SP-2, Hand Tool Cleaning
 - 5. SSPC SP-3, Power Tool Cleaning
 - 6. SSPC SP-6, Commercial Blast Cleaning
 - 7. SSPC SP-10, Near-White Blast Cleaning

1.03 SUBMITTALS

- A. Submit materials data in accordance with Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.
- B. Submittals shall include the following:
 - 1. Manufacturer Contact Information
 - a. Provide manufacturer contact information for each material provider.
 - b. Provide fabricator contact information for each fabricator.
 - 2. Shop Drawings
 - a. Detailed shop drawings shall be submitted for all elements and assemblies.

- (1) This includes but is not exclusive to steel, lumber, timber, plastic, rubber, composite materials, and all related hardware detailed as units and as assemblies.
 - b. Elements in shop drawings shall be shown with respect to grid, bent locations, or other identifying location shown on contract documents.
 - c. Shop drawings shall be approved by the Engineer prior to the fabrication of custom construction materials or material assemblies.
 - d. Show all shop and erection details including cuts, copes, splices, weld preparations, temporary attachments, permanent attachments, cambers, sweeps, lifting holes, fasteners, welds, and other similar conditions.
 - e. Show all welds, both shop and field, using AWS notation.
 - f. If vendor or other supplied products are used as a portion of an assembly, attach manufacturer material specifications, 'cut-sheets,' and other manufacturer information.
- 3. Erection Plans and other information buried below should be listed here and removed from Parts 2 and 3
 - 4. Shop Primer
 - a. Product identification
 - b. Product and product application specifications
 - c. Test reports for Class B coatings for slip-critical connections
 - 5. Laboratory Tests
 - a. Laboratory test results showing physical and chemical properties. Submit mill certificates in accordance with Section 01 33 00 - Submittals of these specifications.
 - 6. Qualification Proofs
 - a. Evidence satisfactory to the Engineer that the steel Contractors for fabrication and steel erection are qualified for the Work in accordance with the requirements of this section of the specifications. Submit in accordance with Section 01 33 00 - Submittals of these specifications.
 - 7. Structural Steel Component Identification
 - a. Steel member identification key plan using design drawings where possible.
 - 8. Fabrication and Erection Drawings
 - a. Fabrication Plan
 - b. Erection Plan

PART 2 MATERIALS

2.01 PROJECT INFORMATION

2.02 PREPARATION FOR MATERIALS

A. Manufacturer Contact Information

2.03 FABRICATION, PRODUCTION, AND SUPPLY OF MATERIALS

A. General Fabrication Criteria

1. All structural steel shall be fabricated in strict accordance with the plans, approved shop drawings, and the reference standards.
2. All material stored at the plant, prior to or after fabrication, shall be protected from rust or an accumulation of dirt, oil, or other foreign matter. Material which shows signs of pitting due to rust will not be accepted.
3. The workmanship and finish shall be first-class and equal to the best practice. Welding, shearing, burning and chipping shall be neatly and accurately done, and all portions of the Work exposed to view shall be neatly finished.
4. Drill or punch all holes required for the attachment of Work of other trades and for bolted connections. Burned holes are not acceptable.

B. Fabrication

1. Fabrication shall be in accordance with the applicable provisions of AISC 325.
2. Fabrication and assembly shall be completed in the shop to the greatest extent possible.
3. Fabricating plant shall be certified under AISC 201.

C. Bolt and Rivet Holes

1. Bolt and rivet holes required for fabrication of all steel structures shall conform to the applicable requirements designated within or referenced by the AISC references listed above.
2. High-strength bolted connections shall be fabricated according to the recommendations of the RCSC.

D. Welding

1. Welding fabrications shall comply with Section 05 05 23 – Welding.

2.04 MATERIAL REQUIREMENTS

A. All Materials

1. Unless noted or specified otherwise, all products shall be new, free from defects, and of the best quality for the intended use.
2. Once in finished form, materials shall remain within specification tolerances throughout the duration of the project, including at the time of installation.
3. When proprietary systems are required, Contractor shall generally conform to manufacturers' specifications as a minimum for best performance in the use of each of their products.

- a. If manufacturer instructions are at variance with these specifications, report the discrepancy to the Port of Seattle before proceeding.
4. Products and materials designated for use may be custom; prices and availability may vary significantly by product.
- B. Corrosion Protection
 1. Where allowable by ASTM, the minimum copper content shall be 0.2% for structural shapes.
- C. Structural Steel Shapes
 1. Structural steel shapes shall comply with values and standards shown in the following table:

SHAPE	GRADE (KSI) YIELD (TENSILE)	STANDARD (ASTM UNLESS OTHERWISE DESIGNATED)
Plate	36 (58)	A36
Plate (dynamically loaded structures)	50 (65)	A572
W	50 (65)	A992
M, S, MC, L	36 (58)	A36
HP	50 (65)	A572 Gr. B
HP Piling	50 (65)	A690
C	50 (65)	A572
Pipe Piling	45 (66)	A252 Gr. 3
Pipe	35 (60)	A53 Gr. B
HSS Round	42 (58)	A500 Gr. B
HSS Rect.	46 (58)	A500 Gr. B
Steel Sheet Piling	50 (65)	A690

2. Steel Sheet Piling

- a. For identification purposes, Bethlehem Steel Company's designations are used on the drawings, but the equivalent section of other manufacturers will be acceptable.
- b. All steel sheet piling shall:
 - (1) Individual piles shall be of length shown, within an allowable tolerance of plus or minus 2'-6"
 - (2) Shall be in one (1) piece.

D. Structural Steel Fasteners

1. Structural steel fasteners shall comply with values and standards shown in the following table:

SHAPE (DIAMETER)	GRADE (KSI) YIELD (TENSILE)	STANDARD (ASTM UNLESS OTHERWISE DESIGNATED)
Conventional Structural Bolts (1" to 1.5" incl.)	(105)	A325
Conventional Structural Bolts (0.5" to 1" incl.)	(120)	A325
Twist-off Tension Control Bolts (0.5" to 1" incl.)	(120)	F1852
Common Bolts (.25" to 4")	(60)	A307 Gr. A
Nuts (0.25" to 4")	N/A	A563
Washers (0.25" to 4")	N/A	F436
Direct Tension-Indicator Washers (0.5" to 1.5")	N/A	F959
Threaded Rods (to 10")	36 (58)	A36
Shear Studs (0.375" to 0.75")	(65)	A108
Anchor Rods	36 (58)	F1554 Gr. 36

E. Shop Primer

1. Unless otherwise designated, a shop-applied primer shall be applied to building structural steel for temporary protection to the steel during delivery, storage on site, and installation in a generally noncorrosive environment.

2. SSPC Paint 25 (alkyd primer) or SSPC PS 13.01 epoxy-polyamide, green primer (Form 150) type 1 shall be applied to structural steel in accordance with SSPC-Paint 15. Test panel testing is not required.
- F. Shop Cleaning and Priming
1. Shop-paint all structural steel with one coat where priming is required, in accordance with Section 09 90 00 - Paints and Coatings.
 2. After fabrication has been completed and before the shop coat of primer is applied, thoroughly clean all structural steel, except machine finishes in accordance with Section 09 90 00 - Paints and Coatings.
 3. Paint all structural steel, after it is thoroughly cleaned as specified above, with one shop coat within 17 hours of cleaning, or sooner if required by paint manufacturer.
 4. Clean all steel to be encased in concrete.
- G. Consumables for Welding
1. Weld materials shall be selected that suitable for strength, ductility, material compatibility, and toughness to the approval of the Engineer.
 2. Weld materials shall conform with the applicable specifications designated or referenced within AWS D1.1
- H. Surface Preparation
1. Fabricator Cleaning
 - a. Dirt, oil, grease and loose mill scale shall be removed in accordance with SSPC-SP1 – Solvent Cleaning.
 2. Minimum Surface Preparation
 - a. Unless otherwise stated, all steel surfaces shall be prepared in conformance with SSPC-SP2 (Hand Tool Cleaning) at the location of fabrication prior to shipping.
 - (1) Where shop primer, coating, galvanizing, fireproofing, or other coating or surface preparation is designated that supersedes this this requirement, the more stringent preparation applies.
 - b. Shop cleaning shall be scheduled with the inspector.
- 2.05 MATERIAL HANDLING, DELIVERY, AND STORAGE
- A. Materials shall be stored out of contact with the ground in such manner and location as will minimize deterioration.
- B. Structural steel surfaces shall be protected during handling, delivery, and storage.
1. Contractor shall provide the equipment, materials, and personnel required for minor surface repairs at the point of delivery.
- 2.06 QUALITY ASSURANCE
- A. Inspection and Testing

1. The Port of Seattle or contractor as noted in the will provide field or plant inspection and testing service to the satisfaction of the Engineer.
 2. Sampling and testing to assure compliance with the contract provisions shall be in accordance Section 01 45 29 - Quality Control; Testing Laboratory Services and Section 01 45 16.13 - Contractor's Quality Control Program as applicable.
 3. The Contractor may obtain copies of results of tests performed by the Port of Seattle from the office of the Engineer at no cost.
 4. Tests conducted for the sole benefit of the Contractor shall be at the Contractor's expense.
- B. Qualification of Manufacturer:
1. The steel fabricator shall have not less than 5 years of continuous experience in the fabrication of structural steel.
 2. The steel erector shall have not less than 5 years of continuous experience in the erection of structural steel.
 3. All welding shall be performed by welders who are currently certified by the Washington Association of Building Officials and shall conform to the current specifications of the AWS.

PART 3 EXECUTION

3.01 PROJECT INFORMATION

3.02 PREPARATION FOR EXECUTION OF WORK

- A. Structural Steel Component Identification
1. Prior to erection or assembly, steel members shall be identified with removable marking materials on the outermost coating layer.
 2. Steel member identification notation shall align with notation shown in shop drawings, reports, and other Contractor-generated materials where possible.
 3. All beams, columns, and other significant structural shapes shall be identified.
- B. Fabrication and Erection Drawings
1. Fabrication drawings shall be prepared in accordance with AISC 325 and 326.
 2. The erection plan for low-rise buildings and building components shall conform to AISC 303.
 3. Fabrication drawings shall include complete information for the fabrication and erection of the structure's components, including the location, type, and size of bolts, welds, member sizes and lengths, connection details, blocks, copes, and cuts.
- C. Erection Plan

3.03 EXECUTION OF WORK

- A. Fabrication

1. Member substitutions of details shown on the contract drawings shall be clearly highlighted on the fabrication drawings.
 - B. Erection Criteria - General
 1. Erect all structural steel in strict accordance with the drawings, the approved shop drawings and all pertinent regulations and standards.
 2. Erection of structural steel shall be in accordance with the applicable provisions of AISC 325.
 3. Erection plans shall be reviewed, stamped, and sealed by a licensed Structural Engineer.
 - C. Erection of Low-Rise Structural Steel Buildings or Building Components
 1. For low-rise structural steel buildings or building components (less than 60' tall and a maximum of 2 stories), structural steel shall be erected in accordance with AISC DG10.
 - D. Tolerances
 1. Align all structural steel straight, plumb and level within tolerances shown in the AISC 303.
 - E. Coatings
 1. After erection is complete, touch up all shop priming coats damaged during transportation or erection and prime all field welds on members requiring priming with primary paint specified for shop priming.
 2. Where epoxy or other special coatings are specified, apply per manufacturer's recommendations.
 - F. Welding
 1. All welding operations shall comply with the methods described or referenced by Section 05 05 23 – Welding.
- 3.04 QUALITY ASSURANCE
- A. Undesignated Splices
 1. Shop splices or other joined metals will be permitted only where indicated on the Contract Drawings.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by a Subcontractor (of any tier) or Supplier.

B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

End of Section

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of the "Cold-Formed Metal Framing" Work is indicated in the Contract Documents.
- B. The work in this section is Bidder Design

1.02 GOVERNING CODES, STANDARDS, AND REFERENCES

- A. American Iron and Steel Institute (AISI)
 - 1. Specifications for the Design of Cold Formed Steel Structural Members
- B. American Society for Testing and Materials (ASTM)

1.03 SUBMITTALS

- A. Submit materials data in accordance with Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.
- B. Submittals shall include the following:
 - 1. Shop Drawings
 - 2. Structural calculations and design stamped by licensed engineer.

PART 2 PRODUCTS

2.01 MATERIAL REQUIREMENTS

- A. "C"-Shaped Heavygauge Studs
 - 1. Materials:
 - a. 16 Gauge and Heavier: For 16 gauge and heavier units, fabricate metal framing components of structural quality steel sheet with a minimum yield point of 40,000 psi; ASTM A653, A570, or A611.
 - b. 18 Gauge and Lighter: For 18 gauge and lighter units, fabricate metal framing components of commercial quality steel sheet with a minimum yield point of 33,000 psi; ASTM A653, A570, or A611.
 - 2. Finish: At the Contractor's option, provide galvanized finish to metal framing components complying with ASTM A525 for minimum G60 coating or provide prime coated finish with one coat of shop-applied red-oxide, zinc-chromate, or other similar rust-inhibitive primer.
 - 3. "C"-Shape Studs: Manufacturer's standard load-bearing steel studs of size, shape, and gauge indicated, with 1.625-inch flange and flange return lip.
- B. Drywall Screw-Type Steel
 - 1. Studs: Manufacturer's standard formed light gauge steel studs complying with ASTM C645, of the height, size, and gauge indicated; with punched webs to facilitate erection of system and passage of mechanical/electrical service lines.
 - a. Gauge: 25 gauge, except provide heavier gauges where specified or as otherwise indicated.

- b. Depth of Section: 4-inch, except as otherwise indicated.
 - c. Flange Width: Not less than 1.25 inches.
 - d. Shape: "C" shape with returned flanges.
 - e. Face of Flanges: Screw type (knurled to facilitate use of self-drilling-tapping fasteners).
 - 2. Steel and Finish: ASTM A591 Commercial Quality electrolytic zinc coated steel, Class B; except as otherwise indicated.
 - C. Stiffeners
 - 1. 3/4-inch cold rolled steel channel, weighing 0.3 lbs. per lin. ft.; rust inhibitive paint finish unless otherwise indicated.
- 2.02 FABRICATION & SUPPLY OF MATERIALS
- A. Fabrication
 - 1. Framing components may be prefabricated into panels prior to erection.
 - 2. Fabricate panels plumb, square, true to line, and braced against racking with joints welded. Perform lifting of prefabricated panels in a manner to prevent damage or distortion in any members in the assembly.
 - 3. Attach similar components by welding. Attach dissimilar components by welding, bolting, or screw fasteners, as standard with the manufacturer.
 - 4. Wire tying of framing components is not permitted.
- 2.03 MATERIAL HANDLING & STORAGE
- A. Product Handling
 - 1. Handle and store metal framing in such a manner as to prevent deflection or warpage.
- 2.04 QUALITY ASSURANCE & INSPECTIONS
- A. Component Design
 - 1. Compute structural properties of studs and joists in accordance with AISI "Specification for Design of Cold-Formed Steel Structural Members."
 - B. Fire-Rated Assemblies
 - 1. Where framing units are components of assemblies indicated for a fire-resistance rating, including those required for compliance with governing regulations, provide units which have been approved by governing authorities having jurisdiction

PART 3 EXECUTION

3.01 EXECUTION OF WORK

- A. Installation of Stud Systems - General
 - 1. General:
 - a. Manufacturer's Instructions: Install metal framing systems in accordance with manufacturer's printed or written instructions and recommendations, unless otherwise indicated.

- b. Gypsum Association Specifications: Comply with the requirements of ASTM C754 where metal studs are indicated to receive gypsum board.
 - c. Runner Tracks: Install continuous tracks sized to match studs.
 - (1) Align tracks accurately to the layout at base and tops of studs.
 - (2) Secure tracks as recommended by the stud manufacturer for the type of construction involved, except do not exceed 24-inch o.c. spacing for nail or power-driven fasteners, nor 16-inch o.c. for other types of attachment. Provide fasteners at corners and ends of tracks.
 - 2. Installation of Wall Stud Systems - General:
 - a. Set studs plumb, except as needed for diagonal bracing or required for non-plumb walls or warped surfaces and similar requirements.
 - b. Where stud system abuts structural columns or walls, including masonry walls, anchor ends of stiffeners to supporting structure.
 - 3. Height of Partition Stud Systems: The stud system shall extend to the structure above the ceiling.
 - 4. Supplementary Framing: Install supplementary framing, blocking, and bracing in the metal framing system wherever walls or partitions are indicated to support fixtures, equipment, services, and similar Work requiring attachment to the wall or partition. Where type of supplementary support is not otherwise indicated, comply with the stud manufacturer's recommendations and industry standards in each case, considering the weight or loading resulting from the item supported.
 - 5. Stud Spacing: Except as otherwise indicated, space studs at 24-inches o.c.
- B. Installation of "C"-Shaped Heavygauge Studs**
- 1. General: Secure studs to top and bottom runner tracks by either welding or screw fastening at both inside and outside flanges.
 - 2. Openings: Frame wall openings larger than 2'-0" square with double stud at each jamb of frame except where more than 2 are either shown or indicated in manufacturer's instructions. Install runner tracks and jack studs above and below wall openings. Anchor tracks to jamb studs with stud shoes or by welding, and space jack studs same as full-height studs of the wall.
Secure stud system all around to wall opening frame in the manner indicated.
 - 3. Stiffeners: Install horizontal stiffeners in stud system, spaced (vertical distance) at not more than 4'-6" o.c. Weld at each intersection.
- C. Installation of Screw-Type Light gauge studs**
- 1. Runner Tracks: At partition corners and intersections, butt runner tracks, except leave clearance where base course of gypsum board is to run through.

2. Friction fit studs to runner tracks by positioning and rotating into place. Provide positive attachment to tracks for studs located at partition corners and intersections, and adjacent to openings, and for jack studs located above and below openings. Attach with either self-tapping screws or by use of clinching tool, at both flanges of stud.
3. Corners: At partition corners and intersections, provide a minimum of 3 studs, positioned to support each surface of partition; or provide 2 studs with the second stud installed after the base course of gypsum board has been run through, and screw anchor the second stud through the gypsum board to the first stud at 2' o.c. spacing.
4. Splices: Install full length studs between runner tracks wherever possible. If necessary, splice studs by nesting with a minimum lap of 8 inches and fasten laps with 2 screws through each flange.
5. Openings: Frame door openings with vertical studs securely attached to each jamb of door frame. On head of door frame install runner track; cut flanges at ends, bend web 90 degrees and screw attach to jamb studs. Install jack studs over door opening, spaced same as full-height studs. Where control joints are shown to extend upward from door jambs, install a jack stud spaced 1/2 inch from jamb stud.
 - a. Space next full-height stud not more than 6 inches from each jamb stud.
 - b. At door openings provide either 20-gauge jamb studs or provide double studs of the same gauge as regular full-height studs, at each jamb of each frame.
 - c. Attach jamb studs to metal door frames with metal clips, each with 2 screws into jamb stud.
 - d. Frame openings other than door openings in the same manner as required for door openings, and install framing below sills of openings to match framing required above door heads.
6. Stiffeners: Install continuous horizontal stiffeners in stud systems indicated to receive gypsum lath and plaster. Space stiffeners 4'-6" o.c. (vertical distance); wire-tie at each stud intersection, and secure ends at partitions and jamb studs, and at abutting construction.

D. System Components

1. With each type of metal framing required, provide manufacturer's standard steel runners (tracks), blocking, lintels, clip angles, shoes, reinforcements, fasteners, and accessories as recommended by manufacturer for the applications indicated, as needed to provide a complete metal framing system.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

- A. No separate measurement or payment will be made for the Work required by this section. The cost for this portion of the Work will be considered incidental to, and included in the payments made for the applicable bid items in the Lump Sum price bid for the Project.

End of Section

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of the "Metal Fabrication" Work is indicated in the Contract Documents. Section includes:
 - 1. Steel framing and supports for mechanical and electrical equipment.
 - 2. Steel framing and supports for applications where framing and supports are not specified in other Sections.
 - 3. Miscellaneous steel trim including stainless steel corner guards and wall cap protection.

1.02 GOVERNING CODES, STANDARDS, AND REFERENCES

- A. International Building Code (IBC)
 - 1. International Building Code as adopted and amended by the Seattle-Tacoma International Airport Building Department.

1.03 SUBMITTALS

- A. Submit materials data in accordance with Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.
- B. Submittals shall include the following:
 - 1. Shop Drawings
 - a. Mill Certificates: Signed by stainless-steel manufacturers, certifying that products furnished comply with requirements.
 - 2. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats

1.04 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 MATERIALS

2.01 MATERIAL REQUIREMENTS

- A. METALS
 - 1. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
 - 2. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
 - 3. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

4. Stainless-Steel Sheet, Strip, and Plate: ASTM A 240/A 240M or ASTM A 666, Type 304.
 5. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304.
 6. "Rolled-Steel Floor Plate" Paragraph below specifies yield strength of 30 ksi (205 MPa); revise if higher strength is required.
 7. Steel Tubing: ASTM A 500/A 500M, cold-formed steel tubing.
 8. Steel Pipe: ASTM A 53/A 53M, Standard Weight (Schedule 40) unless otherwise indicated.
 9. "Slotted Channel Framing" Paragraph below describes typical component of metal channel framing systems such as that manufactured by Unistrut.
- B. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated. Finish: Stainless Steel: Brushed, clear
- C. FASTENERS
1. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
 - a. Provide stainless-steel fasteners for fastening aluminum.
 - b. Provide stainless-steel fasteners for fastening stainless steel.
 - c. Provide stainless-steel fasteners for fastening nickel silver.
 2. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with hex nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.
 3. "Steel Bolts and Nuts" Paragraph below specifies weathering steel bolts and nuts.
 4. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 325, Type 3 (ASTM A 325M, Type 3); with hex nuts, ASTM A 563, Grade C3 (ASTM A 563M, Class 8S3); and, where indicated, flat washers.
 - a. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, ASTM F 593 (ASTM F 738M); with hex nuts, ASTM F 594 (ASTM F 836M); and, where indicated, flat washers; Alloy
 - b. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.
 - (1) Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.

- c. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488/E 488M, conducted by a qualified independent testing agency.
- d. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F 2329.

D. MISCELLANEOUS MATERIALS

- 1. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
 - a. Water-Based Primer: Emulsion type, anticorrosive primer for mildly corrosive environments that is resistant to flash rusting when applied to cleaned steel, complying with MPI#107 and compatible with topcoat.
 - b. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.
 - c. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.
 - d. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
 - e. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.
 - f. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.02 FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Form exposed work with accurate angles and surfaces and straight edges.

- E. Weld corners and seams continuously to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.
- G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

2.03 MISCELLANEOUS FRAMING AND SUPPORTS

- 1. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.
- 2. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.
 - a. Fabricate units from slotted channel framing where indicated.
 - b. Furnish inserts for units installed after concrete is placed.
- 3. Fabricate supports for ceiling hung toilet partitions from continuous steel beams of sizes indicated and recommended by partition manufacturer with attached bearing plates, anchors, and braces as recommended by partition manufacturer. Drill or punch bottom flanges of beams to receive partition track hanger rods; locate holes where indicated on operable partition Shop Drawings.

2.04 MISCELLANEOUS STEEL TRIM

- A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.
 - 1. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.

- a. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.
- 2. Prime miscellaneous steel trim with zinc-rich primer.
- B. STEEL WELD PLATES AND ANGLES
 - 1. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.
- 2.05 FINISHES, GENERAL
 - A. Finish metal fabrications after assembly.
 - B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.
- 2.06 STEEL AND IRON FINISHES
 - A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.
 - B. Retain subparagraph below if galvanized items are painted.
 - C. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
 - D. Preparation for Shop Priming Galvanized Items: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.
 - E. Shop prime iron and steel items unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.
 - F. Delete subparagraph below if specifying only one shop primer.
 - G. Shop prime with universal shop primer unless indicated.
 - H. Preparation for Shop Priming: Prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 - 1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 - 2. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 - 3. Other Items: SSPC-SP 3, "Power Tool Cleaning."
 - 4. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

PART 3 EXECUTION

3.01 INSTALLATION, GENERAL

- A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- C. Field Welding: Comply with the following requirements:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
 - 5. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.
 - 6. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
 - 7. Corrosion Protection: Coat concealed surfaces of aluminum that come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:
 - a. Cast Aluminum: Heavy coat of bituminous paint.
 - b. Extruded Aluminum: Two coats of clear lacquer.

3.02 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.
- B. Anchor supports for ceiling hung toilet partitions securely to, and rigidly brace from, building structure.
- C. Support steel girders on steel pipe columns. Secure girders with anchor bolts with bolts through top plates of pipe columns.
- D. Install pipe columns on concrete footings with grouted baseplates. Position and grout column baseplates as specified in "Installing Bearing and Leveling Plates" Article.

1. Grout baseplates of columns supporting steel girders after girders are installed and leveled.

3.03 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 1. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.
- B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 09 90 002 "Paints and Coatings"
- C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780/A 780M.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontrator (of any tier) or Supplier.
- B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

End of Section

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of "Rough Carpentry" Work is indicated on the Contract Documents.

1.02 GOVERNING CODES, STANDARDS, & REFERENCES

- A. Standards: In addition to complying with all pertinent codes and regulations, all materials of this section shall comply with the pertinent provisions of the following:
 - 1. "West Coast Lumber Inspection Bureau, Rule Book 16"
 - 2. "Construction and Industrial Softwood Plywood" Product Standard PS 1 of U.S. Department of Commerce.
 - 3. "Specification for the Design, Fabrication and Erection of Structural Steel for Building" of the AISC, for rough hardware.

1.03 SUBMITTALS

- A. Submit materials data in accordance with Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.
- B. Erection marks on treated lumber shall be stamped into the wood with a branding hammer in such a location as to be visible after erection.

PART 2 MATERIALS

2.01 MATERIAL REQUIREMENTS

- A. All materials of this section, unless specifically otherwise approved in advance by the Engineer, shall meet or exceed the following:
- B. Lumber
 - 1. Light Framing Lumber: two inches to four inches thick; two inches to four inches wide.
 - a. "Construction" shall conform to paragraph 122-b WCLIB.
 - b. "Standard" shall conform to paragraph 122-c WCLIB.
 - 2. Appearance Framing: 2 inches to 4 inches thick; 2 inches and wider shall conform to the requirements of paragraph 125-b WCLIB.
 - 3. Mark each piece of board lumber or each bundle of small pieces of lumber with the grade mark of a recognized association or independent inspection agency.
 - a. Surfaces that are to be exposed to view shall not bear grademarks, stamps, or any type of identifying mark.
 - b. Hammer marking will be permitted on timbers when all surfaces will be exposed to view.
 - 4. Virgin Lumber: Lumber fabricated from old growth timber is not permitted.
- C. Boards:

1. Boards: 3/4 inch, 1 inch, 1-1/4 inches and 1-1/2 inches thick; 2 inches and wider.
 - a. "Select Merchantable" shall conform to the requirements of paragraph 118-a WCLIB.
 - b. "Construction" shall conform to the requirements of paragraph 118-b WCLIB.
 - c. "Standard" shall conform to the requirements of paragraph 118-c WCLIB.
- D. Rough Hardware
 1. Unless otherwise indicated or specified, rough hardware shall be of the type and size necessary for the project requirements. Sizes, types, and spacing of fastenings of manufactured building materials shall be as recommended by the product manufacturer unless otherwise indicated or specified.. Fasteners may contain post-consumer or post-industrial recycled content. Rough hardware exposed to the weather or embedded in or in contact with preservative treated wood, exterior masonry, or concrete walls or slabs shall be hot-dip zinc-coated in accordance with ASTM A153/A153M.
 2. Bolts, Nuts, Studs, and Rivets
 - a. ASME B18.2.1, ASME B18.5.2.1M, ASME B18.5.2.2M and ASME B18.2.2.
 3. Anchor Bolts
 - a. ASTM A307, size as indicated, complete with nuts and washers.
 4. Lag Screws and Lag Bolts
 - a. ASME B18.2.1.
 5. Wood Screws
 - a. ASME B18.6.1.
 6. Nails
 - a. ASTM F547, size and type best suited for purpose. Nails used with treated lumber and sheathing shall be hot-dipped galvanized in accordance with ASTM A153/A153M. Nailing shall be in accordance with the recommended nailing schedule contained in AWC WFCM. Where detailed nailing requirements are not specified, nail size and spacing shall be sufficient to develop an adequate strength for the connection. The connection's strength shall be verified against the nail capacity tables in AWC NDS. Reasonable judgment backed by experience shall ensure that the designed connection will not cause the wood to split. If a load situation exceeds a reasonable limit for nails, a specialized connector shall be used.
 7. Wire Nails
 - a. ASTM F1667.

8. Clip Angles and French cleats:
 - a. Steel, 3/16 inch thick, size; or zinc-coated steel or iron commercial clips designed for connecting wood members.
 9. Fastening Hardware: All hardware used in contact with salts-treated lumber shall be galvanized.
 - a. Steel hardware shall be manufactured from A36 steel.
 - b. Machine bolts shall be A307.
 - c. Nails shall be bright common, except galvanized at exterior locations.
 10. ICBO approval for equal or greater capacity.
 11. Other Materials: All other materials not specifically described but required for a complete and proper installation, shall be new, suitable for the intended use and subject to the Engineer's approval.
- E. Fire-Retardant Treated Lumber
1. Mark each piece of framing. All wood to be fire-retardant treated.
 - a. Surfaces that are to be of a natural finish, transparent finish, or exposed to view shall not be marked.
 - b. Exterior fire-retardant lumber shall be distinguished by a permanent penetrating blue stain.

2.02 FABRICATION & SUPPLY OF MATERIALS

- A. Sizes and Surfacing
1. Dressed sizes of yard and structural lumber shall be per ALSC PS 20.
 2. Lumber shall be surfaced four sides.
 3. Size references, unless otherwise specified, are nominal sizes, and actual sizes shall be within manufacturing tolerances allowed by the standard under which the product is produced.
- B. Moisture Content
1. Air-dry or kiln-dry lumber.
 - a. Kiln-dry treated lumber after treatment.
 2. Maximum moisture content of wood products shall be as follows at the time of delivery to the job site:
 - a. Framing lumber and board, 19 percent maximum.
 - b. Materials other than lumber; moisture content shall be in accordance with standard under which the product is produced.
- C. Preservative Treatment
1. Treat wood products with waterborne wood preservatives conforming to AWWA P5.
 2. Pressure treatment of wood products shall conform to the requirements of AWWA BOOK Use Category System Standards U1 and T1.

- a. Pressure-treated wood products shall not contain arsenic, chromium, or other agents classified as carcinogenic, probably carcinogenic, or possibly carcinogenic to humans (compounds in Groups 1, 2A, or 2B) by the International Agency for Research on Cancer (IARC), Lyon, France.
 - b. Pressure-treated wood products shall not exceed the limits of the U.S. EPA's Toxic Characteristic Leaching Procedure (TCLP), and shall not be classified as hazardous waste.
 3. The following items shall be preservative treated:
 - a. Wood members that are in contact with water.
 - b. Wood sills, soles, plates, furring, and sleepers that are less than 24 inches from the ground.
 - c. Furring and nailers that are set into or in contact with concrete or masonry.
 - d. Nailers, edge strips, crickets, curbs, and cants for roof decks.
 4. Provide the following recommended amount of preservative treatment:
 - a. Above ground use: 0.25 pcf.
 - b. Ground contact and fresh water use 0.40 pcf.
 - c. Ammoniacal Copper Quaternary Compound (ACQ)-treated pilings use: 0.80 to 1.00 pcf.
 5. Minimize cutting
 - a. Brush coat areas that are cut or drilled after treatment with either the same preservative used in the treatment or with a 2 percent copper naphthenate solution.
 6. Existing Structures
 - a. Use borate, permathrin, or a sodium silicate wood mineralization process to treat wood.
 - (1) Use borate for interior applications only.
- D. Fire-Retardant Treatment
 1. All wood to be fire-retardant treated.
 2. Fire-retardant treated wood shall be pressure treated with fire retardants conforming to AWP A P49.
 3. Fire retardant treatment of wood products shall conform to the requirements of AWP A U1, Commodity Specification H and AWP A T1, Section H.
 4. Treated materials to be exposed to rain wetting shall be subjected to an accelerated weathering technique in accordance with ASTM D2898 prior to being tested.
 5. Such items which will not be inside a building, and such items which will be exposed to heat or high humidity, shall receive exterior fire-retardant

treatment. Fire-retardant-treated wood products shall be free of halogens, sulfates, ammonium phosphate, and formaldehyde.

2.03 MATERIAL HANDLING & STORAGE

- A. Deliver materials to the site in an undamaged condition.
- B. Store, protect, handle, and install prefabricated elements in accordance with manufacturer's instructions and as specified.
- C. Storage
 - 1. Store materials off the ground.
 - 2. Provide drainage.
 - 3. Protect against moisture and dampness.
 - 4. Store all material clearly identified with all grade marks legible.
 - 5. Separate all defective, damaged, reusable wood waste material and stockpile

2.04 QUALITY ASSURANCE & INSPECTIONS

- A. Grade Stamps
 - 1. Other Material: Identify all other material of this section by the appropriate stamp of the agency as approved in advance by the Engineer.
- B. Fire-Retardant Treated Lumber
 - 1. Each treated piece shall be marked in accordance with AWP A M6.
 - a. Labels of a nationally recognized independent testing agency will be accepted as evidence of conformance to the fire-retardant requirements of AWP A M6.
- C. Certificates of Grade
 - 1. Submit certificates attesting that products meet the grade requirements specified in lieu of grade markings where appearance is important and grade marks will deface material.

PART 3 EXECUTION

3.01 PREPARATION FOR EXECUTION

- A. Inspection: Prior to all Work of this section, carefully inspect the installed Work of all other trades and verify that all such Work is complete to the point where this installation may properly commence and be performed in strict accordance with the original design and all pertinent codes and regulations.
- B. Discrepancies: In the event of discrepancy, immediately notify the Engineer. Do not proceed with installation until fully resolved.

3.02 EXECUTION OF WORK

- A. Install all backing required by all other trades.
 - 1. Let-in and bolt backing for wall-hung toilets, urinals, or lavatories.
 - 2. Nail backing for fixtures.

3. Install French cleats at plywood panels used in pipe chases installed so that plywood panels can be removed for easy access.
- B. Do not notch, bore, dap, or cut structural members for pipes, conduit, ducts, or other reasons except as indicated on the drawings, as called for in the specifications, or as approved by the Engineer.
- C. Install all blocking required to support finish items and to serve as fire stops in all horizontal or vertical draft spaces between ceiling and floors.
 - a. Turn, do not drive, all screw fasteners into position.

3.03 QUALITY ASSURANCE

- A. Qualification of Workers: Provide sufficient supervisors and skilled workers who shall be thoroughly familiar with the type of construction involved and the techniques required for the proper execution of the Work.
- B. Rejection: Rough carpentry improperly installed will be rejected and replaced at no additional cost to the Port. Framing errors in stress-rated lumber shall not be "repaired" or "remodeled" unless approved by the Engineer.
- C. Workmanship
 1. General: Install rough carpentry to produce framing which is level or plumb with joints that are true, tight and well nailed. Assemble all members in accordance with the approved drawings and appropriate codes.
 2. Selection of Lumber: Carefully select all lumber. When cutting long lengths into short pieces, exercise care to avoid reducing the grade. Lumber may be rejected by the Engineer at any time for faults or defects.
 3. Shimming: Do not shim structural members to fit.

PART 4 METHOD AND PAYMENT

4.01 PAYMENT

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by a Subcontractor (of any tier) or Supplier.
- B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the

Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

End of Section

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of "Cementitious Fireproofing" Work is shown in the Contract Documents.

1.02 GOVERNING CODES, STANDARDS, AND REFERENCES

- A. American Society for Testing and Materials (ASTM)
- B. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials
- C. ASTM E84
- D. ASTM E84 surface burning characteristics
- E. ASTM E85, Test Method for Air Erosion of Sprayed Fire-Resistive Materials Applied to Structural Members
- F. ASTM E119 Methods of Fire Tests of Building Construction and Materials
- G. ASTM E119 painted steel surfaces
- H. ASTM E605 Test Methods for Thickness and Density of Sprayed Fire-Resistive Material Applied to Structural Members
- I. ASTM E605 dry density
- J. ASTM E605 thickness and density
- K. ASTM E736 Test Method for Cohesion/Adhesion of Sprayed Fire-Resistive Materials Applied to Structural Members
- L. ASTM E736 bond strength
- M. ASTM E759 Test Method for Effect on Deflection of Sprayed Fire-Resistive Material Applied to Structural Members
- N. ASTM E760 Test Method for Effect of Impact on Bonding of Sprayed Fire-Resistive Material Applied to Structural Members
- O. ASTM E760 deflection
- P. ASTM E760 impact resistance
- Q. ASTM E761 Test Method for Compressive Strength of Sprayed Fire-Resistive Materials Applied to Structural Members
- R. ASTM E761 compression
- S. E859, Test Method for Air Erosion of Sprayed Fire-Resistive Materials Applied to Structural Members.
- T. ASTM E859 air erosion
- U. ASTM E937 Test Method for Corrosion of Steel by Sprayed Fire-Resistive Material Applied to Structural Members
- V. ASTM E937 corrosion resistance
- W. King County fire resistance ratings
- X. NFPA fire resistance ratings

- Y. Naval Facilities Engineering Command (NAVFAC) abrasion
- Z. Naval Facilities Engineering Command (NAVFAC) impact penetration
- AA. Underwriters Laboratories, Inc. UL Fire Resistance Directory
- BB. UL quality control program
- CC. Uniform Building Code (UBC) Standard, Thickness and Density Determination for Spray-Applied Fireproofing
- DD. UBC Standard thickness and density
- EE. American Society for Testing and Materials (ASTM, latest editions):

1.03 SUBMITTALS

- A. Submit material data in accordance with Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.
- B. Submittals shall include the following:
 - 1. Provide two copies of:
 - a. Manufacturer's certification or independent test reports confirming that materials meet or exceed performance criteria specified.
 - b. Reports from reputable independent testing agencies, of product proposed for use, which indicate conformance to ASTM E84 and (E119).

1.04 QUALITY ASSURANCE

- A. Applicator: Acceptable to sprayed fireproofing material manufacturer.
- B. Regulatory Requirements:
 - 1. Underwriters Laboratories, Inc.: Products, execution and thickness shall conform to approved UL designs as published in UL Fire Resistance Directory.
 - 2. Conform to NFPA code for fire resistance ratings.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver in unopened containers with UL label verifying compliance with UL quality control program, appropriate fire resistance ratings, manufacturer and brand name.
- B. Keep dry until ready for use. Store off the ground, under cover and away from damp surfaces. Discard all material exposed to water. Rotate stock and use before expiration date.

1.06 ENVIRONMENT REQUIREMENTS

- A. Maintain an air and substrate temperature of 40°F for 24 hours before and a minimum of 24 hours after application of the fireproofing. Air temperature and available ventilation based on job conditions will determine length of drying time required following initial application of the product.
- B. In areas lacking natural ventilation, provide forced air circulation.

- C. Provide a "Material Safety Data Sheet" for the materials proposed for installation.

PART 2 PRODUCTS

2.01 FIREPROOFING

- A. Cementitious spray applied fireproofing as Monokote manufactured by W.R. Grace Company, Intek, Southwest Fireproofing, or approved equal. Formulated without asbestos.

1. SPRAYED INSULATION

- a. Sprayed cellulose thermal insulation, High R-value system
- b. Meet the following ASTM: D739 for floor assembly, N852 for beams, X854 for columns, and P732 for roofs

2.02 SPRAYED WATERPROOFING

- A. Factory mixed material applied to provide compliance with the following performance specifications and test criteria:

1. Dry Density: The field density measured and reported in accordance with ASTM E605.
2. Deflection: No cracks or delamination when tested in accordance with ASTM E760.
3. Impact Resistance: No cracks or delamination when tested in accordance with ASTM E760.
4. Bond Strength: Minimum 200 psf when tested in accordance with ASTM E736.
5. Air Erosion: Maximum 0.025 gm./ft.² allowable weight loss when tested in accordance with ASTM E859.
6. Compression: Ten percent maximum deformation when subjected to 500 psf compressive forces in accordance with ASTM E761.
7. Corrosion Resistance: No evidence of corrosion on steel when tested in accordance with ASTM E937.
8. Abrasion: No more than 1.34 cubic inches shall be abraded or removed from the substrate when tested in accordance with the test methods developed by the City of San Francisco, Bureau of Building Inspection and as required by the Department of the Navy, Naval Facilities Engineering Command (NAVFAC).
9. Impact Penetration: The fireproofing material shall not show a loss of more than 0.37 cubic inches when subjected to impact penetration tests in accordance with the test methods developed by the City of San Francisco, Bureau of Building Inspection and as required by the Department of the Navy, Naval Facilities Engineering Command (NAVFAC).
10. Surface Burning Characteristics: ASTM E84; 0 flame spread, 0 smoked developed.

- B. Mixing water shall be clean, fresh and suitable for domestic consumption and free from such amounts of mineral or organic substances as would affect the set of the fireproofing material.

PART 3 EXECUTION

3.01 PREPARATORY WORK

- A. Where necessary, verify surfaces are clean and ready to receive fireproofing.
- B. Confirm compatibility of surfaces to receive fireproofing material.
 - 1. Painted steel surfaces may require a full scale fire test in accordance with ASTM E119 to determine if the paint formulation will impair adhesion of the fireproofing material at elevated temperatures.
- C. Prior to application of fireproofing, verify that clips, hangers, supports, sleeves and other items required to penetrate fireproofing are in place.
- D. Verify ducts, piping, equipment, or other items which would interfere with application of fireproofing materials are not positioned until fireproofing Work is complete.
- E. Remove loose and damaged fireproofing from areas disturbed by construction.
- F. Prior to application of fireproofing to underside of roof deck, verify roofing application is completed and roof traffic has ceased.

3.02 PROTECTION

- A. Protect adjacent surfaces and equipment from damage by overspray, fallout and dusting.
- B. Close off and seal ductwork in areas where fireproofing is being applied.

3.03 APPLICATION

- A. Repair damaged fireproofing as required.
- B. Apply fireproofing in strict accordance with manufacturer's instructions.
- C. Apply fireproofing in sufficient thickness to achieve rating with as many passes as necessary to cover with monolithic blanket of uniform density and texture.

3.04 FIELD QUALITY CONTROL

- A. Field testing will be performed as directed by the Port.
- B. Verify the thickness and density of the fireproofing in accordance with provisions of ASTM E605 or latest edition of UBC Standard.

3.05 PATCHING

- A. Inspect members for complete coverage. After completion of other Work, correct damaged areas.

PART 4 MEASUREMENT AND PAYMENT

4.01 PAYMENT

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of

Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontrator (of any tier) or Supplier.

B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

End of Section

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

- A. The extent and location of "Firestopping" and "Firesafing" Work is shown in the Contract Documents.
- B. Firestopping of all penetrations through fire barriers, including voids around pipes, ducts, conduit, and other openings, as required by authorities having jurisdiction.

1.02 GOVERNING CODES, STANDARDS, AND REFERENCES

- A. ANSI/UL 1479 "Fire Tests of Through-Penetration Firestops" firestop testing
- B. ANSI/UL 1479 firestop testing
- C. ANSI/UL 1479 fire resistance and hose stream tests
- D. ASTM E84 flame spread
- E. ASTM E84 smoke development
- F. ASTM E136 combustibility
- G. ASTM E814 "Standard Method of Fire Tests of Through-Penetration Fire Stops" firestop testing
- H. ASTM E814 firestop testing
- I. ASTM E814 fire resistance and hose stream tests

1.03 SUBMITTALS

- A. Submit materials data in accordance with Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.
- B. Submittals shall include the following:
 - 1. Include firestopping composition, performance characteristics, and installation procedures.
 - 2. Shop Drawings: Shop drawings showing material installation details including reinforcement, anchorage, and fastenings.
 - 3. Certificates of Compliance: Manufacturer's certificates of compliance that the materials meet the requirements specified.

1.04 QUALITY ASSURANCE

- A. Firestops shall have been tested in accordance with ASTM E814 "Standard Method of Fire Tests of Through-Penetration Fire Stops" or ANSI/UL 1479 "Fire Tests of Through-Penetration Firestops". The firestopping material shall remain securely installed and capable of maintaining its integrity when subjected to such tests.
- B. For mechanical and electrical penetrations which have characteristics (e.g., pipe material and diameter, pipe insulation type and thickness, type of wall that is penetrated) that have not been tested in accordance with ASTM E814 or ANSI/UL 1479 by any firestop manufacturer, provide a written certification stating that the manufacturer's firestop material will meet the requirements for successfully passing the tests in ASTM E814 or ANSI/UL 1479. The certification shall also

contain firestop installation procedures (e.g., sleeve material and size, annular space requirements, quantity of firestop material required). This certification shall be submitted to the local fire authority, with approval of the firestop by that local authority required before ordering.

1.05 DELIVERY AND STORAGE

- A. Deliver materials to the project site in the original unopened containers or packages bearing the manufacturers' names, brand designations, and product descriptions. Store materials under cover and protect from damage. Do not use damaged materials.

1.06 SAMPLING/TESTING

- A. Plan for 10 percent random destructive sampling for testing and inspection. If made, cutouts shall be made representative of each type of system used in the firestopping Work, made by firestopping installer in the presence of the Engineer. Replace cutouts at no additional cost to the Port of Seattle.

PART 2 PRODUCTS

2.01 FIRESTOPPING MATERIALS

- A. Firestopping material shall be asbestos-free and capable of maintaining an effective barrier against flame and gases in compliance with the following requirements:
 - 1. Flame Spread: 25 or less, ASTM E84.
 - 2. Smoke Development: 50 or less, ASTM E84.
 - 3. Fire Resistance and Hose Stream Tests: Firestopping materials shall be rated "F" and "T" in accordance with ASTM E814 or ANSI/UL 1479. Rating periods shall match hour rating of assembly in which firestop material is installed.
 - 4. Combustibility: Non-combustible, ASTM E136.

2.02 SMOKESTOPPING MATERIAL

- A. Smokestopping material shall meet the same requirements as specified for firestopping material.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Firestopping Locations: Provide firestopping material in the following locations:
 - 1. Mechanical and electrical penetrations (e.g., insulated and non-insulated pipe, tubing, wiring, raceways, cable, conduit, and ductwork without fire dampers) through time-rated floors and partitions, and fire walls.
 - 2. Openings between walls and ceilings of time-rated assemblies.
 - 3. Openings and penetrations in enclosures with time-rated doors.
 - 4. Unused openings in floor slabs.
 - 5. Other locations indicated, specified, or required by codes or local authorities.

- B. Coordination with Other Trades: Coordinate annular space, sleeve, and insulation requirements with Work of Division 21 Fire Suppression, Division 22 Plumbing, Division 23 Heating, Ventilating and Air Conditioning and Division 26 Electrical. Firestopping material at penetrations of insulated pipes shall be applied after the insulation is installed. The firestopping material selected for use with insulated pipes shall have been tested in accordance with ASTM E814 or ANSI/UL 1479 for that particular insulated pipe assembly. Calcium Silicate, or other pipe insulation, may be substituted for fiberglass pipe insulation through the sleeve if the insulation is part of an assembly which meets the requirements specified for firestopping.
- C. Surface Preparation: Surfaces to be in contact with firestopping materials shall be free of dirt, grease, oil, loose material, rust, or other substances that may affect proper fitting or the required fire resistance.
- D. Install firestopping materials in accordance with the manufacturer's instructions.
- E. Examine firestopped areas to ensure proper installation. Seal and correct deficiencies prior to concealing or enclosing the areas.

PART 4 MEASUREMENT AND PAYMENT

4.01 PAYMENT

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by a Subcontractor (of any tier) or Supplier.
- B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

End of Section

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of "Joint Sealer" Work is shown in the Contract Documents.

1.02 GOVERNING CODES, STANDARDS, AND REFERENCES

- A. ASTM C920 type 1 sealant
- B. ASTM C920 type 2 sealant
- C. ASTM C920 type 2 sealant increase and decrease of 50 percent of joint width
- D. ASTM C920 type 3 sealant
- E. ASTM C920 type 7 sealant

1.03 SUBMITTALS

- A. Submit material data in accordance with Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.
- B. Submittals shall include the following:

1.04 WARRANTY

- A. Warranty: Provide a written warranty based on model form in Section 01 78 36 - Warranties and Bonds warranting caulking to be free of all defects in materials and workmanship for a period of 3 years from date of acceptance of buildings. Signed by subcontractor and countersigned by Contractor. Leakage, hardening, staining, separation, crumbling, running, melting will be considered defects; replace all defective caulking at no cost to the Port of Seattle.

1.05 DELIVERY

- A. Deliver in manufacturer's original sealed containers.

PART 2 PRODUCTS

2.01 ELASTOMER SEALANT

- A. Type 1 Sealant: Multi-part nonsag urethane sealant, conforming to ASTM C920, Type S, Grade NS, Class 25. Vulkem 227 as manufactured by Mameco International, Dymeric as manufactured by Tremco Inc., Or Approved Equal.
- B. Type 2 Sealant: One-part nonsag low modulus urethane sealant, conforming to ASTM C920, Type S, Grade NS, Class 25, with additional capability to withstand an increase and decrease of 50 percent of joint width as measured at time of application and remain in compliance with other requirements of ASTM C920. Vulkem 921 as manufactured by Mameco International, Sikaflex-15LM as manufactured by Sika Corp., Or Approved Equal.
- C. Type 3 Sealant: Two-part pourable urethane sealant, conforming to ASTM C920, Type M, Grade P, Class 25, Uses T, M. Vulkem 245 as manufactured by Mameco International, Isoflex 880 G.B. as manufactured by The Harry S. Peterson Co., Sonolastic Paving Joint Sealant as manufactured by Sonneborn Building Products Div. of Rexnord Chemical Products, Or Approved Equal.

- D. Type 7 Sealant: One-part mildew-resistant silicone sealant, conforming to ASTM C920, Type S, Grade NS, Uses NT, G, A, O. Dow Corning 999 as manufactured by Dow Corning, Proglaze as manufactured by Tremco, SCS 1200 as manufactured by General Electric Co., Or Approved Equal.
- E. Type 8 Sealant: Preformed, pre-compressed, impregnated open-cell foam sealant manufactured from high-density urethane foam impregnated with a non-drying water-repellant agent; density 8-10 lb./cu. ft. Will-Seal Tape Type 150 as manufactured by Illbruck; Polytite R as manufactured by Sandell Mfg. Co., Or Approved Equal.
- F. Color: The color of the sealant or caulking compound shall approximate the color of the adjacent surfaces, unless otherwise directed by the Architect.

2.02 PRIMERS

- A. Use primers as required by manufacturers.

2.03 BACKING

- A. Closed cell butyl sponge rod, closed cell polyurethane rod, or polyethylene foam. Dimension shall be one-third larger than the joint width. Open celled foam backing shall be accompanied by masking tape to prevent adhesion of sealant to backing.

PART 3 EXECUTION

3.01 CAULKING WITH ELASTOMER SEALANTS

- A. General: All exterior joints and all other joints marked "sealant" except those included under another section.
- B. Joints: Depth of sealant not less than joint width.

3.02 SCHEDULE OF SEALANT USAGE

- A. Exterior:
 - 1. Perimeter of Framed Openings: Type 1.
 - 2. Flashing and Coping Joints: Type 2.
 - 3. Sidewalk Joints: Type 3.
 - 4. Compression Seal Between Skylight and Metal Flashing: Type 8.
- B. Interior:
 - 1. Perimeters of Interior Openings: Type 1.
 - 2. Floor Joints: Type 3.
 - 3. Joints at Vertical Surfaces of Toilet Rooms, Showers, Kitchens: Type 7.

3.03 JOINT PREPARATION

- A. General: Surfaces to receive caulking compound or sealants shall be clean and dry. Mask surfaces adjacent to joints required for complete protection. Joints over 3/4 inch deep which are to be caulked shall be packed with back-up material to within 1/2 inch of the surface, or have polyethylene rod applied to within 1/4 inch of the surface when the joint is to be sealed.
- B. Concrete and Masonry Surfaces: Sandblast or rough brush to remove all dust, dirt, laitance, grease and other foreign matter.

- C. Metal and Glass: Use an oil-free solvent recommended by sealant manufacturer. Take care not to contaminate solvent supply. Use "progressive cleaning" method; i.e., wipe surface to be cleaned with solvent-soaked clean cloth and immediately wipe dry with dry cloth.

3.04 APPLICATION

- A. General: Except where sealant is specified or noted on the drawings, apply the caulking with a gun having a nozzle of proper size to fill the joints and voids solid. Superficial painting with a skin bead will not be accepted. After applying the material, tool the joint as recommended by the sealant manufacturer and remove the surplus material immediately.
 - 1. Install backing rod at all locations. All materials are to be installed by skilled workmen in the following manner: Place nozzle of the gun at bottom of the joint and completely fill from the bottom so that sealant or caulking compound is extruded into the joint without the entrapment of air. Tool joint so that sealant or caulking compound is pressed into the joint and wetting of the joint interface is assured. Protect adjacent surfaces which are not to receive sealant or caulking compound by use of masking tape. Tape shall be removed immediately after sealant is applied, leaving a clean, sharp line.

3.05 PROTECTION

- A. Protect all caulked joints for at least 24 hours. Protect from dust, moisture, and other harmful substances during installation.

3.06 CLEANING

- A. Clean adjacent surfaces free of sealant and caulking compound or soiling; clean as Work progresses. Use solvent or cleaning agent as recommended by manufacturer of sealant or caulking compound.
- B. Do not scratch or otherwise damage visible surfaces.

PART 4 MEASUREMENT AND PAYMENT

4.01 PAYMENT

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontrator (of any tier) or Supplier.
- B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the

Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

End of Section

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of the "Metal Doors and Frames" Work is indicated in the Contract Documents. The Work includes the requirement for providing metal doors and frames, anchors, fasteners and accessories.

1.02 GOVERNING CODES, STANDARDS, AND REFERENCES

- A. Asbestos Containing Material (ACM) free, all doors, and shall bear "ACM Free" label
- B. ANSI A115 preparation for hardware
- C. ASTM E152 hourly fire resistant rating
- D. Door and Hardware Institute "Recommended Locations for Builder's Hardware"
- E. Provide Material Safety Data Sheet (MSDS) certifying ACM free products
- F. Steel Door Institute Specifications (SDI 100) metal doors and frames
- G. SDI-105 frame installation
- H. SDI-107 minimum gauge hardware reinforcing gages
- I. Underwriters' Laboratories, Inc. (UL)
- J. UL hourly fire resistant rating
- K. Underwriters' Laboratories, Inc. metal fire-rated doors
- L. International Building Code (IBC) exit closure doors maximum transmitted temperature

1.03 SUBMITTALS

- A. Submit materials data in accordance with Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.
- B. Submittals shall include the following:
 - 1. Shop drawings shall indicate reinforcements, cutouts, joints, welds, anchors, provisions for hardware and weather stripping. See Section 08 70 00 - Hardware.

1.04 QUALITY ASSURANCE

- A. Metal doors and frames shall conform to the requirements of Steel Door Institute Specifications (SDI 100).
- B. All metal fire-rated doors shall be labeled in strict accordance with the specifications and procedures of Underwriters' Laboratories, Inc.
- C. All doors shall be Asbestos Containing Material (ACM) free and shall bear "ACM Free" label.
- D. Provide Material Safety Data Sheet (MSDS) certifying ACM free products.

1.05 PRODUCT HANDLING

- A. Protection:

1. Deliver, store and handle all metal doors and frames in a manner to prevent damage and deterioration.
 2. Provide packaging, such as cardboard or other containers, separators, banding, spreaders and paper wrappings, required to completely protect all metal doors and frames during transportation and storage.
 3. Store doors upright, in a protected dry area, at least one inch off the ground, and with at least 1/4-inch air space between individual pieces; protect all pre-finished and hardware surfaces as required.
 4. Use all means necessary to protect the installed Work and materials of all other trades.
- B. Replacements: In the event of damage, immediately make all repairs and replacements necessary to the approval of the Engineer and at no additional cost to the Port.

PART 2 PRODUCTS

2.01 METAL DOORS

- A. General:
1. All metal doors and frames shall be the product of one manufacturer.
 2. Manufacturers: Products of the following manufacturers, provided they comply with the requirements of the specifications, will be considered acceptable:
 - a. Builders' Hardware & Supply
 - b. Amweld Building Products, Inc.
 - c. Kewanee Corporation.
 - d. Steelcraft Manufacturing Co.
 - e. Or Approved Equal.
- B. Type and Design:
1. General: All metal doors shall be full-flush design, in the dimensions indicated on the drawings, labeled or non-labeled as indicated on the Door Schedule.
 2. Exterior Doors: Grade III - Extra Heavy-Duty, Model 2 - Seamless (16 gauge).
 3. Interior Doors: Grade II - Heavy-Duty, Model 2 - Seamless (18 gauge.).
- C. Fabrication
1. Close top and bottom of exterior doors as integral part of door construction or by addition of minimum 16 gauge inverted steel channels.
 2. Face sheets shall be joined at vertical edges with full length welds; all welds shall be ground smooth, flush, and invisible. Exterior doors shall have flush filler tops.

3. Reinforce steel stiffened custom-made doors with minimum 22 gauge vertical stiffeners, welded 6 inches on center to face material.
 4. Completely fill cores of interior steel reinforced doors with 3 pound density mineral sound-deadening material; insulate exterior steel reinforced doors with 6 lb. density insulation to provide a "U" factor of 0.14.
 5. Bevel vertical edges of single acting doors 1/8 inch in 2 inches; round vertical edges of double acting doors on 2-1/8 inch radius; provide reverse bevel on meeting edge of inactive leaf of pairs of doors, except where exit devices are specified.
- D. Provide for glazing in doors as scheduled. Non-removable minimum 20 gauge glazing stops shall occur on the outside of exterior doors and on the reverse side of interior doors. Glazing beads on the inside of glass panels shall be removable. See Section 08 80 00 - Glazing.
1. Comply with additional requirements for hardware preparation as specified.

2.02 METAL FRAMES

- A. Type and Design: All metal frames shall be the types and sizes indicated, labeled, as indicated on the Door Schedule. Frames shall be 16-gauge for exterior doors and 18-gauge for interior doors. Frames may be welded or knock-down type.
1. Fabricate frames with mitered and welded corners; grind all welds smooth.
 2. Form fixed stops to a maximum 5/8-inch depth.
 3. Provide minimum 26 gauge mortar guard boxes to protect hardware preparation from grout.
 4. Provide removable spreader at bottom of door frames.
 5. Drill frames for rubber silencers, except at frames where surface mounted smoke gaskets and sound seals are scheduled; drill for three silencers, equally spaced, at each strike jamb, and two silencers at head above double doors. Silencers provided by finish hardware supplier.
 6. Comply with additional requirements for hardware preparation as specified.
- B. Window framing members shall be fabricated from open section members around perimeter and closed sections for intermediate members with no visible seams. The individual sticks shall be cut to length and noticed to assure square joints and corners. All joints and corners of the window frame assembly shall be continuously welded and ground smooth. Form stops to a minimum depth of 3/4 inch. After fabrication, all window units shall be hot-dipped galvanized.
- C. Wall Anchors: Type and quantity shall be as follows: In all cases, provide UL approved anchors on labeled frames. Provide three anchors per jamb for frames up to 84 inches in height, located opposite the top and bottom hinges and equally spaced between top and bottom anchors. For frames over 84 inches in height, provide four anchors with one anchor for each 24 inches or fraction thereof in height.
1. Anchors in steel stud partitions, minimum 18 gauge steel of sizes and design suited to adjoining wall construction and as recommended by frame manufacturer. Provide 2 head anchors for frames mounted in stud wall if over 48 inches in width.

2. Anchors in concrete, minimum 14 gauge steel welded to frame; provide 3/8 inch "Wej-It," wedge anchor Or Approved Equal expansion bolts through sleeve; do not fill and grind smooth over head with body putty.
- D. Floor Anchors: Minimum 14 gauge steel, welded inside each jamb. Provide type suited for floor construction with not less than 2 inch height adjustment. Anchors shall be drilled for 3/8 inch diameter anchor bolts.
- E. Provide removable stops in lengths required at window frames; stops to be minimum 3/4 inch depth. Stops shall be factory cut, formed of not less than 20 gauge steel and secured to frame at 10 inches on center with Phillips head, cadmium plated shall be used for Aviation Projects countersunk screws. Stops shall be butted at corners.

2.03 SHOP FINISH

- A. Finishes: Shop-finish inside of frames to be grouted with one coat of water-resistant bituminous paint. Pre-clean and shop-prime exposed surfaces of doors and frames with one coat of primer which is compatible with the finish coat specified in Section 09 90 00 - Paints and Coatings.

2.04 HARDWARE PROVISIONS AND REINFORCEMENT

- A. General: Prepare doors and frames to receive mortised and concealed finish hardware in accordance with final Finish Hardware Schedule and templates provided by hardware supplier. Comply with applicable requirements of ANSI A115 series specifications for door and frame preparation for hardware. See Section 08 70 00 - Hardware.
 1. Provide minimum gauge hardware reinforcing gauges as specified in SDI-107.
 2. Reinforce doors and frames to receive surface-applied finish hardware. Drilling and tapping for surface-applied finish hardware may be done at project site. See Section 08 70 00 - Hardware.
 3. Locate finish hardware as indicated on final shop drawings or, if not indicated, in accordance with "Recommended Locations for Builder's Hardware", published by Door and Hardware Institute. See Section 08 70 00 - Hardware.

2.05 LABELED DOORS AND FRAMES

- A. General: Where doors and frames are scheduled to have an hourly fire resistant rating, provide doors and frames constructed, tested, and approved by UL or other agency acceptable to the local Building Official having jurisdiction in accordance with ASTM E152. Each labeled door and frame shall bear specific requirements specified herein, but in all cases label requirements shall take precedence.
- B. If any door or frame designated by the Port to be fire rated cannot qualify for appropriate labeling because of design or any other reason, modify such features as required for labeling and obtain Port's approval of required modifications before commencing fabrication of unit. Where rated doors are scheduled, coordinate doors and frames with specified hardware to furnish a complete fire assembly.
- C. Exit Enclosure Doors: At stairways, provide doors conforming with requirements of IBC; maximum transmitted temperature of 450 degrees F. above ambient temperature.

- D. Astragals: Unless otherwise indicated, provide pairs of rated doors with steel astragals as part of each door/frame fire assembly.

2.06 OTHER MATERIALS

- A. Provide all other materials, equipment, tools and methods required for completion of the fabrication, erection and finishing of steel metal doors and frames as indicated on the drawings.

PART 3 EXECUTION

3.01 PREPARATORY WORK

- A. Inspection: Prior to all Work of this section carefully inspect the Work of all other trades and verify that all such Work is complete to the point where this Work may properly commence.
- B. Discrepancies: In the event of a discrepancy do not proceed with the installation of the metal Work until all such discrepancies have been resolved by the Engineer.

3.02 INSTALLATION

- A. Install frames in accordance with SDI-105 and in accordance with labeling requirements.
- B. Install frames accurately at locations indicated on drawings, plumb, rigid and in true alignment. Secure to floors with expansion bolts set in lead shields or power-driven anchors. Brace frames to retain position and continuously check alignment during construction of adjacent walls. Adjust frame locations using shims as necessary before fastening. Secure to wall construction and seal joint of adjacent construction with sealant specified elsewhere. Install doors accurately with proper clearances. Adjust hardware as required See Section 08 70 00 - Hardware.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.
- B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

End of Section

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of the "Hardware" Work is indicated in the Contract Documents. The Work includes providing all necessary architectural hardware and specialty items for the proper operation, fastening, and locking of doors or other movable closures.

1.02 GOVERNING CODES, STANDARDS, AND REFERENCES

- A. None.

1.03 SUBMITTALS

- A. Submit material data in accordance with Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.
- B. Submittals shall include the following:
 - 1. Samples: If requested by the Engineer, submit one sample of each exposed hardware category, finished as required, and tagged with full description for coordination with the hardware schedule.
 - 2. Samples will be reviewed by the Engineer in coordination with the Port Lock Shops, for design and finish only; compliance with other requirements is the responsibility of the Contractor, the compliance shall be detailed on the submittal. Sample units which are acceptable and remain undamaged through submittal may be used on the project.
 - 3. Manufacturer's Data: Submit manufacturer's data for each item of finish hardware.
 - 4. Hardware Schedule including locks for access panels, mechanical enclosures, electrical enclosures, and restroom accessories:
 - a. At the earliest possible date, submit the Finish Hardware schedule and catalog cuts of each item scheduled. Approval of the Hardware schedule does not relieve the Contractor of the responsibility to fulfill the project requirements in accordance with the contract documents.
 - b. The submitted Finish Hardware Schedule shall indicate the complete designation of every item required for each door or opening. List each opening individually. Each heading shall also indicate opening location, hardware group number, door and frame material, type and size, fire rating, handing, and degree of opening. A cross reference for any abbreviations or symbols used shall be included. Schedules in coded or horizontal format are unacceptable. Submittals not conforming to the above requirements will be returned without review, for re-submittal. Delays due to return of non-conforming submittals are the responsibility of the Supplier and General Contractor.
 - c. A Key Schedule and index shall be included in the submittals indicating the locking function of each Opening for the use in the development of Keying System.

- d. After the schedules have been approved by the Engineer, submit the corrected schedules, with catalog cuts of each item and installation and maintenance instructions for inclusion in the O&M Manual. Submit the corrected schedules.
- 5. Templates: Furnish hardware templates for each fabricator of doors, frames, and other Work to be factory prepared for the installation of hardware. Upon request, check the shop drawings of such other Work to confirm that provisions will be made for the proper installation of hardware.

1.04 QUALITY ASSURANCE

- A. Supplier: Finish hardware shall be supplied by a recognized builders' hardware supplier accepted by the Engineer in coordination with Port Lock Shop. The suppliers shall have not less than two years of experience furnishing hardware in the same area as the project. They shall be a factory authorized distributor of the exit devices, locksets, and door closers. The supplier's organization shall include a member of the American Society of Architectural Hardware Consultants who is available within two working days during the course of the Work to meet with the Port of Seattle and/or Contractor for project hardware consultation.
- B. Installer: Finish hardware shall be installed only by experienced trades people, either at the door and frame fabrication plant or at the project site.
- C. Codes:
 - 1. All finish hardware shall comply with applicable local and state current building codes.
 - 2. Hardware for fire-rated openings shall also be in compliance with all fire building codes applicable to the building. Provide only hardware which has been tested and listed by "UL" for the types and sizes of doors required, and which complies with the requirements of the door and door frame labels.

1.05 SPECIAL WARRANTIES

- A. Finish hardware shall be warrantied against defects in workmanship and operation for a period of one year, backed by a factory warranty of the hardware manufacturer. The following products shall be warrantied for periods beyond one year:
 - 1. Door Locks - Lifetime Mechanical
 - 2. Door Closers - Ten Years
 - 3. Panic Devices - Three Years
 - 4. Power Openers – Two Years
- B. No liability shall be assumed by the hardware supplier where faulty operation is due to improper installation or failure to exercise normal maintenance.

1.06 PRODUCT HANDLING

- A. Packaging:
 - 1. Furnish all finish hardware and specialty items with each unit clearly marked or numbered in accordance with the Hardware Schedule.

2. Pack each item complete with all necessary pieces and fasteners.
 3. Properly wrap and cushion each item to prevent scratches during delivery and storage.
- B. Delivery: Deliver all finish hardware and specialty items to the installers in a timely manner to ensure orderly progress of the total Work.

PART 2 PRODUCTS

2.01 GENERAL

- A. Provide hardware capable of 180° door swing.
- B. Manufacturers: Unless specified otherwise, the numbers listed in the hardware groups are taken from the following manufacturers:

ITEM	BRAND	APPROVED ALTERNATE
Butts	Stanley	Lawrence, McKinney, or approved equal
Latches and Locksets	BEST	None
Surface Door Closers	LCN, Model 4040 series 180° swing	Corbin, Russwin, or approved equal
Door Stops	Glynn-Johnson	Corbin, Checkmate, or approved equal
Push and Pull Plates	Builders Brass, Trimco	Hagar, Tice, or approved equal
Thresholds	Pemko	Reese, National Guard, or approved equal
Door Silencers	Pemko/Rockwood	IVES, National Guard, or approved equal
Weatherstripping	Pemko	Reese, National Guard, or approved equal

- C. Finishes: Unless specified otherwise, all architectural hardware shall be dull chrome, US26D finish except:
 - 1. Door closers - sprayed to match.
 - 2. Kickplates, threshold, weather-strip, and door bottoms - as listed in hardware groups.

2.02 FASTENERS

- A. Provide all necessary screws, bolts, expansion shields, toggle bolts and other proper means for correct and secure application and for corrosive environments. Such fastenings shall be of suitable size and type and shall harmonize with the hardware as to design, material and finish. Excepting where flat-head screws are necessary for proper clearance and fit, use oval-head screws for hardware application.
- B. In general, all exposed screws required for the attachment of architectural hardware items shall be Redd & Prince recessed-head type, No Equal.

2.03 HINGES

- A. All butts shall be of the finish specified above and of the metal indicated by catalog number in the hardware sets.
- B. Provide 1-1/2 pair of butts for doors exceeding 60 inches in height, up to 90 inches. Provide two pair of butts for doors wider than 36" and for hold room doors to Passenger Loading Bridges.
- C. The width of butts shall be as required to clear projecting trim. In no case shall the barrel of butts project more than required by the conditions of installation.
- D. All standard butts shall have concealed tips and a retainer device to prevent rising during use.
- E. All butts shall be full mortise, excepting those to be used on channel iron door frames, which shall be half mortise. The jamb leaves of butts for exterior doors opening out and hung in channel iron frames shall be attached with security machine screws.

2.04 LATCHES AND LOCKSETS

- A. Unless otherwise specified, exposed parts of locks and latches shall be of the metal and finish specified above and shall have the following features:
 - 1. Mortise Type: BEST Series 45H (Levers), No Equal. Heavy duty mortise type with 2-3/4-inch backset and 3/4-inch throw latch bolt, conforming to ANSI A156.13, Series 1000, Operational Grade 1, Security Grade 2. Function and design as listed in hardware groups.
 - 2. Cylindrical Type: BEST Series 93K (Levers), No Equal. Heavy duty cylindrical type with 2-3/4-inch backset and 9/16-inch throw latch bolt, conforming to ANSI A156.2, Series 4000, Grade 1. Function and design as listed in hardware groups.
 - 3. Mortise Deadbolts: BEST Series 38H, No Equal with 2-3/4-inch backset and 1-inch throw deadbolt, conforming to ANSI A156.5, Grade 2. Function and design as listed in hardware groups.

4. Tubular Deadbolts: BEST Series 83T, No Equal with 2-3/4-inch backset and 1-inch throw deadbolt, conforming to ANSI A156.5, Grade 1. Function and design as listed in hardware groups.
5. Provide locksets with figure 8, 7-pin Stanley Security Systems (BEST) Small Format Interchangeable Core (SFIC) cylinders as approved by the Engineer.

2.05 SURFACE DOOR CLOSERS

- A. Surface-type door closers shall be of a well-proven mechanical design, liquid-controlled type, as indicated in the following hardware sets and of the proper size and shall include the following features:
 1. Cast iron or pressure-cast aluminum shell and other cast parts
 2. Wrought parts of malleable iron or steel
 3. Coil spring with power adjustment
 4. Steel, brass, or bronze screws or bolts
 5. Regular, parallel arms as specified
 6. Adjustable back-check
 7. Positive door closing and quiet operation
 8. Five-year factory guarantee warranty of satisfactory performance
- B. Closers shall in no case limit the swing of the door and shall permit the door to open as far as construction conditions permit or to the degree specified.
- C. Closers shall be provided with key-type regulating screws.

2.06 DOOR STOPS AND HOLDERS

- A. Provide door stops and holders of the type indicated by catalog number in the hardware groups.
- B. Holders shall be of the proper size and operation to suit the individual door and swing.
- C. If wall bumpers cannot be used due to unusual wall conditions, furnish floor-type stops, F8064X series, Or Approved Equal. Where wall bumpers are used, install solid backing between the wall studs.
 1. Trimco, 1200 Floor Stop
 2. Rockwood, ASSA ABLOY, 470 Floor Stop
 3. Ives, FS444, Floor Stop
 4. Or Approved Equal

2.07 KICKPLATES

- A. Unless specified otherwise, kickplates for exterior doors shall be of 16 gage stainless steel, beveled on four edges; kickplates for interior doors shall be 0.125-inch thick Panelyte or approved Equal, color selected by the Engineer.

- B. Generally, kickplates shall be ten inches high, with a length equal to the width of the door leaf, less clearance for stops unless otherwise noted or specified on the drawings.
- C. Install kickplates with oval-head, full-thread stainless steel screws spaced uniformly at a maximum of eight inches.

2.08 DOOR SILENCERS

- A. Provide rubber door silencers for all door frames at openings having single-acting doors in wood or pressed steel frames.
- B. Provide three silencers for single doors. Locate and install in accordance with manufacturer's printed instructions.

2.09 KEYING

- A. Locksets and cylinders shall be keyed into the existing BEST Lock Co. factory registered Master Key System using figure 8, 7 pin Small Format Interchangeable Cores (SFIC), as approved by the Engineer.
- B. Provide construction cylinders and keys during the construction period.
- C. The lock manufacturer's representative shall meet with the Port of Seattle to prepare the permanent keying schedule.
- D. For locks other than BEST, furnish 2 keys per lock.
- E. For BEST locksets, the permanent key cores shall be furnished provided by the Port of Seattle Lock Shops.
- F. Keys shall match existing Port keys. In addition to the BEST keys for personnel and roll up doors, the current keys in use are:
- G. Furnish:
 - 1. Six Master Keys per set.
 - 2. Four change keys per lockset or cylinder.
 - 3. Six construction keys.
 - 4. Contractor will not supply keys for BEST locksets.

Key	Blank	Application
Flat blade screwdriver		Access panels which are not specified with a key
NSR251		Square D Panels
CAT 45		Access panels, plumbing, piping and other cabinets
Simplex	B	Fire Alarm panels
LL805		Fire Alarm panels
E158	Illinois Lock Co.	Emergency Fuel Shut Off (EFSO)

2.10 HARDWARE SCHEDULE

- A. Refer to Door Schedule and previously listed instructions for related information concerning following hardware groups.

PART 3 EXECUTION

3.01 PREPARATORY WORK

- A. Inspection: Prior to all Work of this section, carefully inspect the Work of all other trades and verify that all such Work is complete to the point where this Work may properly commence.
- B. Discrepancies: In the event of a discrepancy, do not proceed until resolved by the Engineer.

3.02 INSTALLATION

- A. General:
1. Locate hardware strictly in accordance with the hardware manufacturer's printed instructions.
 2. Mortise doors as required before painting. Remove locks and latches until painting is done, then reinstall.
 3. Cover and protect exposed surfaces of hardware in an approved manner during installation and construction operations to avoid damage to finishes.
 4. Install all locksets with a 2-3/4 inch backset unless otherwise specified. Provide soffit shoes for all closers, parallel arm or regular style as required. The installation shall be done by skilled workers using jigs to ensure proper alignment of the butts to permit doors to swing freely. Adjust all moving parts to operate freely at the time of final acceptance. The Contractor shall make any further adjustments required during the one-year warranty period.

- B. Standard Dimensions: Unless otherwise indicated or required, locate hardware items as follows:

Latch and Locksets	38" finish - floor to center of knob
Dead Locks	60" finish - floor to center of cylinder
Push Plates	48" finish - floor to center of push plate
Pulls (on plates)	42" finish - floor to center of pull
Top Hinge	5" head - rabbet to top of hinge
Bottom Hinge	10" finish - floor to bottom hinge
Center Hinge	equal distance between top and bottom hinges

- C. Verify all dimensions and ensure the correct installation and fit of hardware at the locations indicated on the drawings and as specified.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.

B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

End of Section

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of "Wall Louvers" Work is indicated in the Contract Documents.

1.02 GOVERNING CODES, STANDARDS, AND REFERENCES

- A. ASTM B221 aluminum extrusions alloy 6063-T52
- B. Sheet Metal and Air Conditioning Contractor's National Association (SMACNA) fabrication, construction details and installation procedures

1.03 SUBMITTALS

- A. Submit material data in accordance with Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.
- B. Submittals shall include the following:
 - 1. Shop Drawings: Submit shop drawings for the fabrication and erection of louver assemblies which are not completely shown by the manufacturer's data sheet. Include details of sections and connections at not less than 3"-to-1'0" scale. Show anchorage and accessory items.
 - 2. Samples: Submit samples, six inches square, of the type of metal finish required. Prepare samples on metal of the same gage and alloy to be used in the Work. Samples will be reviewed by the Engineer for color and texture only. Compliance with all other requirements is the exclusive responsibility of the Contractor and the compliance shall be detailed in the submittal. .
 - 3. Workers Qualifications: Submit qualifications of all workers that will perform Work covered by this section.

1.04 QUALITY ASSURANCE

- A. Comply with SMACNA (Sheet Metal and Air Conditioning Contractor's National Association) recommendations for fabrication, construction details and installation procedures, except as shown or specified.
- B. Verify size, location and placement of louver units prior to fabrication, wherever possible. Coordinate field measurements and shop drawings with fabrication and shop assembly to minimize field adjustments, splicing, mechanical joints and field assembly of units. Preassemble units in sections as large as practicable.
- C. Qualifications of Workers: Provide at least one person who shall be present at all times during execution of this portion of the Work and who shall be thoroughly familiar with the type of materials being installed and the best methods for their installation and who shall direct all Work performed under this section.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Acceptance at Site: Verify undamaged condition.
- B. Protection prior to application installation:
 - 1. Store under cover
 - 2. Take whatever steps necessary to prevent damage.

- C. Handle carefully at all times to prevent scratching or other defacement.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Aluminum Extrusions: ASTM B221, Alloy 6063-T52.
- B. Fastenings: Use the same material as that for items fabricated, unless otherwise specified. Fasteners for exterior applications may be hot-dip-galvanized stainless steel or aluminum. Provide types, gages and lengths to suit unit installation conditions. Use Phillips flathead machine screws for exposed fasteners, unless otherwise shown or specified.

2.02 EXTRUDED ALUMINUM LOUVERS

- A. Manufacturer: "Airolite" products are specified. Comparable products by "Construction Specialists", Vent cover are also approved, Or Approved Equal. (Airolite Model K609) is cited for type, quality and construction required.
- B. Provide extruded aluminum louvers, stationary type, with extrusions not less than 0.80 inch thick, of the type, depth and size indicated.
- C. Fabricate frames to suit adjacent construction. (See Section 07 60 00 - Flashing and Sheet Metal.)
- D. Assemble louvers and provide all supports, anchorages and accessories for complete installation.
- E. Provide vertical mullions where louver openings exceed manufacturer's recommended span tabulations.
- F. Locate sills where shown, of the same material and thickness as the louvers.
- G. Finish exposed-to-view aluminum surfaces as specified under paragraph 2.04 - Finishing.

2.03 LOUVER SCREENS

- A. Provide removable screens for all exterior louvers, unless otherwise shown.
- B. Fabricate screen frames of the same metal type and finish as the louver units to which secured, unless otherwise shown.
- C. Provide re-wireable frames consisting of formed or extruded metal with a driven spline or insert for securing screen mesh.
- D. Provide bird screening of 1/2 inch square mesh, 0.064 inch anodized aluminum wire. Locate screens on the inside face of louvers, unless otherwise shown. Secure screens to louver frames with machine screws, spaced at each corner and at 12 inches on center between.
- E. Provide bug screens of 1/2 inch square mesh, 0.064 inch anodized aluminum wire.

2.04 FINISHING

- A. See Section 09 90 00 - Paints and Coatings for site painted finish, color as selected by the Engineer.

PART 3 EXECUTION

3.01 PREPARATION

- A. Coordinate setting drawings, diagrams, templates, instructions and directions for the installation of anchorages which are to be connected to fabricated hood on roof. Coordinate the delivery of such items to the project site.

3.02 INSTALLATION

- A. Locate and place louver unit's plumb, level and in proper alignment with adjacent Work.
- B. Use concealed anchorages wherever possible. Provide brass washers fitted to screws where required to protect metal surfaces and to make a weather-tight connection.
- C. Form tight joints with exposed connections accurately fit together. Provide reveals and openings for sealants and joint fillers.
- D. Repair finishes damaged by cutting, welding, soldering and grinding operations required for fitting and jointing. Restore finishes so that there is no evidence of corrective Work as approved by the Engineer. Return items which cannot be refinished in the field to the shop, make the required alterations and refinish the entire unit.
- E. Refer to Section 07 92 00 - Joint Sealers for sealants in connection with the installation of louvers.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontrator (of any tier) or Supplier.
- B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

End of Section

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of "Gypsum Board" Work is shown in the Contract Documents.
- B. Definitions
 - 1. "Paper Cover" means the face paper found on the exterior of all wallboard.
 - 2. "Recycled Gypsum" means gypsum recovered or diverted from the solid waste stream; from construction site and/or manufacturing waste, or synthetic gypsum produced as a by-product of Flue Gas Desulphurization (FGD) or similar processes.
 - 3. "Recycled Material" means post-consumer waste and/or secondary waste that has been recovered or diverted from solid waste, and that can be utilized in place of a raw or virgin material in manufacturing a product.

1.02 GOVERNING CODES, STANDARDS, AND REFERENCES

- A. ASTM A36 interior gypsum panels
- B. ASTM C79 exterior gypsum panels
- C. ASTM C79 gypsum sheathing
- D. ASTM C630 moisture-resistant gypsum board
- E. ASTM C840 "Standard Specifications for the Application and Finishing of Gypsum Board"
- F. ASTM C840 level of finish
- G. International Building Code gypsum board construction
- H. IBC Tables 43-B and 43-C fire-rated construction

1.03 SUBMITTALS

- A. Submit material data in accordance with Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.

1.04 QUALITY ASSURANCE

- A. Conform to the applicable requirements of the International Building Code as it pertains to gypsum board construction.
- B. Conform to the applicable requirements of "Standard Specifications for the Application and Finishing of Gypsum Board" issued by the American Society for Testing and Materials, ASTM C840.

1.05 PRODUCT HANDLING

- A. All materials shall be delivered in original packages, containers, or bundles showing brand name and identifying marks. Protect all material from moisture damage before and after installation. Replace or repair all damaged material at no additional cost to the Port.

PART 2 PRODUCTS

2.01 GYPSUM BOARD MATERIALS

- A. Gypsum Board Shall Contain Recycled Material: Paper cover, 100%; Gypsum core, 10% minimum content recycled gypsum.
- B. Interior Gypsum Panels: ASTM A36. Shall be tapered edge for finished surfaces and butt edge for concealed surfaces; type X fire-rated. Materials shall be the product of Domtar Gypsum, James Hardie Gypsum, U.S. Gypsum, Or Approved Equal.
- C. Exterior Gypsum Panels: ASTM C79. Wall or soffit panels shall have special core and covering T and G edges, core.
- D. Moisture-Resistant Gypsum Board: ASTM C630, standard type, Type X fire-rated, water-resistant gypsum board shall be used in restrooms and other areas of high humidity. The material shall be approved by the Engineer prior to installation.
 - 1. Dens Armor Plus paperless gypsum board by Georgia Pacific
 - 2. Sheetrock Brand Glass-Mat Panels Mod Tough, by USG
 - 3. Or Approved Equal
- E. Gypsum Sheathing: Comply with ASTM C79, moisture resistant type. Nominal Size: Standard width and length, tongue and groove edges, ends square cut. Thickness, 5/8 inch thick or as indicated on the drawings. Gypsum Sheathing shall contain recycled material. Paper cover; 100%, Gypsum core; 10% minimum content recycled gypsum.
- F. Manufacturers: Domtar Gypsum, James Hardie Gypsum, U.S. Gypsum, or Approved Equal.
- G. Thicknesses: As indicated on the drawings for each application.

2.02 ACCESSORY MATERIALS

- A. Fasteners: All fasteners shall be galvanized metal screws specially designed for application of gypsum panels to metal studs.
- B. Cornerbead, Stops and Trim: All accessories shall be galvanized metal or plastic as recommended by the gypsum board manufacturer.
- C. Joint System: The joint system, including tape reinforcement and compound, shall be as recommended by the manufacturer.

2.03 OTHER MATERIALS

- A. All other materials, not specifically described, but required for a complete and proper installation of gypsum wallboard, shall be as selected by the Contractor subject to the approval of the Engineer.

PART 3 EXECUTION

3.01 PREPARATORY REVIEW

- A. Inspection: Prior to all Work of this section, verify that all Work of other trades is complete to the point where this installation may properly commence.

- B. In the event of a discrepancy or omission, notify the Engineer immediately. Do not proceed with the Work in that area until the discrepancy has been resolved by the Engineer.

3.02 INSTALLATION - GYPSUM SHEATHING

- A. Apply tongue and groove sheathing as recommended by manufacturer suiting conditions of installation and including the following:
 - 1. Install with long dimensions horizontal.
 - 2. Abut ends of sheathing at center of supports.
 - 3. Stagger end joints.
 - 4. Attach sheathing to metal studs with screws spaced as recommended by manufacturer.

3.03 INSTALLATION - GYPSUM BOARD PANELS

- A. General: Install all gypsum panels plumb, level and with all abutting edges and ends over supporting members. Use the maximum size and length of boards for the condition of the installation. Gypsum panels shall extend from floor to ceiling in a single length where ceiling height is 12 feet or less. Install board with joints on opposite sides of partition occurring on different studs. Joints shall be staggered in horizontal installations.
- B. Tape all gypsum board. Tape, spackle and sand all exposed gypsum board below suspended ceiling.
- C. Cutting: When cutting of gypsum board is required, cut by scoring and breaking or by sawing, working from the face side. The use of the "score and knockout" method will not be allowed.
- D. Fastening: Space all fasteners in accordance with the manufacturer's recommendations and code requirements.
- E. Ceilings: Install ceilings prior to installing walls where possible. Where permitted by code, float the interior ceiling angles.
- F. Trim: Provide metal or plastic corner beads for all exterior corners. In all finished areas, provide metal or plastic casing [trim] where gypsum board abuts other materials around windows and door frames. Install all trim in strict accordance with the manufacturer's recommendations for method and location. Install trim plumb, level and true to line with firm attachment to supporting members.
- G. Taping and Finishing:
 - 1. General: Contactor shall supply their own heating source. Control heating and ventilating during finishing operations to ensure maintenance of a 55 degree F minimum temperature.
 - 2. Levels of Finish: Finish gypsum panels at levels indicated below, in accordance with ASTM C840, for locations indicated.
 - a. Level 1 - Use in plenums, areas above suspended ceilings: All joints and interior angles shall have tape embedded in joint compound. Surface shall be free of excess joint compound. Tool marks and ridges are acceptable.

- b. Level 2 - Use where water resistant gypsum backing board is used as a substrate for tile: All joints and interior angles shall have tape embedded in joint compound and one separate coat of joint compound applied over all joints, angles, fastener heads, and accessories. Surface shall be free of excess joint compound. Tool marks and ridges are acceptable.
- c. Level 3 - Use in Mechanical Room, Electrical Cabinets, and similar: All joints and interior angles shall have tape embedded in joint compound and two separate coats of joint compound applied over all joints, angles, fastener heads, and accessories. All joint compounds shall be smooth and free of tool marks and ridges.
- d. Level 4 - Use where wall coverings are to be applied: All joints and interior angles shall have tape embedded in joint compound and three separate coats of joint compound applied over all joints, angles, fastener heads, and accessories. All joint compound shall be smooth and free of tool marks and ridges.
- e. Level 5 - Use in all other occupied spaces: All joints and interior angles shall have tape embedded in joint compound and three separate coats of joint compound applied over all joints, angles, fastener heads, and accessories. A thin skim coat of joint compound, or a material manufactured especially for this purpose, shall be applied to the entire surface. The surface shall be smooth and free of tool marks and ridges.

3.04 CLEANUP

- A. Remove scrap materials, tape, taping and finishing compound, sanding dust, from the area prior to painting.

PART 4 MEASUREMENT AND PAYMENT

4.01 PAYMENT

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontrator (of any tier) or Supplier.

- B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the

Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

End of Section

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of "Exterior Lath and Plaster" Work is shown in the Contract Documents.

1.02 GOVERNING CODES, STANDARDS, AND REFERENCES

- A. ASTM C91 masonry cement
- B. ASTM C150 portland cement
- C. ASTM C150 plastic cement
- D. ASTM C206 lime
- E. ASTM C847 metal lathing
- F. ASTM C897 metal lathing
- G. ASTM C926 metal lathing
- H. ASTM C926 mixing
- I. ASTM C1063 metal lathing
- J. Northwest Wall and Ceiling Bureau exterior lathing and plastering

1.03 SUBMITTALS

- A. Submit material data in accordance with Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.
- B. Submittals shall include the following:

1.04 QUALITY ASSURANCE

- A. Conform to requirements of governing codes and ordinances.
- B. Metal lathing: Conform to the latest edition American Society for Testing and Materials Standard Specification for Portland Cement Plastering ASTM C847, C897, C926 and C1063.
- C. Conform to specifications and recommended practices or Northwest Wall and Ceiling Bureau.
- D. Install all items in accordance with manufacturer's instructions.

PART 2 MATERIALS

2.01 LATHING AT SHEATHED WALLS

- A. Welded wire fabric lath shall have two inch openings and shall be made of 16 gage, galvanized wire (self furring) with "D" grade waterproof building paper backing. "Stucco-Rite" standard manufactured by K-Lath Corp., No Equal.

2.02 METAL ACCESSORIES

- A. Shapes used as grounds, size and dimension to provide required plaster thickness. All accessories to be either galvanized or zinc.
 - 1. Corner beads fabricate from 26 gage (min) steel (or UV resistant PVC).

2. Casting Beads fabricate from 24 gage (min) steel (or UV resistant PVC).
3. Control joints fabricate from 26 gage (min) steel (or UV resistant PVC).
4. Foundation sill screeds No. 36 stucco stop by Western Metal Lath & Steel framing products (or Plastic Components No. 631 or 632), No Equal.

2.03 CEMENTAIOUS MATERIALS

- A. Portland Cement: ASTM C150 Type 1 or Type II as required.
- B. Masonry Cement: ASTM C91.
- C. Plastic Cement: ASTM C150 Type 1 or Type II as required.
- D. Lime: Hydrated ASTM C206.
- E. Sand: Clean, suitable for plaster cement Work.
- F. Water: Clean and free from substances harmful to cement.
- G. One-half inch Chopped Fiberglass Strands: E or AR glass as required to resist alkalinity of cement materials used.
- H. Admixtures: Pumping agent may be used if needed for pumpability of cement plaster. Follow manufacturer's instructions for type and amount per mix.

2.04 PROPORTIONS

- A. Base coat proportions (scratch and brown):
 1. Mix according to ASTM C926
- B. Finish coat proportions:
 1. One (1) part Portland Cement
 2. Three-quarters (3/4) or one (1) part Lime
 3. Three (3) parts Sand
- C. Accurately proportion materials for plaster batch with measuring devices of known volume.
- D. Keep water to a minimum in mix.

PART 3 EXECUTION

3.01 INSPECTION

- A. Inspect areas to be plastered, notifying the Engineer at once of items requiring correction, if any. Beginning Work constitutes acceptance of conditions.

3.02 INSTALLATION

- A. Install building paper, lath and accessories as required and per manufacturer's instructions.
- B. Examine construction, grounds and accessories to insure that finish plaster surfaces will be true and plumb by uniform rodding.
- C. Plaster thickness:
 1. First coat - 3/8" or more
 2. Second coat - 3/8" or more

3. (Minimum total thickness of base coats 3/4")
 4. Finish coat - 1/8"
 5. Total thickness - 7/8" to 1"
- D. Apply sufficient material to form keys and bond through lath. Apply second coat with sufficient pressure to insure tight bond to first coat.
- E. Bring surface to true and even plane. Float to uniformly rough surface to provide bond for finish coat.
- F. Finish coat to be sand finish to match interior veneer plaster.
- G. Finish coat to be white.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.

- B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

End of Section

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of "Acoustical Ceiling" Work is indicated in the Contract Documents.

1.02 GOVERNING CODES, STANDARDS, AND REFERENCES

- A. 2012 IBC
- B. ASTM C635 / C635M - 13a: Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings
- C. ASTM E580 / E580M - 11be1: Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions
- D. ASTM C636 / C636M - 13: Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels
- E. ASCE 7-05: Minimum Design Loads for Buildings and Other Structures
- F. Cisca; Ceilings & Interior Systems Construction Association
- G. NWCB; Northwest Wall & Ceiling Bureau Technical Bulletin 401 - Suspension Systems for Acoustical Lay-In Ceilings

1.03 SUBMITTALS

- A. Submit material data in accordance with Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.
- B. Submittals shall include the following:
 - 1. Shop Drawings: Show the proposed method of seismic bracing to conform with design requirements of IBC.
 - 2. Samples: Submit a sample of the acoustical material proposed; show size, texture, color and finish; include complete manufacturer's test data indicating acoustical performance, fire resistance, fire endurance and light reflectance values.
 - 3. Calculations: Submit structural design calculations by a Professional Engineer registered in the State of Washington, defining compliance with seismic bracing requirements of IBC.

1.04 JOB CONDITIONS

- A. Maintain temperature and humidity conditions approximating those in the completed building before, during and after installation of acoustical ceiling materials. Delay installation until the building is enclosed and all "wet" finish Work has dried.

PART 2 PRODUCTS

2.01 ACOUSTIC UNIT MATERIALS

- A. Manufacturers:

1. Armstrong: Miniboard
 2. Celotex: Hytone
 3. USG: Omni
 4. Or Approved Equal.
- B. Acoustic Panel ACT-1 - Conforming to the following:
1. Size: 24" x 24" as indicated on drawings.
 2. Thickness: 5/8"
 3. Composition: Mineral fiber, exterior grade
 4. Light Reflectance: LR-1
 5. NRC Range: 0.50 to 0.60
 6. STC Range: 35 to 39
 7. Edges: Square
 8. Surface Finish: Fissured,
- C. Acoustical Panel ACT-2 – Conforming to the following:
1. Size: 24" x 48" as indicated on drawings.
 2. Thickness: ¾ inch
 3. Composition: Mineral fiber.
 4. Light Reflectance: 90%.
 5. NRC: 0.75
 6. CAC: 35
 7. Edges: Beveled Tegral
 8. Texture: Fine
- D. Spare and extra parts shall be identified for all products, but not provided. Include spare parts information in Operation and Maintenance Manuals.

2.02 METAL SUSPENSION SYSTEM

- A. General: Provide the system manufactured in accordance with requirements of ASTM C635 and as follows: direct-hung type; intermediate heavy-duty classification; seismic bracing as required to conform to IBC requirements. Sections fabricated of Type 6063 T5 extruded aluminum with cross "T's" offset to furnish flush surface with underside of main runner "T's"; finish in white paint finish. Include all main "T's," cross "T's," wall moldings and other accessories required for complete installation.
- B. Accessories: Provide the following accessories for installation where specified or noted:
1. Hold-Down Clips: Acoustical materials of manufacturer's standard type for lay-in panels; number, type and spacing as required for conformance with fire tests.

- 2. Metal Edge Trim: Corrosion-resistant sheet steel; angle or "J" shape; size as suitable for acoustical material; bonderized and painted to match acoustical material.
- C. Hangers: Galvanized, soft-annealed steel wire; gage certified by load test data for five times design load, but in no case less than 12 gage.
- D. Struts and Sway Bracing: Provide all required for conformance with code seismic requirements.

PART 3 EXECUTION

3.01 INSTALLATION

- A. In accordance with NWCB and CISCA performance data and as follows:
 - 1. Inspection: Inspect all spaces to review acoustical ceiling installations to verify their readiness to receive Work. Commencement of installation constitutes acceptance of the Work of other trades. Verify that perimeter wall Work where ceiling abuts is complete and dry, and that all Work above ceiling is complete. It is the Contractor's responsibility to coordinate the Work of all trades to avoid interference in accordance with requirements of ASTM C636.
 - 2. Suspension Systems: Install systems in accordance with the requirements of ASTM E580 and as specified hereinafter. Install systems complete where scheduled, including hanger wires and their anchors or attachment devices. Install perimeter moldings and trim straight and level at heights indicated. Install main runners and cross runners in accordance with ASTM E580. Install main runners on 24-inch centers and connect cross runners at 48-inch centers. Space stabilizer bars at not more than 96-inch centers perpendicular to main runners.
 - 3. Acoustical Panels: Install in a pattern to match existing panels, with tight joints. Cut and fit material as required for installation; where required for fit, provide specially sized or cut pieces and install at perimeters only. Unless otherwise approved, install to true and level planes with all abutting edges flush. Make border units not less than one-half size when measured perpendicular to wall; edge joints tight and in straight lines.
 - 4. Miscellaneous and Cleanup:
 - a. Damage: Unless otherwise approved, replace all damaged and defaced materials.
 - b. Cleanup: Upon completion and after balancing of mechanical systems, clean all soiled materials; reinstall ceilings and level to required lines.
- B. ALLOWABLE TOLERANCES
 - 1. Unless otherwise noted, level within 1/8 inch in 12 feet.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.

B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

End of Section

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of the "Resilient Flooring" Work is indicated in the Contract Documents. Work includes providing base, special moldings, underlayment and all associated materials.

1.02 GOVERNING CODES, STANDARDS, AND REFERENCES

- A. ASTM-F1700 vinyl tile
- B. ASTM F1861 base

1.03 SUBMITTALS

- A. Submit material data in accordance with Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.
- B. Submittals shall include the following:
 - 1. Submit samples of each type of flooring material specified, including accessories, for approval of color, texture and pattern.
 - 2. Submit layout drawings showing location of all panels.
 - 3. Employ at least one person who shall be present at all times during the execution of this portion of the Work and who shall be thoroughly trained and experienced in the installation of the various components specified and who shall direct all Work performed under this section.

1.04 PRODUCT HANDLING

- A. Delivery and Storage of Materials: Deliver all materials to the job site in unopened containers with manufacturers' labels thereon; do not open containers or remove labels until the Engineer inspects and approves.
- B. Precautions: Maintain the temperature of resilient floor covering materials at not less than 70°F for 48 hours just prior to laying.

PART 2 PRODUCTS

2.01 VINYL TILE

- A. ASTM-F1700, Class I, Type A, as manufactured by Amtico, Armstrong, Azrock, Roppe, Or Approved Equal. Standard vinyl flooring tiles; 12-inch x 12-inch size; 3/32-inch thickness.

2.02 BASE

- A. ASTM F1861, Type TP, rubber base, four inch high, top-set, 1/8-inch thickness, with molded corners, as manufactured by Burke, Roppe, Mercer, Or Approved Equal. Color shall be as selected by the Engineer.

2.03 OTHER MATERIALS

- A. General: Provide accessory materials, equipments, tools and methods as required for a complete installation.

- B. Primers, Adhesives and Sealers: Water-resistant types made or recommended by covering manufacturer. Submit a list of types proposed and obtain approval before proceeding.
- C. Reducers: Johnson, Mercer, Or Approved Equal. Standard vinyl floor reducer, thickness to suit adjacent covering thickness; one inch width. Match adjacent flooring material.

PART 3 EXECUTION

3.01 INSTALLATION

- A. General:
 - 1. Install all materials after concrete and masonry is completely dry, in strict accordance with the manufacturer's recommendation and approved by the Engineer; install floor covering by cementing directly to substrate.
 - 2. Condition of Surfaces: Verify the condition of substrates prior to installation; installation of coverings will be construed as acceptance of all conditions of the installation, including temperatures, moisture contents, cleanliness and general condition of substrate. Should surfaces be deemed unacceptable for the installation of covering, notify and await the directions of the Engineer. When required, at no additional cost to the Port, install underlayment material as recommended by the manufacturer.
- B. Installation of Vinyl Tile: Shuffle tile so that finished floors are free of abrupt changes in color or texture. Apply adhesive recommended by the manufacturer for the conditions of the application, spreading adhesive evenly over the surface. Lay tile with the pattern or grain of the tile running in alternate direction; cut and fit tile to room shapes and profiles as scheduled. Lay tile square with the room or space axis.
- C. Installation of Base: Upon unrolling of the base material, lie out and cut to as long lengths as practicable; carefully match edges at all seams, or double-cut adjoining lengths. Arrange with the joints so as to be practically invisible. Adhere base materials securely to substrate, laying the material in straight lines with top edges level and true. Form internal and external corners.
- D. Installation of Accessories:
 - 1. Install the specified accessories in accurate locations as indicated or scheduled on the approved drawings; firmly bond to substrate backing.
 - 2. Provide reducers wherever covering terminates and exposes the edge of floor covering material; where floor covering terminates at a door opening, center stripes under the door. Adhere vinyl reducers securely to floor surfaces in straight, true lines.

3.02 FINISHING

- A. After floor covering, base and accessories have set sufficiently, wash with neutral cleaner; apply two coats of non-slip wax, type recommended by the floor covering materials manufacturer. Buff by machine to a smooth, dull-gloss finish; hand-buff areas inaccessible to machine. Leave surfaces clean and smooth, free from waves, buckles, cracks, projecting edges and other defects.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.

B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

End of Section

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of the "Resilient Wall Base" Work and all associated materials is as shown in the Contract Documents.

1.02 GOVERNING CODES, STANDARDS, AND REFERENCES

- A. None.

1.03 SUBMITTALS

- A. Submit material data in accordance with Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.
- B. Submittals shall include the following:
 - 1. Submit samples of the type of wall base material specified for approval of color, texture and pattern.
 - 2. Employ at least one person who shall be present at all times during the execution of this portion of the Work and who shall be thoroughly trained and experienced in the installation of the wall base specified, and who shall direct all Work performed under this section.

1.04 PRODUCT HANDLING

- A. Delivery and Storage of Materials: Deliver all materials to the job site in unopened containers bearing the manufacturers' labels; do not open containers or remove labels until the Engineer inspects and approves.
- B. Precautions: Maintain the temperature of resilient wall base materials at not less than 70°F for 48 hours before and after laying.

PART 2 PRODUCTS

2.01 BASE

- A. Provide new rubber base four inches and six inches high, as indicated on the drawings, top set, manufactured by Burke, No Equal. Color must be approved by the Engineer.
- B. At carpeted floors, provide new rubber base four inches high carpet base, manufactured by Burke, No Equal. Color must be approved by the Engineer.

2.02 OTHER MATERIALS

- A. General: Provide accessory materials, equipments, tools and methods as required for a complete installation.
- B. Primers, Adhesives and Sealers: Provide water-resistant types made or recommended by the wall base manufacturer;

PART 3 EXECUTION

3.01 INSTALLATION

A. General:

1. Install all materials after the concrete is completely dry, in strict accordance with the manufacturer's recommendation; install wall base by cementing directly to substrate.
2. Condition of Surfaces: Verify the condition of substrates prior to installation; installation of wall base will be construed as acceptance of all conditions of the installation, including temperatures, moisture content, cleanliness and general condition of the substrate. Should surfaces be deemed unacceptable for the installation of wall base, notify and await the direction of the Engineer.

- B. Installation of Base:** Lay out base material and cut to lengths, carefully match edges at all seams, or double-cut adjoining lengths. Arrange the joints so as to be practically invisible. Adhere base materials securely to the substrate, laying the material in straight lines with top edges level and true. Form internal and external corners.

3.02 FINISHING

- A.** After the base has set sufficiently, wash with neutral cleaner; apply two coats of non-slip wax, type as recommended by the base materials manufacturer. Buff to a smooth, dull-gloss finish. Leave surfaces clean and smooth, free from waves, buckles, cracks, projecting edges and other defects.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontrator (of any tier) or Supplier.

B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

End of Section

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. Extent and location of "Acoustical Insulation" Work is indicated in Contract Documents.

1.02 GOVERNING CODES, STANDARDS, AND REFERENCES

- A. ASTM C655 sound attenuation blankets
- B. ASTM E90 mineral-fiber sound attenuation blanket
- C. UL-723 sound attenuation blankets

1.03 SUBMITTALS

- A. Submit material data in accordance with Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.

1.04 PRODUCT HANDLING

- A. Protection from Deterioration: Do not allow insulation materials to become wet or soiled, or covered with ice or snow. Comply with the manufacturer's recommendations for handling, storage and protection during installation.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Sound Attenuation Blankets: Semirigid, friction-fit, spun mineral-fiber blanket without membrane covering; flame-spread, smoke, and fuel ratings of less than 25 UL-723; ASTM C655, Type I; type recommended by manufacturer for maximum sound attenuation; thicknesses as indicated.
- B. Mineral-Fiber Sound Attenuation Blanket: Manufacturer's special formulation and density of not less than four pounds per cubic foot as required for STC rating of 30 when three-inch thickness is tested with one face of heavy Kraft paper ASTM E90.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Comply with manufacturer's instructions for the particular conditions of installation.
- B. Extend insulation at full thickness, as shown, over entire surface to be insulated; cut and fit tightly around obstructions and fill voids with insulation and mastic.
- C. Apply a single layer of insulation of the required thickness unless otherwise shown or required to make up the total thickness. Extend full height from floor to deck.

PART 4 MEASUREMENT AND PAYMENT

4.01 PAYMENT

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of

Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontrator (of any tier) or Supplier.

B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

End of Section

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of "Paints and Coatings" Work is indicated in the Contract Documents.
- B. Surfaces Not To Be Painted
 - 1. Unless specifically specified otherwise, the following surfaces are not to be painted:
 - a. Exposed finish metals (aluminum, brass, bronze, stainless steel, copper, chrome).
 - b. Sealant, interior and exterior.
 - c. Ceramic tile, brick.
 - d. Exterior concrete (both precast and cast-in-place).
 - e. Glass and plastic laminate.
 - f. Resilient floor coverings, bases, mats.
 - g. Acoustic tile, lay-in panels, metal suspension systems.
 - h. Items having a complete factory finish, except items built into surfaces which have painted finish.
 - i. Permanently concealed surfaces need not be painted, except for prime coats on metal and millwork.

1.02 GOVERNING CODES, STANDARDS, AND REFERENCES

- A. All semi-gloss
- B. Federal Specification Standards materials
- C. Manual of Uniform Traffic Control Devices paragraph 3B-18 layout
- D. MPI appendix
- E. MPI exceptions
- F. MPI linked cross-references
- G. Master Paint's Institute Manual additional approved manufacturers - paint
- H. Master Painter's Institute Manual listed type brand and manufacture
- I. Master Painter's Institute materials not specifically noted
- J. MPI preparing painting and finishing schedules
- K. MPI references
- L. MPI selection references
- M. Master Painter's Institute Inc. (MPI) standard specifications 90.00
- N. MPI supplementary references
- O. MPI surfaces not scheduled
- P. SSPC SP-1 ferrous metal surfaces

- Q. State Specification Standards materials
- R. Exterior 1-A, 1-B, 1-F
- S. Exterior 2-A, 2-E
- T. Exterior 11-A, 11-B, 11-C
- U. Exterior 13-A, 13-D
- V. Exterior 16-A
- W. Exterior 17-A
- X. Exterior 18-A, 18-B
- Y. Interior 1-A,
- Z. Interior 3, 3-G, 3-H
- AA. Interior
- BB. Interior 11-A, 11-C
- CC. Interior 12-A, INT 12-A,
- DD. Interior 15-A, 15-B
- EE. Interior 17-A

1.03 SUBMITTALS

- A. Submit material data in accordance with Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.
- B. Submittal shall include the following:
 - 1. Submit color samples of all paints allowing ample time for consideration before the material to be painted is delivered or ready for painting. Where the same color stain is applied to different kinds of wood, carefully sample and test mixing proportions to arrive at the same relative appearance.

1.04 QUALITY ASSURANCE

- A. Standard Specifications: "Master Painter's Institute" (MPI), latest edition, published by the Master Painters Institute Inc., Las Vegas, Nevada (604) 298-7578. The words "Specifying Authority" as used in the Standard Specifications Section shall mean the Port of Seattle.
- B. Application: Shall be by an experienced painter or a painting firm employing experienced personnel.
- C. Manufacturers' Specifications, Directions and Recommendations: Conform to manufacturers' specifications, directions and recommendations for best results in the use of each of their products for each condition. If results are at variance with these specifications, report the discrepancy to the Resident Engineer for decision.
- D. Layout: The location, lettering size, and style of the surface regulatory signs shall be in accordance with the applicable portions of paragraph 3B-18 of the "Manual of Uniform Traffic Control Devices" as published by the U.S. Department of Transportation, Federal Highway Administration.

1.05 PRODUCT HANDLING

- A. Delivery and Storage: Deliver paint materials in unbroken, unopened containers bearing the manufacturers' labels. Do not open containers or remove labels until the Engineer inspects and approves. Store materials in a dry location where the indicated ambient temperature of storage is not less than 50°F.
- B. Precautions: Take extraordinary care to prevent fire, open containers or inflammable materials only as needed. Keep rubbing cloths and oily rags in tightly closed metal containers, or remove from the site daily. Benzene, gasoline and distillate will not be permitted on the job site.
- C. Protection: Care shall be exercised in the handling of painting materials to ensure that this Work and the Work of other trades are not damaged before, during, or after the installation.
- D. Replacements: Repair or replace damaged Work, if any, as necessary to the approval of the Engineer at no additional cost to the Port.

PART 2 PRODUCTS

2.01 MATERIALS

- A. General: Unless otherwise specified, furnish paint, varnish, stain, enamel, lacquer, fillers and related products for prime and intermediate and finish coats, of a type brand and manufacture listed in Master Painter's Institute Manual, latest edition, factory-labeled for positive identification. Materials not specifically noted in the Master Painter's Institute Manual, and required for the Work such as linseed oil, shellac, thinners or other materials required for the Work, shall be of quality not less than required by applicable published Federal or State Specification Standards, and as manufactured by approved firms.
- B. Materials selected for coating systems for each type of surface shall be the product of a single manufacturer.
- C. All paint materials shall be the respective equivalent, in the opinion of the Engineer, to the several types of materials specified. Deliver all materials to the job site in the original, unbroken containers, bearing the manufacturers' labels indicating the contents and directions for use, storage and handling.
- D. Materials not specifically noted but required for the Work, such as linseed oil, shellac, thinners, or other materials, shall be the product of the approved paint manufacturer.

2.02 MIXING

- A. Mix paint products according to the manufacturer's printed directions. Do not adulterate in any manner except upon specific approval of, and in the presence of, the Engineer.

2.03 COLOR SELECTION

- A. The color selection will be made by the Architect basically from Port of Seattle Standard Colors, with additions from other standards as designated by the Engineer.

2.04 IDENTIFICATION

- A. The manufacturer's identification numbers and specifications listed are for the purpose of indicating the type and quality of paint product desired for the purpose indicated.

2.05 SUBSTITUTIONS

- A. If the Contractor desires to use an alternate manufacturer's materials or methods of application, these shall be submitted in writing to the Architect's for review and approval prior to procurement of material. Substantiating technical data is required. Approval will not be granted unless, in the opinion of the Architect's, the quality of finished construction will be equal to that intended. Substitutions shall be at no additional cost to the Port.

PART 3 EXECUTION

3.01 GENERAL

- A. Apply the paints in accordance with the manufacturer's recommendations as to the application, weather and temperature conditions. Provide "highest" quality workmanship performed to the Architect's satisfaction. Use clean equipment and brushes when applying paint; spread paint materials evenly, without runs, sags, laps, or brush marks, without variations in color, texture, or sheen and without "holidays." Vary colors or sheens between coats and apply all coats to uniform thicknesses. Cut sharp lines against glass, other materials and different colors. Recoat suction spots in the first coat on drywall as necessary to produce uniformity of color and gloss. Refinish any Work judged defective at no additional cost to the Port of Seattle; repair all Work damaged during the progress of the construction. Leave finished surfaces clean, completely covered, uniform in appearance and satisfactory to the Architect.

3.02 SURFACE PREPARATION

- A. Provide means to control odors so that they do not affect or impact any Port, tenant, or passenger operations.
- B. Ensure any generation of dust is contained and does not affect or impact any Port, tenant, or passenger operations.
- C. Clean all surfaces thoroughly, removing all rust, mill scale, fabrication films, dust, dirt and other foreign matter from surfaces. Apply film to completely dry surfaces.
- D. Galvanized Metal: Thoroughly clean surfaces, wiping with mineral spirits or xylol. If silicone surface treatments have been applied in the fabrication shop, use xylol; remove silicates or similar surface treatments and deposits of "white rust" by sanding or other approved abrasive methods. Thoroughly clean and rinse contaminants from surfaces.
- E. Ferrous Metal Surfaces: Thoroughly clean using mineral spirits, xylol, or toluol in accordance with SSPC SP-1. Take care to ensure that adequate ventilation is provided at all times when using solvents. Carefully rinse and clean surfaces before applying paint.
- F. Gypsum Wallboard: Inspect surfaces for proper joint treatment and correct as required; sand all joint cement smooth before applying any paint; prime joint cement areas before applying the first coat or prime coat of finish material.
- G. Wood: Before applying the finish to wood surfaces, sand and smooth for even, uniform finish application; use No. 80 grit-1/0 sandpaper for rough sanding and

shaping; use No. 100 or 120 grit-2/0 or 3/0 for preparatory sanding for softwoods; use No. 220 grit-6/0 for finish sanding of softwoods. Seal all sap or knots, fill holes and cracks with plastic wood or putty and sand smooth. Remove all traces of oil, wax, grease, adhesive, or other foreign matter.

- H. Condition of Surfaces: Inspect and approve conditions of substrate surfaces scheduled to receive paint; notify the Engineer of any surfaces unsuitable for application as specified. The application of a paint finish constitutes an acceptance of the surface as suitable, unless directed to proceed in writing by the Engineer. Do no outside Work during wet or freezing weather, or until surfaces have thoroughly dried from the effect of such weather; see that proper temperatures and ventilation are maintained for all interior Work.
- I. Mixing and Thinning: Mix and thin paint products in strict accordance with the manufacturer's directions; mix and thin other materials in accordance with the "best" trade practices as approved.
- J. Sheen: Where gloss or sheen is specified or is listed as standard for approval for the Project, the terms refer to tested luster, shine, or sheen of the dry film. For purposes of this specification, luster, shine, or sheen is defined as follows when tested with a 60-degree gloss-meter; flat, 10-degree gloss or less; eggshell 11- to 19-degree gloss; satin, 20- to 30-degree gloss; semi gloss, 31- to 74-degree gloss; and gloss, 75-degree gloss or more.

3.03 APPLICATION

- A. Number of Coats: As specified in paragraph 3.06 for each type of finish. On shop-primed Work, an additional prime coat is not intended.
- B. Thickness of Coats: Use ample undiluted materials; apply in a uniform thickness over entire areas. Do not exceed the manufacturer's recommended spreading rate per gallon.
- C. Colors of Coats: Tint prime coats if necessary to obtain uniform finish coats. Vary color between coats; the final coat shall exactly match approved samples.
- D. Approval of Successive Coats: Obtain the Engineer's approval of each coat before the succeeding coat is applied; if this approval is not obtained, the Engineer reserves the right to require an additional coat.
- E. Prime and finish door jambs by using brush or spray. Rollers or other methods are not acceptable.

3.04 MECHANICAL OR ELECTRICAL EQUIPMENT

- A. Apply primer and two finish coats as specified for the appropriate metal surface, including ductwork, according to the finish schedule.

3.05 PROTECTION OF FINISHED WORK

- A. Use tarpaulins or drop cloths when working above or adjacent to completed Work; clean all paint splatters and stains from finished surfaces. Protect all Work from dust and insects.

3.06 PAINTING AND FINISHING SCHEDULES

- A. General: Painting and Finishing Titles and Code Numbers -References are from the MPI unless otherwise indicated. With linked cross-references in the MPI, they indicate coating, grades, manufacturers, and the like. Selections relate to surface,

type, coating, grade, and named products and their manufacturers listed in the MPI. Provide Work on the drawings as scheduled, specified, and as directed. Consult MPI for surfaces not scheduled and follow Engineer's directions.

- B. Exterior Painting and Finishing Schedule: Provide the Work as shown on the drawings and as scheduled following:
- C. Interior Painting and Finishing Schedule: Provide the Work as shown on the drawings and as scheduled following:
 - 1. Metal Fabrications: INT 14-A Semi-gloss.
 - 2. Gypsum Board: INT. 3-B Semi-gloss for walls, Eggshell for ceilings.

3.07 PAINT SCHEDULE

- A. PT-1 Match color of Benjamin Moore, Frostine AF-5, Glacial (Ceilings and Soffits)
- B. PT-2 Match color of Benjamin Moore, HC-169, Coventry Gray (Doors and Frames)

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by a Subcontractor (of any tier) or Supplier.
- B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

End of Section

APPENDIX - EXTERIOR PAINTING

FERROUS METAL - (LIGHT AND ORDINARY EXPOSURES) (NOT GALVANIZED)

FINISH SYSTEM CODE			
<i>Description</i>			
Coats:	Custom Grade:	Premium Grade:	Product #:
Exterior 11-A			
<i>Painted Finish Solvent Base (Gloss as Selected)</i>			
1	Primer	Primer	
Exterior 11-B			
<i>Painted Finish Waterborne (Gloss as Selected)</i>			
1	Primer	Primer	
3		Finish	
Exterior 11-C			
<i>Aluminum Paint Finish</i>			
1	Primer	Primer	
2	Finish	Finish	
3		Finish	

GALVANIZED (ZINC-COATED) METAL

FINISH SYSTEM CODE			
<i>Description</i>			
Coats:	Custom Grade:	Premium Grade:	Product #:
Exterior 13-A*			
<i>Painted Finish Solvent Base (Gloss as Selected)</i>			
1		Primer	
2		Finish	
3		Finish	
Exterior 13-D**			
<i>Black Finish (Unexposed)</i>			
1	Bituminous Enamel		

*A Premium Grade system is recommended only. Check manufacturer's recommendation.

**Apply according to manufacturer's recommendation.

ALUMINUM

FINISH SYSTEM CODE			
<i>Description</i>			
Coats:	Custom Grade:	Premium Grade:	Product #:
Exterior 14-A			
<i>Painted Finish (Exposed) Solvent Base (Gloss as Selected)</i>			
1	Aluminum Primer	Aluminum Primer	
2	Finish	Finish	
3		Finish	
1			
2			
3			
Exterior 14-C*			
<i>Black Finish (Unexposed)</i>			
1	Bituminous Enamel		

*Apply according to manufacturer's recommendation.

PLASTIC PIPING (ABS, PVC, ETC.)

FINISH SYSTEM CODE			
<i>Description</i>			
Coats:	Custom Grade:	Premium Grade:	Product #:
Exterior16-A*			
<i>Painted Finish Waterborne (Gloss as Selected)</i>			
1		N/A*	
2		Finish	
3		Finish	

*Exterior 18-A - Piping must be cleaned with lacquer thinner to eliminate all excursion contaminants. Use premium grade system only.

*Primer is not necessary; if warranted, contact manufacturer for recommendations.

APPENDIX - INTERIOR PAINTING

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GYPSUM WALLBOARD, VENEER (THIN WALL PLASTER)*, AND PLASTER WALLS*AND CEILINGS

FINISH SYSTEM CODE <i>Description</i>			
Coats:	Custom Grade:	Premium Grade:	Product #:
Interior 3-A <i>Painted Finish Solvent Base (Gloss as Selected)</i>			
1	Solvent Base or Waterborne Primer Sealer*	Solvent Base or Waterborne Primer Sealer*	
2	Finish	Finish	
3		Finish	
Interior 3-B <i>Painted Finish Waterborne (Gloss as Selected)</i>			
1	Solvent Base or Waterborne Primer Sealer*	Solvent Base or Waterborne Primer Sealer*	
2	Stipple Paint	Finish	
3		Finish	
4		Enamel Finish	
Interior 3-G <i>Fire Retardant Finish</i>			
		Follow manufacturer's recommendations. Check local code requirements	

EXPOSED FERROUS METAL (LIGHT AND ORDINARY EXPOSURES) (EXCEPT GALVANIZED)

FINISH SYSTEM CODE <i>Description</i>			
Coats:	Custom Grade:	Premium Grade:	Product #:
Interior 11-A <i>Painted Finish Solvent Base (Gloss as Selected)</i>			
1	Rust-Inhibitive Primer	Rust-Inhibitive Primer	
2	Finish	Finish	
3		Finish	

Interior 11-C <i>Aluminum Paint Finish</i>			
1	Rust-Inhibitive Primer	Rust-Inhibitive Primer	
2	Finish	Finish	
3		Finish	

GALVANIZED (ZINC-COATED) METAL

FINISH SYSTEM CODE <i>Description</i>			
Coats:	Custom Grade:	Premium Grade:	Product #:
Interior 12-A <i>Painted Finish Solvent Base (Gloss as Selected)</i>			
1	Galvanized Primer	Galvanized Primer	
2	Finish	Finish	
3		Finish	
Interior 12-C <i>Galvanized Metal, Aluminum Finish</i>			
1	Galvanized Primer	Galvanized Primer	
2	Aluminum Paint	Aluminum Paint	
3		Aluminum Paint	
Interior 12-D <i>Galvanized Metal, High Heat Finish (Color as Selected)</i>			
1	Galvanized Primer	Galvanized Primer	
2	High Heat Finish	High Heat Finish	
3		High Heat Finish	

ALUMINUM

FINISH SYSTEM CODE <i>Description</i>			
Coats:	Custom Grade:	Premium Grade:	Product #:
Interior 15-A* <i>Aluminum Finish Solvent Base (Gloss as Selected)</i>			
1	Aluminum Primer	Aluminum Primer	
2	Finish	Finish	
3		Finish	
Interior 15-B* <i>Aluminum Finish Waterborne (Gloss as Selected)</i>			
1	Aluminum Primer	Aluminum Primer	
2	Finish	Finish	
3		Finish	

*Only waterborne system recommended.

GLASS

FINISH SYSTEM CODE			
Description			
Coats:	Custom Grade:	Premium Grade:	Product #:
Interior 17-A			
Painted Finish Waterborne (Gloss as selected)			
1		Alkyd Primer	
2		Int/Ext 100% Acrylic Latex	
3		Int/Ext 100% Acrylic Latex	

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End of Appendix

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of "Identification Device" Work is indicated in the Contract Documents.

1.02 SUBMITTALS

- A. Submit material data in accordance with Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.
- B. Submittals shall include the following:
 - 1. Submit shop drawings

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Signs manufactured by Architectural Signing, Inc. (ASI), Spanger Brothers, Inc., Southwell Company, Or Approved Equal.

2.02 SIGNS

- A. Signs shall be:
 - 1. Signs shall be sized according to identification requirements or as noted; lettering shall be as indicated on drawings. Photopolymer plaque with 1/8" black sintra spacer inset 1/2" from all edges. Braille lettering provided as required by code.
- B. Adhesive door lettering to be located on center of door, mounting height as indicated on drawings.
- C. Lettering: style to match existing font and material – see door schedule for reference.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install signs with adhesives recommended by the manufacturer of signs.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontrator (of any tier) or Supplier.
- B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

End of Section

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of "Specialty Signs" Work is indicated in the Contract Documents.

1.02 GOVERNING CODES, STANDARDS, AND REFERENCES

- A. Certified Ballast Manufacturers (CBM)-certified by Intertek Testing Services, Inc. (ETL) ballasts
- B. Ballast protection per Art. 410-71 of the N.E. Code
- C. Article 600 of the N.E. Code sign wiring and installation
- D. UL approved
- E. Underwriters Laboratories fixtures and installation
- F. Washington Electrical Code fixtures and installation

1.03 SUBMITTALS

- A. Submit material data in accordance with Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.
- B. Submittals shall include the following:
 - 1. Samples: Submit samples of the color and finish of exposed materials and accessories required for specialty signs.
 - a. Submit samples for approval of the following materials and assemblies prior to proceeding with the Work:
 - (1) Aluminum anodized color range: light and dark extremes; and standard mean (minimum 8" x 10" plates).
 - (2) Paint matching above described aluminum color and texture (minimum 8" x 10" plate).
 - b. Shop Drawings: Submit to the Engineer shop drawings of all sign components, fittings, parts, wiring and installation procedures showing layout, jointing, and complete anchoring and supporting systems for the various applications and mounting details. Drawings shall clearly show provisions for all performance functions described herein. Provide details and sections at full size. Differences from the Contract drawings shall be clearly identified and brought to the Engineer's attention in writing.
 - c. Sign Face Patterns: Submit, in duplicate, accurate full-size sign face drawings accurately showing the relationship of all parts to each other, the sign border and a description of the method of executing the Work
 - 2. Accessibility: Submit design of sign face with easy removal, easy access by the maintenance crews to interior of the sign box for changing lamps and ballast and easy, accurate reinstallation by the Port's maintenance crews.

1.04 QUALITY ASSURANCE

- A. Qualifications of Sign Fabricator: The sign company shall be an established firm which is regularly engaged in the fabrication and installation of specialty signs. The company shall also submit a list of sizable installations provided over a period of at least three years, or the Engineer shall be sufficiently convinced by observation and other substantiating data that fabrication and installation of a lesser period of time will prove adequate.
- B. Lettering: Helvetica Medium style to match existing signs on project site.

PART 2 PRODUCTS

2.01 ILLUMINATED SIGNS

- A. Structural Frame: The framework of all signs shall have sufficient strength and rigidity to support the weight and horizontal loads (earthquake) of the entire sign box assembly, from mounting points located as indicated in the mounting detail drawings, without noticeable deformation due to deflection or warping of any part of the assembly.
 - 1. The frame shall be accurate in its dimensions and shall have tight-fitting, rigid, smooth connections. No part of the frame, or other internal parts, shall project into the light path or otherwise cast shadows onto the translucent portions of the sign faces.
 - 2. The frame members, if steel, shall be primed to prevent corrosion and electrolytic action between dissimilar materials.
 - 3. New signs near or being added to existing sign panels shall match existing sign panels in color, material, finish and detail of corner section.
- B. Sign Box Cladding and Trim:
 - 1. Aluminum: 0.125 inch plate and trim. All exposed exterior surfaces shall be Fentron "Eloxal" Dark Gray anodized, No Equal (submit color samples and range of color extremes to Engineer for approval). Pieces shall be true, square and free from warping, bending, blemishes and scratches.
 - 2. Fabrication: Accomplish fabrication of all metal parts in a uniform and "first class" manner. All joints and seams in the exposed cladding shall be precise and tight fitting with no light leaks. Paint any exposed edges not anodized to match the color and texture.
 - 3. Fastenings: Oval-head, Phillips system, stainless steel, sheet metal screws; all exposed fastenings lacquered to match aluminum.
 - 4. Accessibility: Provide for easy access by the Port's maintenance crews to interior of the sign box for changing lamps and ballast. Provide for easy removal and easy, accurate reinstallation of the sign face by maintenance crews.
 - 5. Expansion/Contraction: Provide for expansion and contraction of the sign face, without bowing, warping, or exposure of light leaks, to a range of ambient temperatures from +100°F to 0°F for exterior signs and from 85°F to 55°F for interior signs, taking into account the added temperature of the ballast and lamps.

6. Heat Dissipation: Provide means to adequately and safely dissipate heat from the ballast, ensuring that light leaks, moisture, or dust penetration do not result.
7. Interior Paint: Paint all interior surfaces and parts (except the inside of raceways and translucent faces, but including the inside of opaque portions of sign faces) with two coats of matte white, non-combustible paint compatible with the receiving surface.

C. Sign Faces

1. Plastic: 1/8-inch thick translucent acrylic plastic sheets (Rohm & Haas Co. "Plexiglas," No Equal). The following colors are Rohm & Haas standard and must be strictly adhered to in hue, shade and tone; the color of the face is indicated on the elevations:

White backup or body sheet	White #7328
Blue face with cut-out legend	Blue #2114
Red circled arrow (changeable)	Red #2157

- a. Plastic for faces and backup sheets must not discolor with age or under conditions of normal light, cold, heat and moisture of exterior weather.
 - b. Outside exposed surfaces of sign faces shall have a matte finish and be scratch-resistant. Exposed edges or cut-outs shall be true and smooth and have sharp interior corners.
2. Aluminum Faces: All aluminum sign faces shall be 0.125 (1/8-inch) and shall comply with the same specifications as those for "Sign Box Cladding and Trim" (above). Exposed edges of cut-outs shall be true and smooth, shall have sharp interior corners, and shall be colored identical to the face.
3. Transparency: Translucent sign faces shall have an even level of brightness over the entire surface. Face sheets shall show no discoloration or shadow where bonded to backup sheets. The level of brightness shall be uniform from one sign to another and from one sheet to another in the case of multi-sheet sign faces.
4. Joints: All vertical and horizontal joints in the sign faces shall be true, tight and unnoticeable with respect to shadows, dark strips, light strips, gaps, light leaks, or mismatched transparency of adjacent sheets. Location and frequency of joints shall be only as noted on the drawings.
 - a. Make provision to ensure that joints will remain true and tight under conditions of expansion and contraction of the faces and under conditions of reinstallation of lamps and ballasts by maintenance crews.
5. Arrows: All cut-out circled arrows shall be changeable with respect to direction, by means of rotating the arrow within its circular cut-out and fixing it in position.
6. Removability: All sign faces shall be removable and replaceable, without damage to the faces or the sign box assembly.

7. Illumination: Space lamps and arrange so that the entire sign face has uniform light intensity.
8. Antistatic Treatment: Treat all acrylic surfaces with an antistatic solution following installation.
9. Manufacturer's Identification, Date, Sign Number: Illuminated signs shall have a label on the underside corner showing the manufacturer's name, date of manufacture and numbers of the sign as shown on the drawings (sign number and elevation number), all in 1/4-inch letters. The label shall be of clear material or of a matching bronze aluminum color, with black letters.

2.02 PAINTING

- A. General: Paint all metal items not having a color-anodized finish and paint sign faces as specified in Section 09 90 00 - Paints and Coatings.
- B. Sign Painting: The painting of signs shall be performed only by mechanics skilled in painting and experienced in producing high-class Work. Lines shall be sharply cut.
 1. The shop conditions of the sign manufacturer shall be clean, free of air dust and of proper temperature.
 2. Apply shop painting by spraying except where inaccessible surfaces require brushing. Protect adjoining or adjacent surfaces against any discoloration.

2.03 ELECTRICAL WORK

- A. Electrical Work: All materials and equipment shall be new and UL-approved for the purpose used. Accomplish all Work in accordance with all applicable electrical construction codes and electrical safety codes.
 1. Obtain permits and pay fees required by governmental agencies having jurisdiction over the Work. Arrange for inspections required during installation. Upon completion of the Work, furnish satisfactory evidence that all Work has been installed in accordance with codes.
 2. Do all cutting and patching required for installation of the Work. Perform all cutting and patching carefully to prevent damage to the structure and Work of other trades. All cutting and patching shall be done by mechanics skilled in the trade affected and subject to approval of the Engineer.
 3. Promptly remove and dispose all waste material and rubbish from the site. At completion of the Work, clean all lighting fixtures and signs and check for satisfactory operation.
 4. All materials and workmanship shall be guaranteed for a period of one year after acceptance. Repair or replace all failures or defects in materials or workmanship during this period without delay, at no expense to the Port, provided that in the judgment of the Engineer, such failures are not the result of misuse or abuse.
- B. Raceways and Wiring: Install all wiring in metallic raceways. Conceal all raceways in finished areas. Make bends carefully to avoid flattening or damaging the raceway. Secure conduit to concrete structure by use of one-hole conduit clamps

and anchors drilled into the concrete. In moist or damp areas, conduit shall be rigid galvanized steel; in dry areas, use electrical metallic tubing, galvanized or sherardized. E.M.T. fittings shall be compression type, similar to Appleton 96T050.

1. Where crossing expansion joints or areas of movement of structure, install expansion joints O-Z type AX or AX8. Where approved by the Engineer, flexible steel conduit may be used, either galvanized steel or watertight, depending upon environment. Connectors shall be of the type to provide secure connection for continuity of the raceway system.
 2. Outlet boxes or box extensions shall be galvanized or sherardized, processed steel not less than 1-1/2 inches deep and four inches square or octagonal.
 3. Wire shall be of copper conductors with type THW insulation. Minimum wire size shall be No. 12 A.W.G.
 4. Make all splices or taps with "Scotchlok" connectors with insulating caps. Color-coding of wires shall follow standardized building color-coding system.
 5. Plates, where required, shall be stainless steel in finished areas and galvanized steel in unfinished areas except for sign-mounted switch plates as noted below.
 6. Paint all exposed raceways and boxes with one prime coat and one finish coat of enamel. Colors shall match the surface to which the raceway or box is secured. Submit a sample or color chart to the Engineer for approval.
 7. When voltage and circuit designations are not shown on the drawings, verify these voltages and connection points before proceeding with the manufacture of the electrical portions of the signs and lighting.
- C. Ballasts: All ballasts shall be rated 277 volts, CBM-certified by ETL, Super Premium P, shall be high-power factor, and shall operate with a case temperature not to exceed 90°C in the installed location. Provide ballasts with ballast protection per Art. 410-71 of the N.E. Code.
1. All fixtures located in areas subject to outside temperatures shall have low-temperature ballasts.
- D. Sign Wiring: All sign wiring and installation shall conform to Article 600 of the N.E. Code. Label the stubbed-up conduit with the appropriate load.
- E. Lamps: Lamps shall be standard T-12, rapid-start, high-output, 60-Hz units unless otherwise shown. The color of fluorescent lamps shall be warm white for signs and lighting fixtures. All lamps shall be General Electric, Sylvania, Westinghouse, Or Approved Equal.
- F. Fixtures: All fixtures and installation shall be Underwriters Laboratories - and Washington Electrical Code-approved.
- G. Individual Sign Switch: Provide an "on-off" sign illumination switch, Bryant No. 7201, No Equal, where noted on the drawings or schedule.

PART 3 EXECUTION

3.01 INSPECTION

- A. Examine the substrates and conditions under which the specialty signs are to be installed.

3.02 INSTALLATION

- A. Install sign units and components at the locations shown or scheduled, securely mounted.
- B. Install level, plumb and at the proper height. Cooperate with other trades for installation of sign units to finish surfaces. Repair or replace damaged units as directed by the Engineer.

3.03 TEMPORARY COVERS

- A. Signs which are installed prior to their assigned function being open to public use shall be covered by the Contractor to conceal the face from view. Coverings shall be dark gray or black, paper or cardboard, neatly affixed to the sign face with matching or concealed adhesive. When coverings are removed, clean the signs and treat plastic faces with antistatic solution.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.

- B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

End of Section

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of “Mechanical Work – General” is shown in the Contract Documents.

1.02 GOVERNING CODES, STANDARDS, AND REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.
1. ASME (American Society of Mechanical Engineers)
 - a. ASME A112.6.3 – Floor and Trench Drains
 - b. ASME B16.3 – Malleable Iron Threaded Fittings Class 150 and 300
 - c. ASME B16.18 – Cast Copper Alloy Solder Joint Pressure Fittings
 - d. ASME B16.21 – Nonmetallic Flat Gaskets for Pipe Flanges (2011)
 - e. ASME B16.22 – Wrought Copper and Bronze Solder Joint Pressure Fittings
 - f. ASME B16.26 – Cast Bronze Fittings for Flared Copper Tubes
 - g. ASME B18.2.1 – Square, Hex, Heavy Hex Bolts and Screws (2012)
 - h. ASME B1.20.1 – Pipe Threads, General Purpose, Inch
 2. ASTM (ASTM International)
 - a. ASTM A47 – Ferritic Malleable Iron Castings (2009)
 - b. ASTM A53 – Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
 - c. ASTM A234 – Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
 - d. ASTM A307 – Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod (2012)
 - e. ASTM A536 – Ductile Iron Castings (2009)
 - f. ASTM B584 – Copper Alloy Sand Castings for General Applications
 - g. ASTM B32 – Solder Metal
 - h. ASTM B88 – Seamless Copper Water Tube (ASTM B88M – Seamless Copper Water Tube, Metric).
 - i. ASTM C1540 – Heavy-Duty Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings
 3. AWS (American Welding Society)
 - a. AWS A5.8 – Brazing Filler Metal.
 - b. AWS D1.1 – Structural Welding Code.
 - c. AWS D10.9 – Qualification of Welding Procedures and Welders for Piping and Tubing

4. CISPI (Cast Iron Soil Pipe Institute)
 - a. CISPI 301 – Cast Iron Soil Pipe and Fittings for Hubless Cast Iron Sanitary Systems.
 - b. CISPI 310 – Joints for Hubless Cast Iron Sanitary Systems
5. CDA (Copper Development Association Inc.)
6. MSS (Manufacturers Standardization Society of the Valve and Fittings Industry)
 - a. MSS SP-67 – Butterfly Valves.
 - b. MSS SP-110 – Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.03 SUBMITTALS

- A. Submit materials data in accordance with Section 01 33 00 – Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.
- B. Submittals shall include the following:
 1. Product Data: For dielectric fittings, flexible connectors, mechanical sleeve seals, pipe and fittings, and identification materials and devices.

1.04 QUALITY ASSURANCE

- A. Welding procedures shall be provided in accordance with AWS D10.9, level AR-3. Submittals include Welding Procedure Specification, Contractor's Procedure Qualification Test Records, and Welder Qualification Test Records. Welding inside of occupied buildings is required to comply with the Port Fire Department's requirements for hot work permits.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and prevent entrance of dirt, debris, and moisture.
- B. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.
- C. Protect flanges, fittings, and piping specialties from moisture and dirt.

1.06 SEQUENCING AND SCHEDULING

- A. Coordinate mechanical equipment installation with other building components.
- B. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.
- C. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components, as they are constructed.
- D. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning before closing in building.

- E. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.
- F. Coordinate requirements for access panels and doors if mechanical items requiring access are concealed behind finished surfaces.
- G. Coordinate installation of identifying devices after completing covering and painting, if devices are applied to surfaces. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 PRODUCTS

2.01 WATER PIPING, ABOVE GRADE

- A. General
 - 1. All new piping shall be copper unless otherwise specified.
 - 2. Dielectric unions shall not be used, only use dielectric nipples.
- B. Copper Tubing: ASTM B88, Type L hand drawn.
 - 1. Cast-Copper, Solder Joint Fittings: ASME B16.18 pressure fittings.
 - 2. Wrought-Copper, Solder Joint Fittings ASME B16.22, wrought copper pressure fittings.
 - 3. Joints: ASTM B32, solder, Grade Sn95.

2.02 SANITARY WASTE AND VENT PIPING, ABOVE GRADE

- A. Cast Iron Pipe: CISPI 301, hubless, service weight.
 - 1. Fittings: Cast iron.
 - 2. Joints and Couplings: Heavy-duty CISPI 310 shielded stainless-steel couplings. ASTM C1540 assembly of Type 304 stainless steel shield 0.015-inch-thick minimum, stainless steel fasteners, Type 304 stainless steel bands and rubber sleeve with integral center pipe stop in conformance with ASTM C564. Coupling shall have four (4) bands for pipes up to 4-inches and six (6) bands for pipes over 4-inches. Anaco-Husky SD-4000, Mission Rubber HW series, Tyler Wide Body series, Or Approved Equal.

2.03 COMPRESSED AIR PIPING

- A. Copper Tube: ASTM B88 (ASTM B88M), Type K (A), drawn.
 - 1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
 - 2. Joints: ASTM B32, solder, Grade Sn95.

2.04 HEATING WATER AND GLYCOL PIPING, ABOVE GROUND

- A. Piping:
 - 1. Heating Water Piping 2-inches and smaller: ASTM B88 Type “L” hard drawn copper.
 - 2. Heating Water Piping 2-1/2-inches and larger: ASTM A53, Schedule 40, Grade B, electric resistance welded or seamless, black steel.

B. Fittings:

1. 2-inches and smaller: Wrought copper solder fittings and screwed adapters, ANSI B16.22. Cast bronze solder joint fittings and screwed adapters, ANSI B16.18. 95% tin, 5% antimony solder, ASTM B32.
2. 2-1/2-inches and larger: Wrought-Steel, ASTM A 234/A 234M, butt-weld or flanged.
 - a. Joints: Threaded, or AWS D1.1, welded.
3. Dielectric nipples threaded or sweat, (unions not allowed) required at dissimilar metal junctures.

2.05 CHILLED WATER PIPING, ABOVE GRADE

A. Piping:

1. Chilled Water Piping 2-inches and Smaller: ASTM B88 Type “L” hard drawn copper.
2. Chilled Water Piping 2-1/2-inches and Larger: ASTM A53, Standard weight (Schedule 40), Grade B, electric resistance welded or seamless, black steel.

B. Fittings:

1. 2-inches and Smaller: Wrought copper solder fittings and screwed adapters, ANSI B16.22. Cast bronze solder joint fittings and screwed adapters, ANSI B16.18. 95% tin, 5% antimony solder, ASTM B32.
2. 2-1/2-inches and Larger: Wrought-Steel, ASTM A 234/A 234M, butt weld or flanged.
 - a. Joints: Threaded or AWS D1.1 welded.
3. Dielectric Couplings threaded or sweat (unions not allowed) required at dissimilar metal junctures.

2.06 LOW PRESSURE STEAM PIPING (15 PSIG MAXIMUM)

A. Steel Pipe: ASTM A53, Schedule 40, Grade B, electric resistance welded or seamless, black steel.

1. Fittings: ASTM B16.3 malleable iron Class 125, or ASTM A234 forged steel Class 125.
 - a. Joints: Threaded, or AWS D1.1, welded.
2. Flanges shall be minimum 150-pound forged steel, welding neck type, bored to the inside diameter of the pipe to which it is attached and with raised face. If valve or equipment has a flat face, then the mating flange shall be flat face.

2.07 LOW PRESSURE STEAM CONDENSATE PIPING

A. Steel Pipe: ASTM A53, Schedule 80, Grade B, electric resistance welded or seamless, black steel.

1. Fittings: ASTM B16.3 malleable iron Class 125, or ASTM A234 forged steel Class 125.

- a. Joints: Threaded, or AWS D1.1, welded.
- 2. Flanges shall be minimum 150-pound forged steel, welding neck type, bored to the inside diameter of the pipe to which it is attached and with raised face. If valve or equipment has a flat face, then the mating flange shall be flat face.

2.08 JOINING MATERIALS

- A. Pipe Threads: ASME B1.20.1 for factory threaded pipe and pipe fittings.
- B. Pipe Flange Gasket Materials:
 - 1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness, unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow Face Type: For raised face, Class 250, cast iron and steel flanges.
- C. Flange Bolts and Nuts: ASTM A 307 Grade B, Heavy Hex, Carbon Steel, Dimensions per: ASME B18.2.1 unless otherwise indicated.
- D. Solder Filler Metals: ASTM B 32-08, lead-free alloys Includes water-flushable flux according to ASTM B813.
- E. Brazing Filler Metals: AWS A5.8.
 - 1. BCuP Series: Copper-phosphorus alloys.
 - 2. BAg1: Silver alloy.
- F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.09 DIELECTRIC FITTINGS

- A. General: Assembly or fitting with insulating material isolating joined dissimilar metals, to prevent galvanic action and stop corrosion.
- B. Dielectric Fittings:
 - 1. Manufacturer: Victaulic, EPCO, B & K, Or Approved Equal.
 - 2. ASTM A53 electro zinc plated steel body with threaded end connections and NSF/FDA approved LTHS high temperature stabilized polyolefin polymer liner; suitable for 200 F and 300 psi.
 - 3. Dielectric unions: Not Allowed.

2.10 GENERAL-DUTY VALVES

- A. Ball Valves
 - 1. Construction, 3 inches and Smaller: MSS SP-110, Class 150, 600 psi CWP, B584 Bronze body, 316 SS ball, SS stem, full port, two piece, RTFE or PTFE seats., Teflon stuffing box ring, blowout-proof stem, lever handle solder or threaded ends.

- B. Butterfly Valves, 2 inches and Larger:
 - 1. MSS SP-67, 200 psi CWP, ASTM A126 Class B cast or ductile iron body, aluminum bronze disc, resilient replaceable EPDM seat, lug or grooved ends, extended neck, infinite position lever handle.
- 2.11 TRAP PRIMERS
 - A. Flow Activated Trap Primer:
 - 1. Cast bronze trap primer with 1/2-inch connections.
 - 2. Lead-free design.
 - 3. J.R. Smith model S-2699, Precision Plumbing Products, Watts, Or Approved Equal.
- 2.12 CLEANOUTS
 - A. Manufacturers: J.R. Smith, Zurn, Josam, Wade, Or Approved Equal.
 - 1. Interior Finished Floor Areas (FCO): Lacquered cast iron body with anchor flange, reversible clamping collar, brass internal plug threaded top assembly, and round scored satin brass cover with gasket in service areas and polished nickel bronze, adjustable round depressed cover with gasket to accept floor finish in finished floor areas.
- 2.13 FLOOR DRAINS
 - A. Manufacturers: JR Smith, Josam, Wade, Zurn, Or Approved Equal.
 - B. Floor Drain (FD-1): ANSI A1121.1; Lacquered cast iron two-piece body with double drainage flange, weep holes, reversible clamping collar, and round, adjustable nickel-bronze strainer with polished bronze funnel.
- 2.14 ESCUTCHEONS
 - A. General: Manufactured wall, ceiling, and floor plates; deep pattern type if required to conceal protruding fittings and sleeves.
 - 1. Inside diameter: Closely fit around pipe, tube, and insulation of insulated piping.
 - 2. Outside diameter: Completely cover opening.
 - B. Cast Brass: One-piece, with set screw.
 - 1. Finish: Rough brass.
 - C. Cast Brass: Split casting with concealed hinge and set Finish: Polished chrome-plate screw.
 - 1. Finish: Rough brass.
 - 2. Finish: Polished chrome-plate.
 - D. Stamped Steel: Split plate, with concealed hinge, set screw, and chrome-plated finish preferred.
 - E. Cast Iron Floor Plate: One-piece casting.

PART 3 EXECUTION

3.01 COORDINATION WITH WATER DEPARTMENT

- A. Connection to Main: Do not operate any gate valves or make any connections to the existing water main without prior approval of the Water Department. Make the necessary arrangements with the Water Department Superintendent for the connection to the existing water main. Water Department Superintendent may elect to furnish the materials, equipment, and labor necessary for making the connection and the Contractor shall pay the Water Department all costs for the connection. In the event the Water Department Superintendent does not elect to make the connection, they may authorize the Contractor to furnish the materials, equipment, and labor necessary for making the connection under the supervision of the Water Department.
- B. Completion of Installation: Turn over to the Water Department a portion of the system. Contractor responsible for the materials and for satisfactory operation of the facility for a period of one year from the date of acceptance of the completed project.

3.02 PREPARATORY WORK

- A. Inspections:
 - 1. Prior to all Work, carefully inspect the installed Work of all other trades, and verify that all such Work is complete to the point where the Work of this section may properly commence.
 - 2. Verify that the Work of this section may be performed in strict accordance with all pertinent codes and regulations and the original design.
- B. Discrepancies:
 - 1. In the event of discrepancy, immediately notify the Engineer.
 - 2. Do not proceed with installation in such areas until all discrepancies have been resolved.
- C. Inspect each piece of pipe, tubing, fittings and equipment for defects and obstructions. Promptly remove all defective material from the site.

3.03 DEMOLITION

- A. Refer to Section 02 41 19 – Removal and Alterations for general demolition requirements and procedures.
- B. Disconnect, demolish, and remove piped utility systems, equipment, and components indicated to be removed.
 - 1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - 2. Piping to Be Abandoned in Place: Drain piping. Fill abandoned piping with concrete and cap or plug piping with same or compatible piping material.
 - 3. Equipment to Be Removed: Disconnect and cap services and remove equipment.

- 4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make operational.
- 5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Port of Seattle.
- C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.
- D. Accessible Work: Remove indicated exposed pipe and ductwork in its entirety.
- E. Work Abandoned in Place: Cut and remove underground pipe a minimum of 2-inches beyond face of adjacent construction. Cap and patch surface to match existing finish. Update Redlines to indicate capped and abandoned pipe.
- F. Removal: Remove indicated equipment from Project site and dispose of in accordance with applicable city, county, state, and federal regulations.
- G. Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational equipment indicated for relocation.

3.04 PIPING INSTALLATIONS

- A. General Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Install piping in accord with recognized industry practices which will yield permanently leak-proof piping systems, capable of performing each indicated service without piping failure. Install each run with minimum joints and couplings, but with adequate and accessible unions for disassembly and maintenance/replacement of valves and equipment.
- C. If not otherwise indicated, run piping in shortest route which does not obstruct usable space or block access for servicing construction, columns, and other structural and permanent enclosure elements of building.
- D. Where possible in finished or occupied spaces, conceal piping from view, by locating in column enclosures, in hollow wall construction or above suspended ceilings; but do not encase horizontal runs in solid partitions except where indicated.
- E. Install piping at indicated slope.
- F. Install components with pressure rating equal to or greater than system operating pressure. Keep openings in pipes closed during the progress of the Work. Upon completion of Work, cap or plug all piping on all open ends, but applicable to all Work.
- G. Install piping free of sags and bends.
- H. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- I. Install interior and exterior piping at right angles or parallel to building walls. Diagonal runs are prohibited, unless otherwise indicated.

- J. Install piping tight to slabs, beams, joists, columns, walls, and other building elements. Allow sufficient space above removable ceiling panels to allow for ceiling panel removal.
- K. Install piping to allow application of insulation plus 1 inch clearance around insulation.
- L. Locate groups of pipes parallel to each other, spaced to permit valve servicing. Group piping whenever practical at common elevations.
- M. Install fittings for changes in direction and branch connections.
- N. Install couplings according to manufacturer's written instructions.
- O. Double-wrap underground ferrous piping and fittings (except cast iron soil piping), including risers at buildings to a minimum of six inches above grade, with ten mil thick vinyl, pressure-sensitive tape; provide half-lap coverage each way for a total of four thicknesses.
- P. Install pipe escutcheons for pipe penetrations of concrete and masonry walls, wall board partitions, and suspended ceilings according to the following:
 - 1. Chrome-Plated Piping: Cast brass, one-piece, with set screw, and polished chrome plated finish. Use split casting escutcheons if required, for existing piping.
 - 2. Uninsulated Piping Wall Escutcheons: Cast brass or stamped steel, with set screw.
 - 3. Uninsulated Piping Floor Plates in Utility Areas: Cast iron floor plates.
 - 4. Insulated Piping: Cast brass or stamped steel; with concealed hinge, spring clips, and chrome plated finish.
 - 5. Piping in Utility Areas: Cast brass or stamped steel, with set screw or spring clips.
- Q. Fire Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestopping materials. Refer to Section 07 84 00 – Firestopping for materials.
- R. Verify final equipment locations for roughing in.
- S. Refer to equipment specifications in other sections of these Specifications for roughing in requirements.
- T. Piping Joint Construction: Join pipe and fittings as follows and as specifically required in individual piping specification sections:
 - 1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe – Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
 - 2. Soldered Joints: Construct joints according to CDA's "Copper Tube Handbook."
 - 3. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
 - 4. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream

threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

- a. Note internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
 - b. Apply appropriate tape or thread compound to external pipe threads, unless dry seal threading is specified.
 - c. Align threads at point of assembly.
 - d. Tighten joint with wrench. Apply wrench to valve end into which pipe is being threaded.
 - e. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
 - f. Use thread sealant or Teflon tape on male threads only.
5. Welded Joints: Construct joints according to AWS D10.12, "Recommended Practices and Procedures for Welding Low Carbon Steel Pipe," using qualified processes and welding operators.
- U. Piping Connections: Make connections according to the following, unless otherwise indicated:
1. Install nipples, in piping 2-inch IPS and smaller, adjacent to each valve and at final connection to each piece of equipment with 2-inch IPS or smaller threaded pipe connection.
 2. Install flanges, in piping 2-1/2-inch IPS and larger, adjacent to flanged valves and at final connection to each piece of equipment with flanged pipe connection.
 3. Dry Piping Systems: Install dielectric nipples and flanges to connect piping materials of dissimilar metals.
 4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.05 CLEANING, TESTING, AND STERILIZING

A. Domestic Water Piping:

1. Clean prior to sterilizing by thoroughly flushing with water until all dirt and foreign materials have been removed. Maintain flushing operations for not less than one hour and until piping is clean. Use no less than 80 psi flushing pressure. Inform Port of Seattle Engineer two (2) days in advance so they may witness cleaning.
2. Test new and modified parts of existing piping. Conduct for a period of not less than 8 hours at 150% operating pressure, 125 psig minimum. Repair any leaks and retest. Inform Port of Seattle Engineer two days in advance so that they may witness testing.
3. Sterilize water piping with chlorine before acceptance of project by Port of Seattle. Apply amount of chlorine such as to provide a dosage of not less than 50 ppm. After a contact period of not less than 8 hours, flush system

with clean water until residual chlorine content is not greater than 0.2 ppm. Open all valves in lines being sterilized and close several times during contact period. Inform Port of Seattle Engineer two (2) days in advance so that they may witness sterilization. Provide written certification to Port of Seattle that sterilization has been completed.

B. Sanitary Waste and Vent Piping:

1. Test new and modified parts of existing piping. Unless otherwise directed, plug all openings and fill with water to a height equal to the lowest vent, or 10 feet of head, whichever is greater or as directed by local plumbing inspection authority. Allow to stand one hour or longer as required. Tighten clamps and then retest.
2. Obtain approval for all Work or portions of Work as tested, in writing, prior to covering or concealment in any manner. Notify the Engineer at least 2 normal working days prior to testing any portion of Work and do not conceal any Work until so directed by the Engineer.

C. Compressed Air Piping:

1. Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry air or gaseous nitrogen to pressure of 50 psig above system operating pressure, but not less than 150 psig. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
2. Repair leaks and retest until no leaks exist.

D. Heating Water, Chilled Water, and Steam Condensate Piping:

1. Test new and modified parts of existing piping. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure, but not less than 150 psig.
2. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.

E. Steam Piping:

1. Clean by thoroughly flushing with water until all dirt and foreign materials have been removed. Maintain flushing operations for not less than one hour and until piping is clean. Use no less than 80 psi flushing pressure. Inform Owner two days in advance so they may witness cleaning.
2. Test new and modified parts of existing piping. Test steam piping systems as follows: Conduct for a period of not less than 8 hours at 150% operating pressure, 25 psig minimum. Repair any leaks and retest. Inform Port of Seattle two days in advance so they may witness testing. Clean strainers after testing.

3.06 FIELD QUALITY CONTROL

A. Section 01 45 16.13 – Contractor's Quality Control Program.

3.07 EQUIPMENT INSTALLATION

- A. Install equipment level and plumb, unless otherwise indicated.
- B. Install equipment to provide maximum possible headroom if mounting heights are not indicated.
- C. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to Engineer.
- D. Install equipment level and plumb, parallel, and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- E. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- F. Install equipment giving right of way to piping installed at required slope.
- G. Install flexible connectors on equipment side of shutoff valves, horizontally and parallel to equipment shafts if possible.

3.08 CONCRETE BASES

- A. Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project location.
- B. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
- C. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of base.
- D. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
- E. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
- F. Install anchor bolts to elevations required for proper attachment to supported equipment.
- G. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
- H. Use 3000 psig, 28-day compressive strength concrete and reinforcement as specified in Section 03 30 00 – Cast-in-Place Concrete.

3.09 ERECTION OF METAL SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
- B. Field Welding: Comply with AWS D1.1, "Structural Welding Code Steel."

3.10 CUTTING AND PATCHING

- A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of trades involved.

- B. Repair cut surfaces to match adjacent surfaces.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.

- B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

End of Section

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of “Hangers and Supports” Work is shown in the Contract Documents.

1.02 GOVERNING CODES, STANDARDS, AND REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.
 - 1. ANSI (American National Standards Institute)
 - 2. ASME (American Society of Mechanical Engineers)
 - a. ASME B31.9 – Building Services Piping
 - 3. ASTM (American Society for Testing and Materials)
 - a. ASTM F708 – Design and Installation of Rigid Pipe Hangers.
 - 4. AWS D1.1/D1.1M, “Structural Welding Code – Steel.”
 - 5. MSS (Manufacturers Standardization Society of the Valve and Fittings Industry)
 - a. MSS SP58 – Pipe Hangers and Supports – Materials, Design and Manufacturer.
 - b. MSS SP69 – Pipe Hangers and Supports – Selection and Application.
 - c. MSS SP89 – Pipe Hangers and Supports – Fabrication and Installation Practices.
 - 6. NFPA (National Fire Protection Association)
 - a. NFPA 13 – Installation of Sprinkler Systems.
 - 7. International Mechanical Code

1.03 SUBMITTALS

- A. Submit materials data in accordance with Section 01 33 00 – Submittals. Furnish manufacturers’ technical literature, standard details, product specifications, and installation instructions for all products.
- B. Submittals shall include the following:
 - 1. Product Data: Submit manufacturer’s catalog data including load capacity for each type of product indicated.
 - 2. Manufacturer’s Installation Instructions: Submit special procedures and assembly of components.

1.04 QUALITY ASSURANCE

- A. Perform Work in accordance with referenced standards and local codes for piping support and in conformance with NFPA 13 for support of sprinkler piping and standpipes.

- B. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code – Steel."
- C. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

1.05 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

PART 2 PRODUCTS

2.01 PIPE HANGERS AND SUPPORTS

- A. General Requirements for all Pipe Hangers and Supports
 - 1. Manufacturers: Rilco, PHD, Anvil, Or Approved Equal.
 - 2. Manufacturers must conform to MSS SP-58, Types 1 through 58, factory fabricated components.
 - 3. Conform to ANSI B31.9 for Building Services Piping.
 - 4. Galvanized metallic coatings shall be pre-galvanized or hot-dipped galvanized.
 - 5. For clevis or band hangers, insert and shield shall cover lower 180 degrees of the pipe.
 - 6. Pipe Saddles and Insulation Shields: All hangers with fiberglass or other insulation shall have pipe protection saddles and insulation protection shields to support bearing surface of piping.
 - 7. Hanger Rods: Continuous-thread rod, nuts, and washers made of galvanized steel.
 - 8. Single rod offset, adjustable ring hangers, wall hooks, and "J" Hook style supports are not allowed.
- B. Fire Protection Piping:
 - 1. Hangers for Pipe Sizes 1/2-inch to 1-1/2-inches: Malleable iron, adjustable swivel, split ring.
 - 2. Hangers for Pipe Sizes 2-inches and Over: Carbon steel, adjustable, clevis.
- C. Copper Piping
 - 1. Copper Coated Steel, factory-fabricated components.
- D. Plumbing Piping:
 - 1. Hangers for Pipe Sizes 1/2-inch to 1-1/2-inches: Malleable iron, adjustable swivel, split ring.
 - 2. Hangers for Pipe Sizes 2-inches and Over: Carbon steel, adjustable, clevis.
- E. Plumbing Piping – Water:
 - 1. Hangers for Pipe Sizes 1/2-inch to 1-1/2-inches: Malleable iron, adjustable swivel, split ring.
 - 2. Hangers for Cold Pipe Sizes 2-inches and Over: Carbon steel, adjustable, clevis.

3. Hangers for Hot Pipe Sizes 2 to 4-inches: Carbon steel, adjustable clevis.
 4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 5. Hanger Rods: Mild steel galvanized threaded both ends, threaded one end, or continuous threaded with galvanized bolts and nuts and galvanized side beam bracket. Rods shall be, as a minimum, sized as follows:
 - a. 3/8-inch diameter for 1-1/4-inch through 2-inch pipe.
 - b. 1/2-inch for 2-1/2-inch through 3-1/2-inch pipe.
 - c. 5/8-inch for 4-inch pipe.
 - d. 3/4-inch for 6-inch to 10-inch pipe.
 6. Saddles: Provide pipe protection saddles and insulation protection shields at hangers and supports.
 7. Inserts: Malleable iron case of steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.
 8. Insulation-Insert Material for Cold Piping: ASTM C552, Type II cellular glass with 100-psig or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.
- F. Hydronic Piping:
1. Hangers for Pipe Sizes 1/2 to 1-1/2-inch: Malleable iron, adjustable swivel, split ring.
 2. Hangers for Cold Pipe Sizes 2-inches and Over: Carbon steel, adjustable, clevis.
 3. Hangers for Hot Pipe Sizes 2 to 4-inches: Carbon steel, adjustable, clevis.
 4. Hanger Rods: Mild steel galvanized threaded both ends, threaded one end, or continuous threaded with galvanized bolts and nuts and galvanized side beam bracket. Rods shall be, as a minimum, sized as follows:
 - a. 3/8-inch diameter for 1-1/4-inch through 2-inch pipe.
 - b. 1/2-inch for 2-1/2-inch through 3-1/2-inch pipe.
 - c. 5/8-inch for 4-inch pipe.
 - d. 3/4-inch for 6-inch to 10-inch pipe.
 5. Saddles: Provide pipe protection saddles and insulation protection shields at hangers and supports
 6. Inserts: Malleable iron case of steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.
 7. Insulation-Insert Material for Cold Piping: ASTM C552, Type II cellular glass with 100-psig or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

8. Insulation-Insert Material for Hot Piping: ASTM C552, Type II cellular glass with 100-psig or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.
- G. Steam and Steam Condensate Piping:
 1. Hangers for Pipe Sizes 1/2 to 1-1/2-inch: Malleable iron, adjustable swivel, split ring.
 2. Hangers for Hot Pipe Sizes 2 to 4-inches: Carbon steel, adjustable clevis, and cast-iron roller.
 3. Hangers for Hot Pipe Sizes 6-inches and Over: Adjustable steel yoke, cast-iron roll, double hanger.
 4. Hanger attachment to building: Concrete inserts or top beam C-clamps.
 5. Hanger Rods: Mild steel galvanized threaded both ends, threaded one end, or continuous threaded with galvanized bolts and nuts and galvanized side beam bracket. Rods shall be, as a minimum, sized as follows:
 - a. 3/8-inch diameter for 1-1/4-inch through 2-inch pipe.
 - b. 1/2-inch for 2-1/2-inch through 3-1/2-inch pipe.
 - c. 5/8-inch for 4-inch pipe.
 - d. 3/4-inch for 6-inch to 10-inch pipe.
 6. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.
 7. Saddles: Provide pipe protection saddles and insulation protection shields at hangers and supports.
 8. Insulation-Insert Material for Hot Piping: ASTM C552, Type II cellular glass with 100-psig or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.

2.02 FASTENER SYSTEMS

- A. Mechanical Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors for use in concrete. Pullout, tension, and shear capacities that are appropriate for the design loads.

2.03 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A36/A36M, carbon steel plates, shapes, bars, black or galvanized.
- B. Grout: ASTM C1107, factory mixed and packaged, dry, hydraulic cement, non-shrink, nonmetallic grout. Suitable for interior and exterior installations. Non-staining, noncorrosive. Design mix: 5000 psi, 28-day compressive strength.

2.04 EQUIPMENT SUPPORTS

- A. Description: Welded, shop-, or field-fabricated equipment support made from structural carbon-steel shapes.

2.05 SLEEVES

- A. Sleeves for Pipes Through Non-Fire Rated Floors: 18-gauge-thick galvanized steel.
- B. Sleeves for Pipes Through Non-Fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18-gauge-thick galvanized steel.
- C. Sleeves for Pipes Through Fire-Rated and Fire-Resistive Floors and Walls, and Fireproofing: Prefabricated fire-rated sleeves including seals, UL listed, refer to Section 07 84 00 – Firestopping.
- D. Sleeves for Round Ductwork: Galvanized steel.
- E. Sleeves for Rectangular Ductwork: Galvanized steel or wood.
- F. Fire-Stopping Insulation: Glass fiber type, non-combustible, refer to Section 07 84 00 – Firestopping.
- G. Sealant: Acrylic, refer to Section 07 92 00 – Joint Sealers.

PART 3 EXECUTION

3.01 INSERTS

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

3.02 PIPE HANGERS AND SUPPORTS

- A. General:
 - 1. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate movements of expansion joints, expansion loops, and expansion bends.
 - 2. Install lateral bracing in conjunction with pipe hangers and supports to prevent lateral movement.
 - 3. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including but not limited to valves, flanges, strainers, air separators, at changes in direction of piping. Install concrete inserts prior to placement of concrete. Fasten inserts to concrete forms and install reinforcing bars through openings at the top of the inserts.
 - 4. Load Distribution: Install hangers and supports so that piping live and dead loads, including seismic forces, are not transmitted to connected equipment.
 - 5. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and not to exceed maximum deflections allowed by ASME B31.1, ASME B31.5, and ASME B31.9.
- B. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

- C. Support horizontal and vertical piping as scheduled. Provide maximum horizontal and vertical piping support spacing per Table 305.4, International Mechanical Code.
- D. Install hangers to provide minimum 1/2-inch space between finished covering and adjacent Work.
- E. Place hangers within 12-inches of each horizontal elbow.
- F. Use hangers with 1-1/2-inch minimum vertical adjustment.
- G. Support horizontal cast-iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers.
- H. Support vertical piping at every floor. Support vertical cast-iron pipe at each floor at hub.
- I. Support riser piping independently of connected horizontal piping.
- J. Provide copper plated hangers and supports for copper piping.
- K. Design hangers for pipe movement without disengagement of supported pipe.
- L. Pipes shall not be hung or supported from each other.
- M. Prime coat exposed steel hangers and supports. Refer to Section 09 90 00 – Paints and Coatings. Hangers and supports located in crawlspaces, pipe shafts, and suspended ceiling spaces are not considered exposed. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- N. Use a separate hanger for each branch. Support vertical risers at the floor with extension pipe clamps approved by the Engineer.
- O. Protect the insulation at point of contact with saddles approved by the Engineer.
- P. Insulated Piping:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
 - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

- a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12-inches long and 0.048-inch thick.
 - b. NPS 4: 12-inches long and 0.06-inch thick.
 - c. NPS 5 and NPS 6: 18-inches long and 0.06-inch thick.
5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.03 HANGER AND SUPPORT SCHEDULE

- A. Comply with MSS SP-69 for pipe hanger selections and applications.
- B. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system sections, install the following types:
 1. Adjustable, Steel Clevis Hangers (MSS Type 11): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1,050 degrees F, pipes NPS 4 to NPS 24, requiring up to 4-inches of insulation.
 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4-inches of insulation.
 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
 5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of non-insulated, stationary pipes NPS 3/4 to NPS 8.
 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
 8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
 10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 8.
 11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 3.
 12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

- C. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system sections, install the following types:
 - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
 - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- D. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system sections, install the following types:
 - 1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6-inches for heavy loads.
 - 2. Steel Clevises (MSS Type 14): For 120 to 450 degrees F piping installations.
 - 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 - 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 - 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 degrees F piping installations.
- E. Building Attachments: Unless otherwise indicated and except as specified in piping system sections, install the following types:
 - 1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 - 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
 - 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 - 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 - 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 - 6. C-Clamps (MSS Type 23): For structural shapes.
 - 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 - 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 - 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 - 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 - 11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.

12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lbs.
 - b. Medium (MSS Type 32): 1500 lbs.
 - c. Heavy (MSS Type 33): 3000 lbs.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- F. Saddles and Shields: Unless otherwise indicated and except as specified in piping system sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- G. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.
- H. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

3.04 EQUIPMENT BASES AND SUPPORTS

- A. Provide housekeeping pads of concrete, minimum 3-1/2-inches-thick and extending 6-inches beyond supported equipment. Refer to Section 03 30 00 – Cast-in-Place Concrete.
- B. Provide templates, anchor bolts, and accessories for mounting and anchoring equipment.
- C. Construct supports of steel members. Brace and fasten with flanges bolted to structure.

3.05 SLEEVES

- A. Set sleeves in position in forms. Provide reinforcing around sleeves.
- B. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- C. Extend sleeves through floors a minimum of 2-inches above finished floor level. Caulk sleeves.
- D. Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent Work with stuffing, fire stopping, insulation and caulk airtight. Provide close-fitting metal collar or escutcheon covers at both sides of penetration.

- E. Install chrome plated steel, plastic, stainless steel, escutcheons at finished surfaces.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.

- B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

End of Section

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of “Mechanical Identification” Work is shown in the Contract Documents.
- B. Obtain equipment identification numbers from Port of Seattle Aviation Maintenance at preliminary design stage.

1.02 GOVERNING CODES, STANDARDS, AND REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.
 - 1. ASME (American Society of Mechanical Engineers)
 - a. ASME A13.1 – Scheme for the Identification of Piping Systems
- B. Submit materials data in accordance with Section 01 33 00 – Submittals. Furnish manufacturers’ technical literature, standard details, product specifications, and installation instructions for all products.
- C. Submittals shall include the following:
 - 1. Product Data: Provide manufacturer’s catalog literature for each product required.
 - 2. Manufacturer’s Installation Instructions: Indicate installation instructions, special procedures, and installation.
 - 3. Schedules: Provide Equipment Label Schedule and Valve Tag Schedule. Equipment and tag numbers shall be updated to reflect POS standards and actual location of the equipment.

1.03 QUALITY ASSURANCE

- A. Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

PART 2 PRODUCTS

2.01 PRODUCTS

- A. Manufacturers: Seton, W. H. Brady Company, M.S.I., Or Approved Equal.

2.02 EQUIPMENT LABELS

- A. Plastic Labels for Equipment:
 - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16-inch-thick, and having predrilled holes for attachment hardware.
 - 2. Letter Color: White.
 - 3. Background Color: Black.
 - 4. Maximum Temperature: Able to withstand temperatures up to 160°F.
 - 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 inches by 3/4-inch.

6. Minimum Letter Size: 1/4-inch for name of units if viewing distance is less than 24-inches, 1/2-inch for viewing distances up to 72-inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
 7. Fasteners: Stainless-steel rivets or self-tapping screws.
 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.
- C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.03 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 2. Fasteners: Brass beaded chain.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
1. Valve-tag schedule shall be included in operation and maintenance data.

2.04 PIPING IDENTIFICATION AND LABELS

- A. Manufacturers: Seton, M.S.I., W.H. Brady, Or Approved Equal.
1. Materials: Self-adhesive vinyl or pre-coiled type with over-coated UV-resistant ink and heavy-duty vinyl.
 2. All accessible utility service piping is to be coded with color banding tape.
 3. Piping in concealed spaces (ceiling and crawl spaces, plumbing chases, at access doors, etc.) shall have the coding applied prior to concealment.
 4. Piping in mechanical rooms and spaces and other areas where exposed to view (boiler rooms, utility tunnels, fan rooms, pump rooms, etc.) shall have the coding applied after painting.
 5. The 3-band color-coding system shall relate the following information (reading downstream in direction of flow):
 - a. The character or degree of hazard of the medium contained.

- b. The temperature level.
 - c. The media or material contained.
 - d. The direction of flow.
6. The first (upstream) band is to be not less than three-fourths inch (3/4-inch) wide and is to indicate media (hazard) indicator consistent with all standard adopted color schemes as follows:

Green	Safe Material
Yellow	Dangerous Material
Red	Fire Protection System
Blue	Protective Material
Purple	Valuable Material

7. The second (middle) band is to be not less than three-quarters inch (3/4-inch) wide but the same width as the first and is to indicate "Temperature Range" and is to be spaced three-fourths inch (3/4-inch) from the first band.

CODE COLOR	TEMPERATURE RANGE	TYPICAL SYSTEMS	RANGE (°F)
Red	Very Hot	Heating Hot Water Supply Steam Condensate	Above 180°
Orange	Hot	Hot Water (domestic) Heating Hot Water Return Refrigerant Hog Gas	Below 180°
Yellow	Warm	Condenser Water Refrigerant Liquid Supply	Less than 100°
Green	Cool	Cold Water (domestic) Well Water	50°
Blue	Cold	Chilled Water Return	Less than 50°
Purple	Very Cold	Chilled Water Supply Refrigerant Suction	Less than 40°

8. The third (downstream) band is to be not less than one and one-half-inches (1-1/2-inch) wide or not less than twice the width of the preceding bands and is to indicate the "media" and "direction" and spaced three-fourths inch (3/4-inch) from the preceding band.

COLOR	WHAT IT INDICATES
Blue	Water
Brown	Soil or Waste
Aluminum	Vent
Red	Steam

COLOR	WHAT IT INDICATES
Orange	Condensate
Purple	Refrigerant
Yellow	Fuel Oil
Green	Natural Gas
White	Air
Black	Product

9. When flow can be in either direction, a second one and one-half-inch (1 1/2-inch) band is to follow the first band arranged to indicate the probable principal flow direction and located three-fourths inch (3/4-inch) from the adjacent (i.e., four (4) bands are required on reversible-flow piping).
10. Banding schedule

	WIDTH OF BAND		
	3/4	3/4	1-1/2
Cold Water (domestic)	G	G	B
Hot Water (domestic)	G	O	B
Hot Water, Circulating/ Tempered Water (domestic)	G	Y	B
Non-Potable Water/Process Water	Y	G	B
Waste/Indirect Waste/Pumped Waste/ IWS Waste	G	G	BR
Grease Waste	G	O	BR
Vent/Grease Vent/Foundation Vent/ IWS Vent	G	G	AL
Rain Leader/Overflow Rain Leader	G	Y	BR
Steam (high/low pressure)	Y	R	R
Condensate (including pumped)	Y	R	O
Steam Vent	Y	O	AL
Hot Water Heating (supply) including glycol	Y	R	B
Hot Water Heating (return) including glycol	Y	O	B
Chilled Water (supply)	G	P	B
Chilled Water (return)	G	B	B
Glycol Chilled Water (supply)	Y	P	B
Glycol Chilled Water (return)	Y	B	B
Condenser Water (supply)	G	BR	B
Condenser Water (return)	G	BLK	B

	WIDTH OF BAND		
	3/4	3/4	1-½
Fuel Oil (supply)	Y	G	Y
Fuel Oil (supply – preheated)	Y	O	Y
Fuel Oil (return)	Y	Y	Y
Fuel Oil Vent	Y	Y	AL
Compressed Air	G	G	W
Fire Protection	R	G	B
Natural Gas	Y	G	G
Natural Gas Vent	Y	G	AL
Refrigerant Vent	Y	P	AL
Refrigerant Relief	Y	P	P
Refrigerant, Hot Gas (Freon)	P	O	P
Refrigerant, Liquid Supply (Freon)	P	Y	P
Refrigerant, Suction (Freon)	P	P	P
Well Water	Y	G	P
Generator Cooling Water (supply)	O	G	B
Generator Cooling Water (return)	O	O	B

Legend:

G = Green
BR = Brown
R = Red
B = Blue
P = Purple
BLK = Black
Y = Yellow
AL = Aluminum
O = Orange
W = White

11. Fire protection piping shall be identified using three-color band system as well as being labeled with sprinkler riser number sticker and on all piping 3-inches and larger.

2.05 CEILING TACKS

- A. Description: Steel with 3/4-inch diameter color-coded head.
- B. Color code as follows:
 1. HVAC equipment: Yellow.
 2. Fire dampers/smoke dampers: Red.
 3. Plumbing valves: Green.
 4. Heating/cooling valves: Blue.

PART 3 EXECUTION

3.01 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.02 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.
- D. Install identifying devices after completion of coverings and painting.

3.03 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.04 PIPE LABEL INSTALLATION

- A. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 - 7. On piping above removable acoustical ceilings, omit intermediately spaced labels.
 - 8. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

3.05 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets,

convenience and lawn-watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
1. Valve-Tag Size and Shape:
 2. Cold Water: 1-1/2-inches, round.
 3. Hot Water: 1-1/2-inches, round.
 4. Low-Pressure Compressed Air: 1-1/2-inches, round.
 5. The colors listed in subparagraphs below comply with color designation according to ASME A13.1. Background and lettering colors should comply with recommendations in ASME A13.1 unless otherwise indicated. Note also that all colors listed in ASME A13.1 preceded by the word "Safety" are required to comply with ANSI Z535.1. Retain "Natural" option for brass or stainless-steel valve tags.
 6. Valve-Tag Colors:
 - a. Cold Water: Natural.
 - b. Hot Water: Natural.
 - c. Low-Pressure Compressed Air: Natural.
 - d. Letter Colors:
 - (1) Cold Water: White.
 - (2) Hot Water: White.
 - (3) Low-Pressure Compressed Air: White.

3.06 ADDITIONAL LABEL INSTALLATION REQUIREMENTS

- A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive.
- B. Install labels with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer. For unfinished canvas covering, apply paint primer before applying labels.
- C. Install tags using corrosion-resistant chain. Number tags consecutively by location.
- D. Identify air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates. Small devices, such as inline pumps, may be identified with tags.
- E. Identify control panels and major control components outside panels with plastic nameplates.
- F. Identify valves in main and branch piping with tags.
- G. Identify air terminal units and radiator valves with numbered tags.
- H. Tag automatic controls, instruments, and relays. Key to control schematic.

- I. Provide ceiling tacks to locate valves or dampers above T-bar type panel ceilings. Locate in corner of panel closest to equipment.
- J. All accessible utility service piping (excepting electrical conduit only, which is not included here) is to be coded with color banding tape.
- K. Piping in concealed spaces (ceiling and crawl spaces, plumbing chases, at access doors, etc.) shall have the coding applied prior to concealment.
- L. Piping in mechanical rooms and spaces and other areas where exposed to view (boiler rooms, utility tunnels, fan rooms, pump rooms, etc.) shall have the coding applied after painting.
- M. Pipe coding is to be applied where piping:
 - 1. Changes direction,
 - 2. Passes through walls and partitions, or
 - 3. Is closely grouped.
- N. In groups of piping running parallel, bands are to be staggered alternately on adjacent pipes.
- O. Valves are to have banding on the upstream side wherever other banding is not within five (5) feet.
- P. Where banding is to be applied on black-colored pipe (C.I. waste, asphaltum-coated, etc.), a white background may be provided, using white banding tape, or painted with aluminum or white as indicated above.
- Q. Banding tape is to be lapped 1-1/2 turns around the piping to assure adequate adhesion.
- R. A readable, identifying, graphic legend is to be provided in each mechanical room. The legend shall consist of a listing of each system which may be found in that area or at the site, and a short strip of the tapes actually used on the piping, opposite each of the system names.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.
- B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and

specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

End of Section

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of “Mechanical Insulation” Work is shown in the Contract Documents. Work to include ductwork insulation, duct liner insulation jackets, equipment insulation, covering, breeching insulation, thermal insulation for piping systems including vapor retarders, jackets and accessories, and liquid storage vessels and accessories.

1.02 GOVERNING CODES, STANDARDS, AND REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.
1. ASTM (ASTM International)
 - a. ASTM C195 – Standard Specification for Mineral Fiber Thermal Insulating Cement.
 - b. ASTM C547 – Standard Specification for Mineral Fiber Preformed Pipe Insulation.
 - c. ASTM C553 – Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
 - d. ASTM C795 – Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
 - e. ASTM C1136 – Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
 - f. ASTM D1784 – Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
 - g. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials.
 - h. ASTM E96 – Standard Test Methods for Water Vapor Transmission of Materials.
 2. NAIMA (North American Insulation Manufacturers Association)
 - a. NAIMA – National Insulation Standards.

1.03 SUBMITTALS

- A. Submit materials data in accordance with Section 01 33 00 – Submittals. Furnish manufacturers’ technical literature, standard details, product specifications, and installation instructions for all products.
- B. Submittals shall include the following:
1. Product Data: Provide product description, thermal characteristics and list of materials and thickness for each service, and locations.
 2. Manufacturer’s Installation Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.04 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years of documented experience.
- B. Applicator: Company specializing in performing Work of this section with minimum three years of experience.
- C. At least one quality assurance person shall be always present during execution of all portions of the Work. This person shall be thoroughly familiar with the type of materials being installed and the best methods for their installation.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.06 ENVIRONMENTAL REQUIREMENTS

- A. Do not install insulation outside ambient conditions required by manufacturer of each product.
- B. Maintain temperature during and after installation for minimum period of 24 hours.

1.07 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

PART 2 PRODUCTS

2.01 GENERAL

- A. Manufacturers: Armstrong, Johns-Manville, Owens-Corning, Knauf GmbH, Pittsburgh Corning, Armacell, Or Approved Equal.
- B. As far as practicable, the products hereinafter described shall be of one manufacturer and shall meet the following requirements listed as to their function.
- C. Insulation thickness is based on insulation having a thermal resistance of 4.0 to 4.6 per inch of thickness at a mean temperature of 75°F. Insulation thickness shall be increased or decreased for materials having R values less than 4.0 per-inch or greater than 4.6 per-inch.
- D. Tape: Pressure-sensitive lap of facing material. No duct tape will be used for joining or holding insulation service. Use insulation manufacturer's approved tape or joining methods.
- E. Adhesive: Foster, Sealfos #30-36, Arabol, Armstrong 520, Or Approved Equal.

2.02 MANMADE MINERAL FIBER

- A. Insulation: ASTM C547 Mineral Fiber Pipe Insulation, Type I 850(454). Manville Micro-Lok. Conform to ASTM C795 for application on austenitic stainless steel.
- B. Vapor Retarder Jacket:
 - 1. White kraft paper with glass fiber yarn, bonded to aluminized film.
 - 2. Moisture vapor transmission: ASTM E96; 0.02 perm-inches.

- C. Tie Wire: 0.048-inch stainless steel with twisted ends on maximum 12-inch centers.
 - D. Vapor Retarder Lap Adhesive:
 - 1. Compatible with insulation.
 - E. Insulating Cement/Mastic:
 - 1. ASTM C195; hydraulic setting on mineral wool.
- 2.03 MINERAL FIBER, FLEXIBLE INSULATION FOR THE EXTERIOR OF SHEET METAL DUCTS
- A. Insulation: ASTM C553 mineral fiber blanket thermal insulation for commercial and industrial applications, Type II.
 - B. Vapor Retarder Jacket:
 - 1. Kraft paper with glass fiber yarn and bonded to aluminized film.
 - 2. Moisture vapor transmission: ASTM E96; 1.3 perm.
 - 3. Secure with pressure-sensitive tape.
 - C. Vapor Retarder Tape:
 - 1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure-sensitive rubber-based adhesive.
 - D. Tie Wire: Annealed steel, 16 gauge.
- 2.04 JACKETS
- A. PVC Pipe Jacket: ASTM D1784, one-piece molded type fitting covers and sheet material, off-white color.
 - 1. Thickness: 10 mils.
 - 2. Connections: Pressure-sensitive color matching vinyl tape.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that piping, equipment, and ductwork has been tested before applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION

- A. Install in accordance with NAIMA National Insulation Standards.
- B. To prevent shrinkage, the covering shall be applied when the building is thoroughly dry.
- C. Repair and/or replace damaged or removed covering on existing equipment and piping where damaged by Work under this contract.
- D. All surfaces shall be insulated which would: reduce heat gain or loss, avoid undesirable condensation and/or reduce corrosion.
- E. Exposed Piping: Locate insulation and cover seams in least visible locations. Finish exposed piping and equipment insulation with white pigmented lagging

adhesive (not required on AP jacket finish). Equipment, piping, valves, etc., in boiler rooms, mechanical rooms and fan rooms are considered exposed whether in a plenum or not.

- F. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor): Finish with PVC jacket and fitting covers.
- G. Insulated Pipes Conveying Fluids Below Ambient Temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints. Apply insulating cement to all fittings, valves, and strainers, equal to the adjacent thickness. Cover with four-ounce canvas jackets or preformed PVC fitting covers.
- H. Manmade mineral fiber insulated pipes conveying fluids below ambient temperature:
 - 1. Provide factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal all staple penetrations with vapor retarder mastic.
 - 2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor retarder adhesive or PVC fitting covers.
- I. For hot piping conveying fluids over 140°F, insulate flanges and unions at equipment.
- J. Manmade mineral fiber insulated pipes conveying fluids above ambient temperature:
 - 1. Provide factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or the pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.
 - 2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
- K. Inserts and Shields:
 - 1. Application: Piping or Equipment 2-inches diameter or larger.
 - 2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
 - 3. Insert Location: Between support shield and piping and under the finish jacket.
 - 4. Insert Configuration: Minimum 6-inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
 - 5. Insert Material: Compression resistant insulating material suitable for the planned temperature range and service.
 - 6. Protective Saddle: Insulate under pipe hangers (full thickness) and provide 18-gauge galvanized protective saddles covering lower half of insulation.

Protective saddle length equal to pipe size with 6-inches minimum length.
Use high density insulation insert on pipe 2-inches and larger.

- L. Continue insulation through penetrations of building assemblies or portions of assemblies having a fire resistance rating of one hour or less. Provide intumescent firestopping when continuing insulation through assembly. Finish at supports, protrusions, and interruptions. See Section 07 84 00 – Firestopping for penetrations of assemblies with a fire resistance rating greater than one hour.
- M. Insulation is not required on sound-lined ductwork.
- N. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
- O. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.
- P. Insulated equipment that contains fluids below ambient temperature: Insulate entire system.
- Q. Mineral fiber insulated equipment that contains fluids below ambient temperature: Provide vapor retarder jackets, factory-applied or field-applied. Finish with glass-cloth and vapor barrier adhesive.
- R. For hot equipment that contains fluids over 140°F, insulate flanges and unions with removable sections and jackets.
- S. Mineral fiber insulated equipment that contains fluids above ambient temperature: Provide standard jackets, with or without vapor retarder, factory-applied or field-applied. Finish with glass cloth and adhesive.
- T. Finish insulation at supports, protrusions, and interruptions.
- U. Equipment in Mechanical Equipment Rooms or Finished Spaces: Finish with canvas jacket sized for finish painting.
- V. Nameplates and ASME Stamps: Bevel and seal insulation around; do not insulate over.
- W. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation so it can be easily removed and replaced without damage.
- X. Insulated Ductwork Conveying Air Below Ambient Temperature:
 - 1. Provide insulation with vapor retarder jackets.
 - 2. Finish with tape and vapor retarder jacket.
 - 3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
 - 4. Insulate entire system including fittings, joints, flanges, fire dampers, risers, branches, flexible connections, and expansion joints.
- Y. Insulated Ductwork Conveying Air Above Ambient Temperature:
 - 1. Provide with or without standard vapor retarder jacket.
 - 2. Insulate fittings and joints. Where service access is required, bevel and seal the ends of insulation.

Z. External Duct Insulation Application:

1. Secure insulation with vapor retarder with wires and seal jacket joints with vapor retarder adhesive or tape to match jacket.
2. Secure insulation without vapor retarder with staples, tape, or wires.
3. Install without sag on underside of ductwork. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift ductwork off trapeze hangers and insert spacers.
4. Seal vapor retarder penetrations by mechanical fasteners with vapor retarder adhesive.
5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.
6. Insulate supply and return ductwork exposed to the weather as noted for exposed supply ductwork and finish cover with two (2) 1/8-inch coats of mastic, reinforced with glass fabric. (Lap all seams and joints 2-inches).

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.

B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

End of Section

PART 1 GENERAL**1.01 SUMMARY OF WORK**

- A. The extent and location of “Basic Fire Suppression Materials and Methods” Work is shown in the Contract Documents. Section includes pipe, fittings, valves, and connections for sprinkler systems.

1.02 GOVERNING CODES, STANDARDS, AND REFERENCES

- A. ASME (American Society of Mechanical Engineers)
1. ASME B16.1 – Cast-Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800.
 2. ASME B16.3 – Malleable Iron Threaded Fittings, Class 150 and 300.
 3. ASME B16.4 – Cast-Iron Threaded Fittings, Class 125 and 250.
 4. ASME B16.5 – Pipe Flanges and Flanged Fittings.
 5. ASME B16.9 – Factory-Made Wrought Steel Buttwelding Fittings.
 6. ASME B16.11 – Forged Steel Fittings, Socket-Welding and Threaded.
 7. ASME B16.25 – Buttwelding Ends.
- B. ASTM (ASTM International)
1. ASTM A53 – Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
 2. ASTM A135 – Electric-Resistance-Welded Steel Pipe.
- C. AWS (American Welding Society)
1. AWS A5.8 – Joints.
 2. AWS D1.1 – Structural Welding Code.
 3. AWS D10.9 – Welding.
- D. NFPA National Fire Protection Association)
1. NFPA 13 – Installation of Sprinkler Systems
- E. FM Global
1. FM Global Data Sheet 2-8 “Earthquake Protection for Water-Based Fire Protection Systems.”
 2. FM Global Data Sheet 2-8N “Standard for the Installation of Sprinkler Systems.”
 3. FM Global Data Sheet 1-3 “High Rise Buildings.”
 4. FM Global Data Sheet 4-4N “Standpipe Systems.”
 5. FM Global P7825: Approval Guide – Equipment, Materials, Services for Conservation of Property; latest edition.
- F. Seattle-Tacoma International Airport “Rules for Airport Construction.”
- G. Underwriters Laboratories (UL): Fire Protection Equipment Directory, latest editions.

1.03 SUBMITTALS

- A. Submit materials data in accordance with Section 01 33 00 – Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.
- B. Submittals shall include the following:
 - 1. Minimum of six (6) complete sets, drawings, calculations, product data and accessories are required. If submitting electronically, provide a minimum of three (3) full size (24-inches x 36-inches minimum) hard copy wet stamped sets of drawings and three (3) hard copies of wet stamped calculations (if required) to the Building Department. One copy is for the Building Department and two copies are for the Fire Department.
 - 2. Shop Drawings and calculations: Indicate pipe materials used, joining methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections. Include elevations, clearances, dimensions, and seismic bracing. Refer to Section 1.10 Design for additional submittal requirements.
 - 3. Product Data: Submit manufacturer's catalogue information. Indicate valve data and ratings.
 - 4. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
 - 5. Welding submittals and procedures shall be provided in accordance with NFPA 13 Section 3-12 and AWS D10.9, Level AR-3. Submittals include Welding Procedure Specification, Contractor's Procedure Qualification Test Records, and Welder Qualification Test Records. Welding inside of occupied buildings is required to comply with Port Fire Department requirements for hot work permits.

1.04 QUALITY ASSURANCE

- A. Provide materials in accordance with the design documents and this specification.
- B. Systems shall be designed in accordance with current codes and consistent with FM Global, although FM Global does not inspect or certify installations.
- C. Schedule 40 is the minimum acceptable wall thickness by the Port of Seattle for fire suppression sprinklers piping. NO EXCEPTIONS.

1.05 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years' documented experience approved by manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store valves in shipping containers, with labeling in place.
- B. Provide temporary protective coating on cast-iron and steel valves.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation fabrication.

1.07 WARRANTY

- A. Section 01 78 36 – Warranties and Bonds.

1.08 EXTRA MATERIALS

- A. Spare and extra parts shall be identified for all products, but not provided. Include spare parts information in Operation and Maintenance Manuals.

1.09 DESIGN

- A. Coordinate fire sprinkler design with Port of Seattle Fire Department and FM Global Engineering. For purposes of code compliance, the Port of Seattle Fire Department shall be the Authority Having Jurisdiction (AHJ).
- B. Systems, extensions, or revisions shall be designed and calculated hydraulically by a State of Washington licensed Fire Protection Engineer or Washington NICET Level 3. Riser locations, fire flows, and pressures including locations where the measurements were taken, mains, and areas to be designed and installed shall be shown on the contract drawings. Provide a site plan that will show the location of the main and fire hydrants. Calculations and drawings shall be stamped and signed by this engineer. Seismic restraint submittal and calculations must be designed and stamped by a licensed Washington State structural engineer. Calculations shall utilize an importance factor of 1.5 for life safety systems and 1.0 for others. Restraint detail submittals shall indicate loads imparted to the structure and be approved by the Structural Engineer prior to the installation.
- C. The spacing of sprinklers shall not exceed 130 sq. ft. per sprinkler for ordinary hazard areas. Where the design basis is for a light hazard system, the sprinkler spacing shall not exceed 168 sq. ft.

1.10 DESIGN FOR NEW SYSTEMS AND DESIGN FOR EXISTING SYSTEMS

- A. All areas of the building are to be fully sprinklered, including any areas above ceilings or any voids required to formally meet requirements of NFPA, IBC, Factory Mutual and Port of Seattle Fire Department “Rules for Airport Construction.”
- B. Obtain latest water supply engineering test data prior to design. The proposed sprinkler system demand must be 10% or 10 psi (whichever is greater) below the water supply curve. Contact Port of Seattle Fire Department for water supply information.
- C. Existing piping shall be shown for the complete system on the submittal shop drawings with elevation, pressure, and supply connections, etc. per NFPA 13 for new Work connecting to existing systems on remodel projects.
- D. Earthquake bracing for the sprinkler systems shall be designed in accordance with FM Global Data Sheets 2-0 and 2-8 “.” Earthquake bracing design calculations are to be submitted to the Port of Seattle for review and approval.
- E. Provide guards where clear height under sprinkler head is less than 7-feet-0-inches.

PART 2 PRODUCTS**2.01 VALVES**

- A. Gate Valves: Cast or ductile iron gate valve, outside screw and yoke (OS&Y), non-rising stem, bronze mounted, 250 psi rated working pressure, double disc, parallel

seats, grooved or flanged ends. Valve shall be equipped with FM and UL approved tamper switch. UL listed and FM approved for fire service.

B. Globe Valves:

1. Up to and including 2 inches: Bronze body, bronze trim, rising stem and hand wheel, inside screw, renewable rubber disc, threaded ends, with back-seating capacity.
2. Over 2 inches: Iron body, bronze trim, rising stem, hand wheel, OS&Y, plug-type disc, flanged ends, renewable seat and disc.

C. Ball Valves:

1. 600 psi cold working pressure, bronze, 2-piece body forged brass, chrome plated or stainless-steel full port ball, PTFE or RTFE seats, and stuffing box ring, lever handle, threaded ends. UL/FM approval for installation in fire systems. FPPI 2R97, Apollo 64, Viking FBV3, Or Approved Equal.

D. Butterfly Valves:

1. Bronze Body: Stainless steel disc, resilient replaceable seat, threaded or grooved ends, extended neck, hand wheel and gear drive and integral indicating device.
2. Cast or Ductile Iron Body: Cast or ductile iron, chrome- or nickel-plated ductile iron or aluminum bronze disc, resilient replaceable EPDM seat, wafer, lug, or grooved ends; with an extended neck, hand wheel and gear drive and integral indicating device.
3. Iron body, bronze or stainless disc with stainless steel spring, resilient seal, 250 psi rated, flanged or grooved ends suitable for vertical or horizontal position. Include automatic drains as required by NFPA 14. Manufacturers to be Viking, Tyco, Reliable, Grinnell, Or Approved Equal.

E. Drain Valves:

1. 600 psi cold working pressure, bronze, 2-piece body forged brass, chrome plated or stainless-steel full port ball, PTFE or RTFE seats, and stuffing box ring, lever handle, threaded ends. UL/FM approval for installation in fire systems. Include with hose thread nipple, cap, and chain. FPPI 2R97, Apollo 64, Viking FBV3, Or Approved Equal.

F. Airport Requirement: Automatic Ball Drip Valves:

1. Bronze body and ball: Designed to drain water (leak) in an open position and to close when flow of water exceeds 4 through 10 GPM; 175 psi rated working pressure. UL listed and FM approved.

2.02 ABOVEGROUND PIPING

- A. Above-Grade Piping 4-inches and under shall be steel Schedule 40 ASTM A53 seamless or ERW. Piping over 4-inches shall be Standard 40 ASTM A53 seamless or ERW. Schedule 10, 20, 30, and flow piping are not allowed at Port of Seattle Aviation Facilities. Flexible type piping or adjustable type drop nipples located on branches for the purpose of sprinkler head installation is not allowed.
- B. Above-Grade Fittings shall be steel in accordance with ASME B16.9 welded, B16.25 welded, B16.5 flanged, B16.11 welded/threaded, ASTM A234 welded,

cast-iron in accordance with ASME 16.1 flanged, ductile iron in accordance with ASTM A536 grooved, or malleable iron in accordance with ASME B16.3 threaded per ASTM A47. Fittings to be standard pattern flow type or short pattern with flow characteristics equal to standard pattern. Fittings above grade shall be actual elbows, tees, reducers, and other required fittings. Coupling reducers, coupling tees, or mechanical tees are not allowed. Plain end fittings or drain elbows are not allowed.

- C. Couplings shall consist of two (2) standard weight ASTM A536, Grade 65-45-12 ductile iron housings, and pressure responsive EPDM or nitrile gasket for service temperatures of -20°F to 180°F minimum, and ASTM A183 Grade 2 zinc-electroplated steel bolts and nuts conforming to ASTM A563. Rigid couplings to be utilized that are in conformance with ANSI B31.1 and allow for working pressures up to 750 psi when used on standard roll or cut grooved pipe. Flexible couplings to be utilized in vibration transmission applications or seismic. Flexible couplings shall not be used in place of expansion joints. Flange adapters to comply with type of grooved system utilized.
- D. Weld-o-lets, Threadolets, or actual tees with mechanical couplings are the only connections allowed at pipe connections where more than two connections are required (tees/crosses). Coupling tees and mechanical tees are not allowed.

2.03 RISER DRAIN

- A. Copper Tubing, ASTM B75 or ASTM B88, Type M, hard drawn.

2.04 ABOVEGROUND PIPE IDENTIFICATION

- A. Manufacturers: Seton, Wesline, M.S.I., W.H. Brady, Or Approved Equal.
- B. Materials: Self-adhesive vinyl or pre-coiled type with over coated UV resistant ink and heavy-duty vinyl. Seton model M3968, Wesline, M.S.I., W.H. Brady, Or Approved Equal.
- C. Piping in concealed spaces (ceiling and crawl spaces, plumbing chases, at access doors, etc.) shall have the identification applied prior to concealment. Piping in mechanical rooms and spaces and other areas where exposed to view (boiler rooms, utility tunnels, fan rooms, pump rooms, etc.) shall have the identification applied after painting.
- D. Fire protection pipe shall have three-band color-coding system applied based upon the following (reading downstream in direction of flow):
 - 1. The first (upstream) band is to be not less than ¾-inch wide and is to indicate media (hazard) indicator consistent with all standard adopted color schemes as follows.
 - 2. The second (middle) band is to be not less than ¾-inch wide but the same width as the first and is to indicate "Temperature Range" and is to be spaced ¾-inch from the first band.
 - 3. The third (downstream) band is to be not less than 1½-inch wide or not less than twice the width of the preceding bands and is to indicate the "media" and "direction" and shall be spaced ¾ inch from the preceding band. This wide band indicates the direction of flow.
 - 4. When flow can be in either direction, a second 1½-inch band is to follow the first band arranged to indicate the probable principal flow direction and

located three-fourths inch ($\frac{3}{4}$ -inch) from the adjacent (i.e., four [4] bands are required on reversible-flow piping).

- E. Fire Protection Pipe Banding shall be colored Red (0.75-inch), Green (0.75-inch), Blue (1.5-inch).
- F. When applied to dark colored piping, provide a white background sticker full circumference and extending 1-inch beyond each end of three-band identification bands.

2.05 PIPE HANGERS AND SUPPORTS

- A. Conform to NFPA 13 “Hangers, Bracing, and Restraint of System Piping.” All fire protection/suppression hangers shall be UL listed and FM approved. All hanger systems to be approved by a Structural Engineer licensed in Washington State.
- B. Side beam clamps shall be tandem with channel support. Single side beam clamps not allowed.
- C. Pipes are not to be used for support of systems, including substitution for channel.
- D. U hooks are not allowed for longitudinal bracing.
- E. Hangers for Pipe Sizes 1/2- to 1-1/2-inches: Malleable iron, adjustable clevis.
- F. Hangers for Pipe Sizes 2-inches and Over: Carbon steel, clevis, pipe used as a support not allowed.

PART 3 EXECUTION

3.01 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and foreign material, from inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.02 INSTALLATION

- A. Install piping in accordance with NFPA 13 for sprinkler systems.
- B. Plastic, PVC, CPVC, or other plastics are not allowed for any piping, products, accessories, receptacles, valves, risers, or other.
- C. Existing systems shall be drained, and temporary fire watch coordinated/provided prior to embarking upon Work. Standard Port of Seattle Aviation shutdown procedures shall be followed.
- D. Obtain hot work permits for any required welding or other type of Work related to hot work permits.
- E. Components and Installation: Piping system and components shall be rated for 175 psig minimum working pressure.
- F. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
- G. Install piping to conserve building space, to not interfere with use of space and other Work.

- H. Group piping whenever practical at common elevations. Maintain a minimum of 12-inches clear adjacent to pipes running in parallel where maintenance staff may be required to assemble or disassemble pipe, equipment, or other appurtenances.
- I. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- J. Pipe Hangers and Supports:
 - 1. Install in accordance with NFPA 13.
 - 2. Install hangers to provide minimum 1/2-inch space between finished covering and adjacent Work.
 - 3. Place hangers within 12 inches of each horizontal elbow.
 - 4. Use hangers with 1-1/2-inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 - 5. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 - 6. Prime coat exposed steel hangers and supports. Refer to Section 09 90 00 – Paints and Coatings Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- K. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level. Elbow tees or elbow drains are not allowed.
- L. Prepare pipe, fittings, supports, and accessories for finish painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of primer to welding. Refer to Section 09 90 00 – Paints and Coatings.
- M. Do not penetrate building structural members unless indicated.
- N. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.
- O. Die cut threaded joints with full cut standard taper pipe threads with non-toxic joint compound applied to male threads only.
- P. Install valves with stems upright or horizontal, not inverted. Remove protective coatings after installation.
- Q. Place pipe runs to minimize obstruction to other Work.
- R. Place piping in concealed spaces above finished ceilings.
- S. All installations shall be approved by Port of Seattle Facilities & Infrastructure Department and by Port of Seattle Fire Department prior to construction.
- T. Port of Seattle Fire Department shall witness all tests. Contractor will present all necessary test forms at the time of the test. All tests require 48 hours' advance notice to Port of Seattle Water Department (Facilities & Infrastructure) and Port of Seattle Fire Department.

3.03 INTERFACE WITH OTHER PRODUCTS

- A. Inserts and Sleeves:
 - 1. Sleeve pipes passing through partitions, footings, walls, and floors. Seal pipe and sleeve penetrations to achieve fire resistance equivalent to fire separation required.
 - 2. Provide Schedule 40 steel sleeves for placement in concrete forms. Allow for NFPA required clearance from sleeve to pipe. Sleeve shall extend 2-inches above concrete finish.
 - 3. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 4. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4-inches or as required by Structural Engineer.
 - 5. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
- B. Testing: Test piping systems to 150 psi and base results on NFPA (any allowed leakage). Require test be witnessed by Authority having jurisdiction.

3.04 CLEANING

- A. Section 01 74 00 – Cleaning.
- B. Clean entire system after all other construction is complete.
- C. Flush entire piping system of foreign matter in accordance with NFPA.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.
- B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

DIVISION 21 – FIRE SUPPRESSION

Section 21 10 00 – Basic Fire Suppression Materials and Methods

End of Section

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of “Wet-Pipe Fire Suppression Sprinkler” Work is shown in the Contract Documents.

1.02 GOVERNING CODES, STANDARDS, AND REFERENCES

- A. Factory Mutual Engineering and Research Council Data Sheets
- B. NFPA 13 (National Fire Protection Association) – Installation of Sprinkler Systems.
- C. NFPA 70 – National Electrical Code.

1.03 SUBMITTALS

- A. Submit materials data in accordance with Section 01 33 00 – Submittals. Furnish manufacturers’ technical literature, standard details, product specifications, and installation instructions for all products.
- B. Submittals shall include the following:
 - 1. Product Data: Submit data on sprinklers including manufacturer’s catalog information. Submit performance ratings, rough-in details, and piping connections.
 - 2. Manufacturer’s Certificate: Certify that products meet or exceed specified requirements.

1.04 CLOSEOUT SUBMITTALS

- A. Section 01 78 39 – Construction Document Management System.
- B. Project Record Documents: Record actual locations of sprinklers and deviations of piping from drawings. Indicate drain and test locations.
- C. Operation and Maintenance Data: Submit servicing requirements, record drawings, inspection data, replacement part numbers and availability, and location and numbers of service depot.

1.05 QUALITY ASSURANCE

- A. Perform Work in accordance with Port of Seattle standards.

1.06 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years’ documented experience approved by manufacturer.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Store products in shipping containers until installation. Provide and maintain temporary inlet and outlet caps until installation.

1.08 WARRANTY

- A. Section 01 78 36 – Warranties and Bonds.

1.09 EXTRA MATERIALS

- A. Spare and extra parts shall be identified for all products, but not provided. Include spare parts information in Operation and Maintenance Manuals.
- B. Provide:
 - 1. Supply extra sprinklers under provisions of NFPA 13.
 - 2. Supply suitable wrenches for each sprinkler type.
 - 3. Supply metal storage cabinet

PART 2 PRODUCTS

2.01 SPRINKLERS

- A. Perform Work in accordance with Port of Seattle standards.
- B. Exposed Area Type:
 - 1. Type: Standard upright type with guard when within 7 feet above floor.
 - 2. Unfinished Areas, Ceiling Spaces, and Mechanical Rooms: Upright or pendent, 1/2-inch orifice, plain brass finish, deflector.
 - 3. Unheated Areas subjected to Freezing (supplied from Wet Pipe Sprinkler System): Dry pendent or sidewall, 1/2-inch orifice, chrome finish.
 - 4. Dry System Sprinklers: Upright or sidewall, 1/2-inch orifice, chrome finish.
 - 5. Temperature rated for specific area hazard.
- C. Side wall Type:
 - 1. UL listed and FM approved for use intended, sidewall type, quick response heads. Temperature ratings shall be per NFPA 13 and design criteria. Reliable F1FR, Viking Microfast series, Or Approved Equal.
 - 2. Temperature rated for specific area hazard.
- D. Guards: Finish to match sprinkler finish. Guards shall be provided in all low clearance (below 10-feet) unfinished areas including all baggage conveyor areas.
- E. Escutcheons: Flanged steel, hinged, with set screws, nickel-plated finish. Escutcheons shall be listed, supplied, and approved for use with the sprinkler.

2.02 PRE-ACTION FOR POWER CENTER ROOMS

- A. Manual Flooding Pre-Action Valve: Gate type valve with rubber faced disc actuated manually with electric alarm, with alarm testing trim. Valve will have a fire department key that is located outside the Electrical Room.
- B. The valve will pressurize the pipe in the room and be equipped with a tamper switch.
- C. The sprinkler head will be heat activated in order for the system to deploy. Sprinkler heads will be rated for 250°F.
- D. The fire sprinkler pipe inside the room will be pressurized and will not contain water under normal circumstances.

2.03 AIR COMPRESSOR

- A. Provide oilless, automatic type, riser-mounted air compressor including pressure switch, air piping, and tank.
- B. Compressor shall have a minimum capacity of charging the complete sprinkler system to normal system air pressure within 30 minutes and 15 minutes for the pre-action system pneumatic detection system. Provide an approved automatic air maintenance device for the system.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Perform Work in accordance with Port of Seattle standards. Install guards on sprinklers located below 7-feet.

3.02 PROTECTION OF INSTALLED CONSTRUCTION

- A. Protect sprinklers to ensure concealed sprinklers, cover plates, and sprinkler escutcheons do not receive field paint finish. Remove after painting.
- B. The Contractor is responsible to replace sprinklers that get overspray, paint, or other foreign material that renders them out of compliance with NFPA requirements.
- C. Any new sprinklers installed under this contract required to be replaced due to damage by the project Work shall be replaced at no cost to the Port of Seattle.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.
- B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

End of Section

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of “Sanitary Waste and Vent Piping” Work is shown in the Contract Documents.
- B. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. References and standards listed herein are to be the latest edition available, unless specifically stated otherwise.
 - 1. AISI (American Iron and Steel Institute)
 - a. AISI 304 – Stainless Steel
 - 2. ASTM (American Society for Testing and Materials)
 - a. ASTM A74 – Cast Iron Soil Pipe and Fittings.
 - 3. IAPMO (International Association of Plumbing and Mechanical Officials)
 - a. Uniform Plumbing Code, Latest edition.
 - 4. ICC (International Code Council)
 - a. International Building Code (IBC), Latest edition.
 - 5. Washington State Department of Ecology
 - a. Washington State Department of Ecology
 - 6. Washington State Department of Health regulations
 - a. Washington State Department of Health regulations.

1.02 SUBMITTALS

- A. Submit materials data in accordance with Section 01 33 00 – Submittals. Furnish manufacturers’ technical literature, standard details, product specifications, and installation instructions for all products.
- B. Submittals shall be as follows:
 - 1. Shop Drawings: Indicate dimensions and weights. Drawings shall include riser diagrams. Drawings shall show invert elevations of all sanitary drain lines leaving the building and of all existing piping being connected-to by the Work.
 - 2. Product Data: Submit data on pipe materials, fittings, and accessories. Provide manufacturer’s catalog information. Provide component sizes, rough-in requirements, service sizes, and finishes.
 - 3. Manufacturer’s Installation Instructions: Submit installation instructions for all material and equipment.
 - 4. Manufacturer’s Certificate: Certify that products meet or exceed specified requirements.
 - 5. Drain schedules and locations.
 - 6. Riser diagrams (Waste, Vent and Storm).

- 7. Indicate invert elevations of all sanitary waste piping leaving the building and at existing piping being connected.
 - 8. Indicate where piping is from and routing to for all piping on drawings.
- 1.03 QUALITY ASSURANCE
 - A. Maintain one copy of each document on site.
- 1.04 QUALIFICATIONS
 - A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
 - B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.
- 1.05 DELIVERY, STORAGE, AND HANDLING
 - A. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.
- 1.06 ENVIRONMENTAL REQUIREMENTS
 - A. Do not install underground piping when bedding is wet or frozen.
- 1.07 FIELD MEASUREMENTS
 - A. Verify field measurements prior to fabrication.
- 1.08 EXTRA MATERIALS
 - A. Spare and extra parts shall be identified for all products, but not provided. Include spare parts information in Operation and Maintenance Manuals.

PART 2 PRODUCTS

- 2.01 SANITARY SEWER PIPING, ABOVE GRADE
 - A. Stainless Steel Pipe: AISI 304/EN 1.4301
 - 1. Fittings and Joints: Stainless steel, push-fit connections.
 - 2. Gaskets: Viton.
 - 3. Manufacturer: Josam, Blucher, Or Approved Equal.
- 2.02 CLEANOUTS
 - A. Manufacturers: J.R. Smith, Zurn, Josam, Wade, Or Approved Equal.

PART 3 EXECUTION

- 3.01 EXAMINATION
 - A. Coordination and project conditions per project phasing plan.
 - B. Verify that excavations are to required grade, dry, and not over-excavated.
- 3.02 PREPARATION
 - A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
 - B. Remove scale and dirt, on inside and outside, before assembly.
 - C. Prepare piping connections to equipment with flanges or unions.

3.03 INSTALLATION

- A. Install Work in accordance with Section 20 00 00 – Mechanical Work – General.
- B. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- C. Provide and install pipe hangers and supports. Also, provide supporting shoes and anchors at the base of stacks.
- D. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
- E. Provide access where valves and fittings are not exposed.
- F. All pipes, valves, cleanouts, and particularly waste piping must be accessible for maintenance. Where recessed in wall cavities, provide removable access panels or other approved methods for access.
- G. For sanitary waste piping, provide a grade of 1/4 inch per foot where possible, but in no case less than 1/8 inch per foot. Install main vertical soil and waste stacks with provisions for expansion and extend full size to roof line as vents.
- H. Pitch all vents for proper drainage. Install vent piping with each bend at a minimum of 45 degrees from the horizontal wherever structural conditions will permit.
- I. Sanitary Drains
 - 1. Invert elevations of all sanitary sewer lines leaving the buildings shall be of sufficient depth to permit future connection of a waste line from any point in the lowest level of the building.
 - 2. Connections in waste lines for food service areas shall turn down with a 1/8 bend at the connection to the next branch.
 - 3. Food service waste shall be collected separately from sanitary building waste and routed through a Port of Seattle approved grease interceptor.
 - 4. Crosses shall not be used in waste piping
- J. Provide cleanouts every 40 feet and install at all locations required by code and to permit cleaning of all sewer piping. Provide cleanouts full size of pipe, but not larger than 4 inches.
- K. Close cleanout openings with brass screw plugs. Where cleanouts occur in floor, install a brass ferrule complete with a screwed brass cover, flush with floor.
- L. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for snaking drainage system.
- M. Encase exterior cleanouts in concrete flush with grade.
- N. Cushion all traps and bearings to minimize transfer of sound. Firmly anchor all pipes in position.
- O. Establish elevations of buried piping outside the building to ensure not less than 3 feet of cover unless otherwise approved by the Engineer.
- P. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

- Q. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting.
- R. Install bell and spigot pipe with bell end upstream.
- S. Sleeve pipes passing through partitions, walls, and floors.
- T. Concealed plumbing components shall have access doors indicated on drawings.
- U. Grading: Provide a grade of 1/4-inch per foot where possible, but in no case less than 1/8-inch per foot. Install main vertical sanitary waste stacks with provisions for expansion and extend full size to roof line as vents.
- V. Invert elevations of all sanitary sewer lines leaving the buildings shall be of sufficient depth to permit future connection of a waste line from any point in the lowest level of the building.
- W. Testing Requirements: Subject all Work to hydrostatic test of 10-foot head of water. Obtain approval for all Work or portions of Work as tested, in writing, prior to covering or concealment in any manner. Owner shall witness testing.

3.04 ERECTION TOLERANCES

- A. Establish invert elevations and slopes for drainage to at least 1/4 inch per foot minimum. Maintain gradients.

3.05 TESTING

- A. Unless otherwise directed, plug all openings and fill with water to a height equal to the lowest vent, or 10 feet of head, whichever is greater or as directed by local plumbing inspection authority. Allow to stand one hour or longer as required. Recaulk leaking joints or tighten clamps as directed and then retest.
- B. Obtain approval for all Work or portions of Work as tested, in writing, prior to covering or concealment in any manner. Notify the Engineer at least 2 normal working days prior to testing any portion of Work and do not conceal any Work until so directed by the Engineer.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

- A. No separate measurement or payment will be made for the Work required by this section. The cost for this portion of the Work will be considered incidental to, and included in the payments made for the applicable bid items in the Lump Sum price bid for the Project.

End of Section

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of “Testing, Adjusting and Balancing” Work is shown in the Contract Documents. Section includes all mechanical equipment and components to assure optimum performance of mechanical systems under all operating conditions.

1.02 GOVERNING CODES, STANDARDS, AND REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.
 - 1. AMCA (Air Movement and Control Association)
 - a. AMCA Publication 203 – Fan Application Manual, Part 3, field performance measurement.
 - 2. AABC (Associated Air Balance Council)
 - a. AABC – Test and Balance Procedures
 - 3. ACGIH (American Conference of Governmental Industrial Hygienists)
 - a. ACGIH – Industrial Ventilation: A Manual of Recommended Practice for Design
 - b. ACGIH – Industrial Ventilation: A Manual of Recommended Practice for Operation and Maintenance
 - 4. NEBB (National Environmental Balancing Bureau)
 - a. NEBB – Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.
 - 5. IBC (International Building Code)

1.03 SUBMITTALS

- A. Submit materials data in accordance with Section 01 33 00 – Submittals. Furnish manufacturers’ technical literature, standard details, product specifications, and installation instructions for all products.
- B. Submittals shall include the following:
 - 1. Firm and onsite staff qualifications and resumes.
 - 2. Test Reports: Submit preliminary report with complete drawings of all systems to be tested, system operation sequences clearly stated, and seasonal system requirements delineated (Summer/Winter, etc.). Indicate data forms containing information indicated in Schedules.
 - 3. Certificates of equipment calibration for all equipment to be used for this project.
 - 4. Field Reports: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.

5. Prior to commencing Work, submit report forms or outlines indicating adjusting, balancing, and equipment data required.
6. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Engineer and for inclusion in operating and maintenance manuals.
7. Provide reports in soft cover, letter size, three-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets and indicating thermostat locations.
8. Indicate data forms containing information indicated in Schedules. Include detailed procedures, agenda, and sample report forms prior to commencing system balance.
9. Drawings:
 - a. Indicate design minimum and maximum (CFM, GPM, etc.) parameters on drawings.
 - b. Show a unique (POS) number for each piece of equipment or terminal.
 - c. Air quantities and temperatures in air handling/energy transfer equipment schedules.
 - d. Water quantities and temperatures in thermal energy transfer equipment schedules.
 - e. Water quantities and heads in pump schedules.

1.04 QUALITY ASSURANCE

- A. Perform Work in accordance with NEBB – Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.
- B. Testing and Balancing Agencies:
- C. The following Testing and Balancing agencies have been previously qualified:
 1. Neudorfer Inc. (Seattle), (206) 621-1810.
 2. Hardin Co. (Kent), (253) 804-9081.
 3. HDR (Tacoma), (253) 896-9805.
 4. Or Approved Equal.

1.05 QUALIFICATIONS

- A. Agency: Company specializing in the testing, adjusting, and balancing of air and water systems specified in this section with minimum three years' experience certified by NEBB.
 1. Contractor shall be independent of general contractor, subcontractor, and designers from both a management and financial association within this project scope.
 2. Contractor shall submit references demonstrating a record of balance work on single fan air systems of 100,000 CFM or greater with variable airflow

and 100 or more zones; and on hydronic systems of 4,500 GPM or greater with primary-secondary-tertiary variable flow pumping systems; multiple pump systems operating at variable flow on common loop systems; multiple and varying size chillers (500-to-2,100-ton units) on common header system.

3. Contractor shall agree to submit a current NEBB Certificate of Conformance of Certification covering the balancing Work for each project.
 4. Contractor shall perform a quality check witnessed and approved by the Engineer on at least 10% of all readings.
 5. Failure of 25% of quality check readings shall initiate a formal complaint (resolution) to the NEBB firm.
- B. On sight project staff Qualifications:
1. Contractor shall submit certification that employees engaged in SeaTac Work shall have successfully completed the Siemens 4-day training course in field-level network device operations prior to submittal process.
 2. Contractor shall arrange with the Engineer to have onsite supervisor attend a half-day plant-wide tour, a review of all mechanical drawings and recent balance documents to gain an understanding of the SeaTac mechanical systems prior to Work onsite.
 3. Onsite supervisor shall be on the job site throughout the balance Work and shall be a NEBB Certified Supervisor

1.06 TEST AND BALANCE EQUIPMENT

- A. Test equipment and instrumentation shall be provided as necessary and appropriate to perform the Work outlined in this section. All test equipment and instruments shall have been factory calibrated as recently as six months prior to starting the TAB process for this project.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION

- A. Section 01 31 13 – Project Coordination.
- B. Coordinate all testing, adjusting, and balancing procedures and schedules with the Contractor, Commissioning Agent, and Test Engineer. Refer to Section 01 91 00 – Commissioning.
- C. Verify and document that systems are complete and operable before commencing Work. Ensure and document the following conditions:
1. Contractor shall complete commissioning installation and operational checklist in accordance with Section 01 91 00 – Commissioning.
 2. Systems are started and operating in a safe and normal condition.
 3. Temperature and pressure control systems are installed complete and operable with initial setting in place and devices calibrated.
 4. Proper thermal overload protection is in place for electrical equipment.

5. Fans and pumps are rotating correctly.
 6. Proper strainer baskets, ductwork, dampers, all filters, etc. are clean and in place or in normal position.
 7. Service and balance valves are open.
 8. Provide a complete set of worksheets to specify each piece of equipment and to show each terminal device.
 9. Contractor will provide access to all devices and equipment to be tested within this section.
 10. Contractor has provided final approved sheet metal and control system shop drawings catalog cuts for all equipment and balancing devices, etc.
 11. Contractor test plans and procedures, smoke control and pressurization plans, and Resident Engineer's Commissioning plan are complete and available.
- D. Make a "first pass" through the entire system (approximately one month prior to beginning Work) to determine and document the critical path and to locate possible construction or design problems.
- E. Following this inspection, the balancer shall:
1. Immediately submit a report to the Engineer of any construction or design deficiencies that could delay or affect balancing.
 2. Meet with the Engineer to discuss the results and determine the scope of Work to be completed by the Contractor and/or the consultant.
 3. The Engineer meets with construction coordinators and/or consultant to determine schedule to complete Work and resolve problems.
 4. The Engineer ensures that the Work is properly and sufficiently completed so that balancing can continue uninterrupted through completion.
 5. Meet with the Engineer to determine scope of Work to be completed in "second pass."
 6. Make "second pass" through the system and complete most of the balancing. The area should be ready for occupancy at the end of this phase of the Work.
 7. Complete rough draft of the complete report and provide two (2) copies to the Engineer for review and comment. This report should include a narrative description of all problems requiring major construction or design changes.
 8. Meet with the Engineer to discuss the report and determine scope of Work to complete the project.
 9. Complete fieldwork so that the system is completely balanced, and permanently mark all valves, dampers, etc. to show final settings.
 10. Complete the report and provide two (2) copies to the Engineer for review.
 11. Meet with the Engineer for final review comments.
 12. Complete the report and provide three (3) bound copies to the Engineer.

13. Final acceptance of the general construction contract shall not occur prior to acceptance of all balancing Work.
- F. Submit field reports. Report defects and deficiencies noted during performance of services, which prevent system balance.

3.02 PREPARATION

- A. Provide instruments and personnel required for testing, adjusting, and balancing operations. Make available to the Engineer to facilitate spot checks during testing.
- B. Balancing shall be accomplished in accordance with schedules approved by the Engineer. Procedures shall be in conformance with AABC “Test and Balance Procedures” and NEBB “Testing, Adjusting or Balancing of Environmental Systems,” except as supplemented and modified by this section.
- C. Instruments used for measurements shall be accurate and calibration histories for each instrument shall be in accordance with NEBB procedures.
- D. Before balancing and testing can commence, check fans, pumps, and other rotating equipment for proper rotation and lubricate per the manufacturer’s recommendations and operate fans, pumps, and auxiliary equipment. Provide the following:
 1. Access to volume dampers, valves, balancing devices, and safety devices including ceiling tile removal and replacement.
 2. Ladders, scaffolds, staging, and accessories required to gain access to dampers, valves, balancing devices, and safety devices.

3.03 INSTALLATION TOLERANCES

- A. Air Handling Systems: Adjust to within $\pm 10\%$ of design.
- B. Air Outlets and Inlets: Adjust total to within $+10\%$ and -5% of design to space. Adjust outlets and inlets in space to within $\pm 10\%$ of design.
- C. Hydronic Systems: Adjust to within $\pm 10\%$ of design.

3.04 ADJUSTING

- A. Section 01 77 00 – Project Closeout.
- B. Ensure recorded data represents actual measured or observed conditions.
- C. Work with respect to startup and correct operation of equipment shall remain the responsibility of the Mechanical Contractor. Port (only) shall shut down equipment as required by balancing agency. Mechanical Contractor shall make necessary adjustments and corrections as required by balancing Contractor to balance the systems. Any corrective measures required in the function of any part of system to complete balancing shall be done by Mechanical Contractor’s employees as directed by balancing agency. Balancing agency shall contact Engineer for required modifications to system. Allow 48 hours.
- D. Permanently mark settings of valves, dampers, and other adjustment devices, allowing settings to be restored. Set and lock memory stops.
- E. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

- F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
- G. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Engineer.

3.05 AIR SYSTEM PROCEDURE

- A. Prior to air balance, air balance agency shall notify the Engineer that balancing will commence, allowing 48 hours for filter replacement by Mechanical Contractor.
- B. Air balance agency shall perform the following tests, and balance systems in accordance with the following requirements: (Test and record items 1 through 5 and 8 before any adjustments are made.)
 - 1. Test and adjust equipment RPM to design requirements. Record: Manufacturer, size, arrangement, class, motor H.P., volt, phase, cycle, RPM, amps.
 - 2. Duct Test Ports:
 - a. Where required for air balance measurements, provide duct test ports in ductwork or casings located inside of the building with static pressure greater than 3-inches w.g. Installation shall be airtight and complete with screw cap and gasket. Extend cap through the insulation and seal airtight.
 - b. Where required for air balance measurements, provide duct test ports in all ductwork.
 - 3. Open all terminal boxes to fully open position for full load test.
 - 4. Test and record motor full load amperes.
 - 5. Make pitot tube traverse of main supply ducts; record and obtain design CFM at fans.
 - 6. Test and record system static pressures, suction, and discharge.
 - 7. Test, adjust and record systems for CFM outside air.
 - 8. Test and record entering air temperatures (dry bulb [DB], heating).
 - 9. Test and record leaving air temperatures (dry bulb [DB], heating).
 - 10. Test, adjust and record each diffuser, grille, and register to within 10% of design requirements.
 - 11. Identify grille, diffuser, and register to location (room number) and area.
 - 12. Identify and list size, type, and manufacturer of diffusers, grilles, registers, and all tested equipment. Use manufacturer's ratings on all equipment to make required calculation.
 - 13. Readings and test of diffusers, grilles, and registers shall include required FPM velocity and test resultant velocity, required CFM, and test resultant CFM after adjustments.
 - 14. In cooperation with Controls Representative, set adjustments of automatically operated dampers to operate as specified, indicated, or

noted. Testing agency shall check all controls for proper calibrations and list all controls requiring adjustment. Adjust and calibrate terminal boxes and record settings.

15. All diffusers, grilles, and registers shall be adjusted to minimize drafts in all areas.
 16. Make any changes in pulleys, belts and dampers or add dampers required for correct balance, at no additional cost to the Port.
 17. Check fire dampers to ensure open and closed configuration. Verify in writing.
 18. Final settings shall be clearly marked on each damper with a center punch.
- C. Determine the minimum operating static pressure required to deliver the required air volumes: for each high-pressure mixing box, inlet vane, VFD or other automatic static pressure regulator and note the setting adjacent to the regulator and on the record sheets.

3.06 WATER SYSTEM BALANCING PROCEDURE

A. Water Balance Procedure – Phase I

1. Balance Engineer or technician shall prepare water systems for balancing in the following manner:
 - a. Complete air balance must have been accomplished before actual water balance begins.
 - b. Open all valves to fully open position. Close coil bypass stop valves. Set mixing valve to full coil flow.
 - c. Check operation of all relief valves. Verify in writing.
 - d. Examine water in system and determine if water has been treated and cleaned. Verify in writing.
 - e. Check pump rotation. Verify in writing.
 - f. Check expansion tanks to determine they are not air bound and system is completely full of water. Verify in writing.
 - g. Check all air vents at high points of water systems and determine all are installed and operating freely. Verify in writing.
 - h. Set all temperature controls so all coils are calling for full heating. This should close all automatic bypass valves at coils.
 - i. Check operation of automatic bypass valves. Verify in writing.

B. Water Balance Procedure – Phase II

1. Balance Engineer or technician shall make final water system settings as follows:
 - a. Adjust and record water flow of hot water through pumps to main.
 - b. Set pumps to proper gallons per minute delivery. Record: RPM, GPM, Head, BHP, manufacturer, size, type of drive, motor horsepower, volts, cycle, phase, and full load amps. Plot actual operating test data on pump curves.

- c. In the presence of Control Subcontractor, check calibration of all thermostats with accurate thermometers. Check operation of all automatic dampers, valves, etc., simulating “full” cooling and “full” heating.
- d. Test water temperatures at inlet and outlet side of coils. Record rise and drop of temperatures from source, EAT, EWT, LAT, LWT, GPM, and coil type.
- e. Test water temperatures at inlet side and outlet side of convectors or fin tube radiation riser. Record temperature drop from source and across convector fin tube loop, MBH, GPM, LWT and type of unit.
- f. Systems shall be adjusted to provide the approved pressure drops through the heat transfer equipment prior to the capacity testing.

3.07 CLOSEOUT ACTIVITIES

A. TRAINING AND DEMONSTRATION

- 1. TAB shall support and participate in the training of Port personnel in accordance with Section 01 91 00 – Commissioning and Section 01 79 00 – Training.

B. CERTIFIED REPORTS

- 1. Three copies of the report, submitted in the following format, covering air and water system balances shall be submitted to the Engineer. The test reports shall be certified by a certified registered Professional Engineer, licensed in the State of Washington, who is experienced in air and water balancing or by a certified member of National Environmental Air Balancing Bureau (NEBB). Certification shall include adherence to agenda, calculation procedures, and final summaries.
- 2. Provide drawings indicating equipment and outlets labeled in accordance with the report numbering system.
- 3. Types, serial numbers, and dates of calibration of instruments shall be included.
- 4. General description of system and specific balancing procedures used for each system.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.

B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

End of Section

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of “Direct Digital Controls” Work is shown in the Contract Documents.
- B. Section includes control equipment and software, pneumatic controls, and sequence of operation for:
 - 1. Supply fans.
 - 2. Chilled water fan-coil units.
 - 3. Chilled water pumps.
 - 4. Heating coils.
 - 5. Terminal air units.

1.02 GOVERNING CODES, STANDARDS, AND REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.
- B. NFPA (National Fire Protection Association)
 - 1. NFPA 70 – National Electric Code.
- C. UL (Underwriters Laboratories)
 - 1. UL 1449 – Surge Protection Devices.
 - 2. UL 916 – Energy Management Equipment.
 - 3. UL 864 – Control Units and Accessories for Fire Alarm Systems.

1.03 SUBMITTALS

- A. Submit materials data in accordance with Section 01 33 00 – Submittals. Furnish manufacturers’ technical literature, standard details, product specifications, and installation instructions for all products.
- B. Submittals shall be as follows:
 - 1. Shop Drawings:
 - a. Indicate trunk cable schematic showing programmable control-unit locations and trunk data conductors.
 - b. List connected data points, including connected control unit and input device.
 - c. Indicate system graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations.
 - d. Show system configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
 - e. Indicate description and sequence of operation of operating, user, and application software.

2. Product Data: Submit data for each system component and software module.
3. Manufacturer's Installation Instructions: Submit.
4. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
5. Operation and Maintenance Data:
 - a. Submit interconnection wiring diagrams complete for field-installed systems with identified and numbered system components and devices.
 - b. Include keyboard illustrations and step-by-step procedures indexed for each operator function.
 - c. Include inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.

1.04 SYSTEM DESCRIPTION

- A. Automatic temperature controls field monitoring and control system using field-programmable microprocessor-based units.
- B. Contractor shall integrate this facility with the central Operator Interface Console (OIC). Operator shall have access to all facilities via the same login screen and will utilize the same program commands, control loop software programming languages, and graphics representation as with all other similar systems on the facility-wide existing DDC system. Provide any additional Central Operator Interface software as required and as specified herein.
- C. Include computer software and hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators.
- D. Controls for supply fans, and fan coils, and the like when directly connected to the control units.
- E. Provide control systems consisting of thermostats, control valves, dampers, and operators, indicating devices, interface equipment and other apparatus and accessories required to operate mechanical systems, and to perform functions specified.
- F. Unless otherwise noted, mount thermostats 48 inches above finished floor.
- G. Include installation and calibration, supervision, adjustments, and fine-tuning necessary for complete and fully operational system.

1.05 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years of documented experience, and with service facilities within 100 miles of Project.
- B. Installer: Company specializing in performing Work of this section with minimum three years of documented experience approved by manufacturer.

1.06 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.07 MAINTENANCE SERVICE

- A. Provide service and maintenance of energy management and control systems for one year from Date of Substantial Completion.
- B. Provide two complete inspections per year, one in each season, to inspect, calibrate, and adjust controls as required, and submit written reports.
- C. Provide complete service of systems, including callbacks. Make minimum of two (2) complete normal inspections of approximately four hours duration in addition to normal service calls to inspect, calibrate, and adjust controls, and submit written reports.
- D. During the warranty period, provide a 24-hour emergency service number where a qualified automation service engineer familiar with the installed system may be reached. This engineer shall have the capability of remotely communicating with the system for troubleshooting and component failures.

1.08 EXTRA MATERIALS

- A. Spare and extra parts shall be identified for all products, but not provided. Include spare parts information in Operation and Maintenance Manuals.

PART 2 PRODUCTS

2.01 DIRECT DIGITAL CONTROLS

- A. Manufacturers: Components shall be manufactured or supplied by Siemens, Building Technologies – No Equal.

2.02 OPERATOR STATION

- A. Existing Servers
 - 1. The existing control system includes workstations residing on a dedicated Ethernet TCP/IP network.
 - 2. The existing client server controls system access for all users includes access to information, command and programming capabilities and user alarm routing capabilities.
 - 3. The existing client server also administrates the customer site licensing agreement to ensure that the number of concurrent software users signed on to the network at any one time does not exceed the number of licensed seats available.
 - 4. All new workstations, control panels, and control points shall be added to the existing server and configured to meet the specific access and privilege requirements of the new equipment added by under the project scope.
 - 5. Reference the Central Monitoring System Standards and Planning Manual dated 6/98 for additional information regarding the site-wide systems.
- B. Existing Site-Wide Software
 - 1. The existing control system includes a site-wide software license that allows the graphical interface software to be installed and operated at multiple PCs throughout the facility. New graphics shall be installed on the existing server to allow access at all graphical workstations on the system.

2.03 CONTROL UNITS

- A. Units: Modular in design and consisting of processor board with programmable RAM memory, local operator access and display panel, and integral interface equipment.
- B. Battery Backup: For minimum of 48,100 hours for complete system including RAM without interruption, with automatic battery charger.
- C. Control Units Functions:
 - 1. Monitor or control each input/output point.
 - 2. Completely independent with hardware clock/calendar and software to maintain control independently.
 - 3. Acquire, process, and transfer information to operator station or other control units on network.
 - 4. Accept, process, and execute commands from other control units or devices or operator stations.
 - 5. Access both database and control functions simultaneously.
 - 6. Record, evaluate, and report changes of state or value that occur among associated points. Continue to perform associated control functions regardless of status of network.
 - 7. Perform in standalone mode:
 - a. Start/stop.
 - b. Duty cycling.
 - c. Automatic temperature control.
 - d. Demand control via a sliding window, predictive algorithm.
 - e. Event initiated control.
 - f. Calculated point.
 - g. Scanning and alarm processing.
 - h. Full direct digital control.
 - i. Trend logging.
 - j. Global communications.
 - k. Maintenance scheduling override monitoring.
 - l. Alarm management.
 - m. Dial-up communications.
- D. Global Communications:
 - 1. Broadcast point data onto network, making that information available to all other system controls units.
 - 2. Transmit any or all input/output points onto network for use by other control units and utilize data from other control units.
- E. Input/Output Capability:
 - 1. Digital inputs for status/alarm contacts.

2. Digital outputs for on/off equipment control.
 3. Analog inputs for temperature, pressure, humidity, flow, and position measurements.
 4. Analog outputs for valve and damper position control, and speed capacity control of primary equipment.
 5. Pulse inputs for pulsed contact monitoring.
 6. Spare points: Provide a minimum of one spare point for each Input/Output point type (not including pulse inputs).
- F. Standalone DDC panels shall be provided with at least two RS-232C serial data communication port for operator I/O devices such as industry standard portable operator's terminals or portable laptop computers. In lieu of above, one RS-232C serial data communication port and a local operator access and display panel shall be provided.
- G. Point Scanning: Set scan or execution speed of each point to operator selected time from 1 to 250 seconds.
- H. Upload/Download Capability: Download from or upload to operator station. Upload/Download time for entire control unit database maximum 10 seconds on hard-wired LAN or 60 seconds over voice grade phone lines.
1. Each DDC panel shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all subsidiary equipment. The DDC panel shall provide both local and remote annunciation of any detected component failures, or repeated failure to establish communication. Indication of the diagnostic results shall be provided at each DDC panel and shall not require the connection of an operator I/O device.
- I. In the event of the loss of normal power, there shall be an orderly shutdown of all standalone DDC panels to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data, and battery backup shall be provided to support the real-time clock and all RAM memory. Upon restoration of normal power, the DDC panel shall automatically resume full operation without manual intervention. Should DDC panel memory be lost for any reason, the user shall have the capability or reloading the DDC panel via the local area network or via the local RS-232C port. All necessary software to form a complete operating system as described in this specification shall be provided. The software programs shall be provided as an integral part of the DDC panel and shall not be dependent upon any higher-level computer for execution. Power line surge protection surge suppressers external to digital controller shall be installed on all incoming AC power. Surge suppresser shall be rated by UL 1449, and have clamping voltage ratings below the following levels:
1. Normal Mode (Line to Neutral): 350 Volts.
 2. Common Mode (Line to Ground): 350 Volts.
- K. Provide Uninterruptible Power Supplies (UPS) for each new standalone DDC panel installed. UPS shall be capable of powering the DDC panel for a minimum of five (5) minutes and protecting panel from a restart in the event of a momentary

power outage of switchover to emergency power. It is not necessary to provide UPS power to each of the field devices associated with the DDC panel.

- L. Sensor and Control Wiring Surge Protection: Controllers shall have sensor and control wiring surge protection with optical isolation, metal oxide varistors (MOV), or silicon avalanche devices. Fuses are not permitted for surge protection.
- M. Test Mode Operation: Place input/output points in test mode to allow testing and developing of control algorithms online without disrupting field hardware and controlled environment. In test mode:
 - 1. Inhibit scanning and calculation of input points. Issue manual control to input points (set analog or digital input point to operator determined test value) from workstation.
 - 2. Control output points but change only database state or value; leave external field hardware unchanged.
 - 3. Enable control-actions on output points but change only database state or value.
- N. Local display and adjustment panel: Portable or integral to control-unit containing digital display, and numerical keyboard. Display and adjust:
 - 1. Input/output point information and status.
 - 2. Controller set points.
 - 3. Controller tuning constants.
 - 4. Program execution times.
 - 5. High and low limit values.
 - 6. Limit differential.
 - 7. Set/display date and time.
 - 8. Control outputs connected to the network.
 - 9. Automatic control outputs.
 - 10. Perform control unit diagnostic testing.
- O. Application Specific Controllers
 - 1. General
 - a. Provide Application Specific Controllers (ASCs) as required for control of unitary mechanical systems or pieces of equipment. Each ASC shall be a microprocessor-based DDC control unit and shall be capable of operating either as a standalone controller or on a LAN communications network originating at the DDC controller. Provide each ASC with sufficient memory to operate in a truly independent manner; that is, each ASC shall support its own inputs and outputs, operating systems, database, and programs necessary to perform control sequences and energy management routines.
 - b. Provide the following types of ASCs as necessary:
 - (1) Unitary Controllers (UCs)

- (2) Terminal Equipment Controllers (TECs)
- 2. Unitary Controllers (UCs)
 - a. UCs shall include all point inputs and outputs necessary to perform the specified control sequences. Provide a hand-off-automatic switch for each binary output for manual override capability. Switches shall be mounted either within the controller's key-accessed enclosure, or externally mounted with each switch keyed to prevent unauthorized overrides. In addition, each switch position shall be supervised in order to inform the system that automatic control has been overridden. As a minimum, 50% of the point inputs and outputs shall be of the universal type, allowing for additional system flexibility. In lieu of universal inputs and outputs, provide a minimum of 50% spare points of each type.
 - b. Each UC shall support its own real-time operating system. Provide a time clock with 72-hour battery backup to allow for standalone operation and to insure protection during power outages. Should the controller reside on a DDC controller network, the clock operation shall be overridden by the DDC controller clock to ensure network continuity.
 - c. All databases and programs shall be stored in non-volatile EEPROM or a minimum of 100-hour battery backup shall be provided. All programs shall be field customized to meet the user's exact control strategy requirements. Controllers utilizing pre-packaged or canned programs shall not be acceptable.
 - d. Local alarming and trending capabilities shall be provided for convenient troubleshooting and system diagnostics. Alarm limits and trend data information shall be user-definable for any point.
 - e. Each UC shall have connection provisions for a portable laptop or similar programming tool. This tool shall allow the user to display, generate or modify all point databases and operating programs. All new values and problems shall then be restored to EEPROM.
- 3. Terminal Equipment Controllers (TECs)
 - a. Control of terminal units such as VAV boxes, heat pumps and reheat boxes shall be accomplished by a microprocessor-based standalone controller utilizing direct digital control. The Terminal Equipment Controller (TEC) shall interface to the building control system on a LAN communications network originating at the DDC field panel. An individual controller shall be provided for each terminal unit. The terminal controller must be listed by Underwriters Laboratory under UL 916 PAZX and UL 864 UDTZ.
 - b. For VAV boxes, the Controls Contractor shall furnish the terminal controller (controller, damper motor, and flow transducer) to the terminal unit manufacturer for factory mounting. All costs associated with factory mounting of the terminal controller shall be covered by terminal unit manufacturer. The terminal box manufacturer shall

- provide an averaging air velocity sensor suitable for interfacing with the TEC's differential pressure transducer.
- c. The controller shall include a differential pressure transducer that shall connect to the terminal unit manufacturer's standard averaging air velocity sensor to measure the average differential pressure in the duct. The controller shall convert this value to actual airflow. Single point air velocity sensing is not acceptable. The differential pressure transducer shall have a measurement range of 0 to 4000 fpm (0 to 20.4 m/s) and measurement accuracy of $\pm 5\%$ at 400 to 4000 fpm (2 to 20 m/s), ensuring primary airflow conditions shall be controlled and maintained to within $\pm 5\%$ of set point at the specified parameters. The BAS Contractor shall provide the velocity sensor if required to meet the specified functionality.
 - d. Each controller shall include provisions for manual and automatic calibration of the differential pressure transducer in order to maintain stable control and insuring against drift over time. Calibration shall be accomplished by stroking the terminal unit damper actuator to a 0% position so that a 0-CFM air volume reading is sensed. The controller shall automatically accomplish this whenever the system mode switches from occupied to unoccupied or vice versa. Manual calibration may be accomplished by either commanding the actuator to 0% via the POT or by depressing the room sensor override switch. Calibration of the transducer at the controller location shall not be necessary.
 - e. Each TEC shall be accessible for purposes of control and monitoring from a central or remote operator's terminals as specified herein.
 - f. TEC damper actuator shall be of the 24 VAC floating point type. Upon power loss, the actuator maintains its current damper position. Position status is shown in percentage open notation.
 - g. TEC room temperature sensor shall come complete with a terminal jack and programmable override switch integral to the sensor assembly. The terminal jack shall be used to connect the portable operator's terminal to control and monitor all hardware and software points associated with the terminal unit. A terminal jack may be alternatively located on a stainless-steel wall plate mounted adjacent to the sensor. An override switch shall initiate override of the night setback or unoccupied mode to normal operation when activated. A thumbwheel-type temperature setpoint dial shall also be provided with 1 degree F temperature increments. Override switch and temperature set point functions may be locked out, canceled, or limited as to time or temperature via software.
 - h. TEC's for VAV or CV applications shall be provided with integral differential pressure transducer capable of accepting an average air flow measurement signal from the terminal box averaging air velocity sensor. The value is converted through a square root function to average airflow by the TEC.

- i. TEC control valve electronic actuators shall mount on the valve body and provide complete modulating control of the valve. Valve body shall separate from actuator for servicing without requiring any special tools or electrical connections. The actuator shall be of the floating control point type.
 - j. TEC wiring terminal bars are to be detachable type allowing quick serviceability of the electronic controller hardware without removal of the existing wiring.
- 4. Wiring
 - a. Provide complete electric wiring for temperature control apparatus, including transformer primaries. Control circuit conductors which run in the same conduit as power circuit conductors shall have the same insulation level as power circuit conductors.
 - b. AC Control Wiring:
 - (1) Control wiring for 24V circuits shall be insulated copper 24 AWG minimum and shall be rated for 300VAC service.
 - (2) Wiring for 120VAC shall be 18 AWG minimum and shall be rated for 600VAC service.
 - c. DDC Analog Signal Wiring: Analog signal wiring for analog inputs and analog outputs shall be minimum 24 AWG single or multiple twisted pair. Each pair greater than one shall be 100% shielded and have drain wire. Exception is direct connected RTD wiring which shall be minimum 24 AWG minimum twisted pair, 100% shielded, with drain wire. Each wire shall have insulation rated to 300 VAC. Cables shall have an overall aluminum-polyester or tinned-copper cable-shield tape tinned copper cable drain wire, and overall cable insulation rated to 300VAC.
 - d. Plenum Cable: Plenum cable shall be UL approved for use in ceiling return air plenums. Plenum cable external to electrical raceway is permissible in the following locations as allowed by local codes:
 - (1) Standalone DDC communication trunk serving application specific controllers within a building.
 - (2) DDC system sensor and end device wire installed above suspended accessible ceilings or in other accessible, protected areas.
- P. Control Components
 - 1. Temperature Sensors:
 - a. Duct and air handling unit temperature sensors shall be nickel or platinum type RTDs, factory calibrated within ± 0.5 degrees F.
 - b. Use insertion elements in and ducts air handling unit not effected by temperature stratification. Use duct averaging elements in air handling unit prone to stratification with length at least the widest dimension of the duct cross-section.

- c. Room Temperature Sensors: Analog or thermistor type complete with mounting bracket, blank vertical locking cover. Each room temperature sensor shall be provided with an integral terminal jack for portable operator's terminal interface. Provide momentary pushbutton type override switch integral to room temperature sensor and cover.
 - d. Temperature spans and ranges:
 - (1) 50 degrees F span: Room, return air sensors.
 - (2) 100 degrees F span: Outside air, heating coil discharge air, mixed air sensors.
- 2. Actuators: Provide electric actuators for all control dampers on the project. Actuators shall be sufficient size and type, matched to application.
 - a. Provide analog, current proportional, two-position or three-point floating type, suitable for pulse width modulation control with solid state positioner to stop automatically at end of travel, complete with a permanently lubricated gear train.
 - b. Provide spring return to normally-closed on loss of control power for all outside air applications or applications requiring a Normally Open or Normally Closed condition.
 - c. Terminal Equipment Controller applications will not require spring return actuators unless applied to outside air applications
 - d. Control Dampers:
 - (1) Provide low leakage control dampers where not furnished with package units.
 - (2) Damper Leakage rate shall not exceed 0.5% (of damper based on 2000 fpm duct velocity) when closed against 4-inch water gauge static pressure; complete with extruded aluminum, stainless steel, or zinc-coated steel blades, with extruded vinyl or rubber edge seals.
 - (a) Blade ends sealed with aluminum or stainless steel "arc" seals.
 - (3) External frame of heavy gauge welded steel with 1/4-inch plate bearing bars and bronze insert bearings.
 - (4) Coordinate with Section 23 31 00 – Ducts and Section 23 33 00 – Duct Accessories for installation provisions.
- 3. Control Valves:
 - a. Modulating Valves 2-inches and Smaller: Bronze body and seat with stainless steel stem and screwed ends. ANSI Class 250 body rating. Suitable for fluid temperatures of up to 300 degrees F. Equal percentage flow characteristics capable of smooth operation at differential pressures present in system. Landis & Gyr Powers VE VVG/VXG 44, VE698, Flowrite VE598, Or Approved Equal.

- b. Modulating Valves 2-1/2-Inches and Larger: Cast iron body with bronze trim and stainless-steel stem and flanged ends. ANSI Class 125 body rating. Suitable for fluid temperatures of up to 300 degrees F. Equal percentage flow characteristics capable of smooth operation at differential pressures present in system. Landis & Gyr Powers, Flowrite VE598, Or Approved Equal.
 - c. Sizing: Modulating control valves shall be correctly selected for service and flow of system served. A pressure drop of 5 psi shall be used as a sizing guideline unless specifically noted otherwise in project documents. Two-position shutoff valves shall be line size.
- 4. Valve Actuators
 - a. All modulating valve actuators shall be 24VAC electric motor type; floating point, 0-10VDC, 0-16VDC or other industry standard input signal type. Actuators shall function properly within the range of 85% to 110% of line voltage.
 - b. Provide actuators in sufficient size, quantity, and type to match application.
 - c. All valve actuators for steam applications shall be mounted at a 45-degree offset from vertical to avoid heat damage to actuator.
 - d. Actuators shall be spring return as indicated by Normally Closed or Normally Open designation on drawings or in sequence of operation.
- 5. Differential Pressure Switches for Filter Status:
 - a. Diaphragm operated which actuate a SPDT snap action switch. A field adjustable pressure set point with a range suitable for air flow status applications.
 - b. The switch voltage and current rating shall be double the load requirements.
 - c. Provide sensing tubes connected to tips with multiple holes and bulkhead fittings specifically designed for air flow sensing.
- 6. Differential Pressure Sensors/Transmitters:
 - a. Provide integral pressure transducer and transmitter.
 - b. Output of pressure instrument shall be 4-20 mA signal proportional to the pressure span. Accuracy shall be 1.0%; linearity shall be 0.1%. Supply voltage shall be 24 V.
 - c. Unidirectional with range not exceeding 150% of maximum expected input.
- 7. Freeze Protection Thermostat:
 - a. Double pole double throw (DPDT), incremental bulb type.
 - b. Actuates if any 12-inch maximum increment is below its setting, adjustable setting, manual reset.

- c. Provide capillary element length of 2.14 equaling 2.14 square feet of coil area per foot capillary element.
 - d. One DPDT contact shall shut down equipment and the second contact shall signal the DDC system.
- 8. Current Sensing Relays:
 - a. For equipment status. Designed to convert monitored AC current to a proportional DC voltage of 0-5 volts or 4-20 mA output.
 - b. Range 1 to 10, 50, 100 amps as required. Accuracy 2% of full scale. Repeatability $\pm 2\%$ of full scale. Response time 100 milliseconds.
- 9. Control Relays:
 - a. Shall be rated for the application, with a minimum of two sets of Form C contacts, enclosed in a dustproof enclosure.
 - b. Relays shall be rated for a minimum life of one million operations.
 - c. Operating time shall be 20 milliseconds or less, with release time of 10 milliseconds or less.
 - d. Relays should be equipped with coil transient suppression devices to limit transients to 150% of rated coil voltage.
- 10. Temperature Indication:
 - a. Provide Bimetal dial type indicator suitable for duct-mounted air sensing.
 - b. If readability is not possible with duct-mounted thermometers, provide remote bulb dial type mounted for easy reading and labeled to identify temperature as indicated; 3-inch dial, range 0-160 degrees F. Accuracy: 2% of full range.
- 11. Pressure Indication:
 - a. Provide gauge range so normal pressures are approximately equal to the midpoint readings on the scale, unless otherwise specified, as indicated.
 - b. Accuracy shall be $\pm 2\%$ of the range. Gauges for differential pressure measurements shall be 4-1/2-inch (nominal) size with two sets of pressure taps and zero-point adjustment.
- 12. Transformer:
 - a. Provide transformers shall conformance to UL 506.
 - b. Power digital controllers on the primary communication trunk from dedicated circuit breakers.
 - c. Provide a fuse cutout on the secondary side of the transformer.
- 13. Nameplates:
 - a. Laminated plastic 1/16-inch thick with neatly beveled edges and screwed to panel.

- b. Color shall be black with 0.375-inch white engraved block lettering.
- 14. Differential Pressure Sensor/Transmitter:
 - a. Provide integral pressure transducer and transmitter assembly for sensing differential pressure between two hydronic pipes.
 - b. Output shall be 4-20 mA signal proportional to the pressure span. Provide with NEMA4 rated enclosure complete with valve assembly and pressure gages. Accuracy +0.25% of span with externally adjustable zero and span.
- 15. Modular Programmable Controller
 - a. Siemens Building Technology, model PX100-PE96.A, No Equal.
- 16. I/O Power Supply Module, 24VDC
 - a. Siemens Building Technology, model TXS1.12 F 10, No Equal.
- 17. BUS Connection Module
 - a. Siemens Building Technology, model TXS1.EF 10, No Equal.
- 18. Universal I/O Module
 - a. Siemens Building Technology, model TXM1.8-ML, No Equal.
- 19. Relay Output Module
 - a. Siemens Building Technology, model TXM1.6R-M, No Equal.
- 20. Nameplates:
 - a. Laminated plastic 1/16-inch thick with neatly beveled edges and screwed to panel.
 - b. Color shall be black with 0.375-inch white engraved block lettering.

2.04 LOCAL AREA NETWORKS (LAN)

- A. Provide communication between control units over local area network (LAN).
- B. The existing Central Operator Interface and the new standalone DDC panels shall reside directly on a local area network such that communications may be executed directly between controllers, and between controllers and workstation on a peer-to-peer basis. All points connected to network shall be accessible through any operator workstation on the network. Any point on the network shall be available to any controller on the network for control loop processing.
- C. All operator devices shall have the ability to access all point status and application report data or execute control functions for any and all other devices via the local area network. Access to data shall be based upon logical identification of building equipment. Access to system data shall not be restricted by the hardware configuration of the facility management system. The hardware configuration of the network shall be transparent to the user when accessing data or developing control programs.
- D. Control manufacturer's highest available speed data transfer rates shall be provided for all communications, alarm reporting, quick report generation from controllers, and upload/download efficiency between network devices.

- E. LAN Capacity: Not less than 60 stations or nodes.
- F. Break in Communication Path: Alarm and automatically initiate LAN reconfiguration.
- G. LAN Data Speed: Minimum 19.2 Kb/s.
- H. Communication Techniques: Allow interface into network by multiple operation stations and by auto-answer/auto-dial modems. Support communication over telephone lines utilizing modems.
- I. Transmission Median: Fiber optic or single pair of solid 24 gauge twisted, shielded copper cable.
- J. Network Support: Time for global point to be received by any station shall be less than 3 seconds. Provide automatic reconfiguration if any station is added or lost. If transmission cable is cut, reconfigure two sections with no disruption to system's operation, without operator intervention.
- K. Provide synchronization of the real-time clocks in all DDC.

2.05 ELECTRICAL CHARACTERISTICS AND COMPONENTS

- A. Refer to Section 26 05 19 – 600 Volt or Less Wire and Cable and Section 26 27 26 – Wiring Devices.
- B. Disconnect Switch: Factory-mount in control panels.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that conditioned power supply is available to the control units and to the operator workstation. Verify that field end devices, wiring, and pneumatic tubing is installed prior to installation proceeding.

3.02 DDC INSTALLATION

- A. Install control units and other hardware in position on permanent walls where not subject to excessive vibration. Locate and install components for easy accessibility; in general, mount 60 inches (panels measured from top edge) above floor with minimum 3-feet-0-inches clear access space in front of units.
- B. Install software in control units and in operator workstation. Implement all features of programs to specified requirements and appropriate to sequence of operation.
- C. Provide with 120VAC, 15 amp dedicated emergency power circuit to each programmable control unit.
- D. Duct Sensors: Locate to accurately sense air temperature. Do not locate sensors in dead air spaces or positions obstructed by equipment. Where an extended surface element is required to sense the average or lowest air temperature, position and securely mount sensor within duct in accordance with sensor manufacturer's recommendations.
 - 1. Temperature sensing elements shall be thermally isolated from brackets and supports.
 - 2. Provide separate duct flange for each sensing element; securely seal ducts where elements or connections penetrate duct.

3. Mount sensor enclosures to allow easy removal and servicing without disturbance or removal of duct insulation.
- E. Pressure Indication: Provide pressure indication at each differential pressure sensor and pressure transmitter.
- F. Control Wiring and Conduit
 1. All control wiring, all conduit for control wiring, and all miscellaneous accessory equipment for control wiring systems shall be provided by the Control Subcontractor as part of the control system. Conform to Division 26 Electrical requirements, NFPA 70, and all local code requirements.
 2. All wire in or through mechanical rooms, finished spaces, on roofs, in walls, below grade and inside equipment (except within control wiring compartments or control panels) shall be installed in conduit and properly supported. Maximum conduit fill shall be 40 percent. Label wire groups to match corresponding wiring diagrams.
 3. Plenum Cable: Plenum cable type, installation methods and use shall be subject to City and State Codes and Regulations. Within ceiling space, attach directly to wall or slab on 4-foot centers, or support from ceiling suspension wires on 4-foot centers. Do not attach cables to pipes or ducts, or lay on ceilings.
 4. Instrumentation and communication cable shall not be run together in the same conduit or raceway as power wiring.
 5. Communication Cable: Provide all communication wiring between the existing Central Operator Interface Console, new standalone DDC panels and new Application Specific Controllers. All communication cable shall be checked for continuity, grounding, and shielding. Local area network communication wiring between the Central Operator Interface Console and standalone DDC panels shall be in conduit. Wiring to ASCs may be run with plenum rated cable subject to all compliance with applicable State or City codes.
 6. Grounding: Ground controllers to a good earth ground. Grounding of the green AC ground wire, at the breaker panel, alone is not adequate. Run metal conduit from controller panels to adequate building grounds. Ground sensor drain wire shields at controller end.
 7. Provide all control power requirements for all control components from the nearest electrical panel. Coordinate control power requirements with the electrical subcontractor.
- G. DDC Point Summary
 1. Provide all database generation.
 2. Dynamic Color Display: Provide dynamic graphic displays at the existing Central Operator Interface Console. System graphical displays shall be color coded. Provide outside air temperature indication on air handling display. As a minimum, the following shall be provided:
 - a. Runtime Totalization: At a minimum, runtime totalization shall be incorporated, but not limited to, each monitored supply fan, and

exhaust fan warning limits for each point shall be entered with Owner-defined messages.

- b. Trend Log: All binary and analog points shall be trended. Historical archiving of Owner selected points shall be provided at the existing Central Operator Interface Console with the capability of transfer to graphic format representation.
- c. Alarm Points: All analog inputs and selected digital inputs alarm points shall be prioritized, printed, routed, with alarm message per Owner's requirements. Loss of communication network shall also initiate an alarm. Provide all software timers necessary to prevent false alarms.
- d. Heavy Equipment Delays and Power Fail Restart Software: Each standalone DDC panel shall be provided with heavy equipment and power fail restart application software. Each standalone DDC panel shall start respective equipment in sequence and shall be time based and not dependent on prior system startup.
- e. Database Save: Provide a backup database for all standalone DDC panels at the existing Central Operator Interface Console computer hard disk. Provide additional backup database for each standalone DDC panel on floppy disk or other removable media (e.g., USB drive).

H. Field Quality Control and Testing

- 1. Demonstrate compliance of the HVAC control system with the contract documents. Calibrate instrumentation and controls and verify the specified accuracy using calibrated test equipment. Adjust controls and equipment to maintain conditions indicated, to perform functions indicated, and to operate in the sequence specified. Furnish personnel, equipment, instrumentation, and supplies necessary to perform calibration and site testing. Ensure that tests are performed by competent employees of the DDC system installer or the DDC system manufacturer regularly employed in the testing and calibration of DDC systems. Calibrate field equipment and verify equipment and system operation before placing the system on-line. Field testing shall include the following:
 - a. System Inspection: Observe the HVAC system in its shutdown condition. Check dampers and valves for proper normal positions. Document each position for the test report.
 - b. Calibration Accuracy and Operation of Inputs Test: Check for proper calibration and operation of each input instrument. For each sensor (temperature), record the reading at the sensor, and using a traceable test equipment, and record the reading at the digital controller. Document each reading for the test report.
 - c. Operation of Outputs Test: Check the operation of each output to verify correct operation. Command analog outputs to minimum range, such as 4 mA, and maximum range, such as 20 mA, measure and record commanded and actual output values. Document each command and result for the test report.

- d. Actuator Range Adjustment Test: With the digital controller, apply a control signal to each actuator and verify that the actuator operates properly from its normal position to full range of stroke position. Record actual spring ranges and normal positions for all modulating control valves and dampers. Include documentation in the test report.
 - e. Digital Controller Startup and Memory Test: Demonstrate that programming is not lost after a power failure, and digital controllers automatically resume proper control after a power failure.
 - f. Surge Protection: Show that surge protection, meeting the requirements of this specification, has been installed on incoming power to the digital controllers and on communication lines.
- I. Application Software Operation Test:
 - 1. Test compliance of the application for:
 - a. Ability to communicate with the digital controllers, and uploading and downloading of programs.
 - b. Text editing program: Demonstrate the ability to edit the control program offline.
 - c. Reporting of alarm conditions: Cause alarm conditions for each alarm and ensure that the existing Central Operator Interface Console receives alarms.
 - d. Reporting trend and status reports: Demonstrate ability of software to receive and save trend and status reports.
 - e. Execution of Sequence of Operation: Furnish graphic trends to show the sequence of operation is executed in correct order. Demonstrate the HVAC system operates properly through the complete sequence of operation, for example optimal start/warm-up and occupied/unoccupied modes of operation. Demonstrate proper control system response for abnormal conditions for which there is a specified response by simulating these conditions. Demonstrate hardware interlocks and safeties work. Demonstrate the control system performs the correct sequence of control after a loss of power.
 - f. Control Loop Stability and Accuracy: Furnish graphic trends of control loops to demonstrate the control loop is stable and that set point is maintained. Control loop response shall respond to set point changes and stabilize within 1 minute.
 - 2. Document all tests with detailed results. Provide statement that all corrective action taken. Include test report in Operation and Maintenance Manuals.
 - 3. Provide conduit and electrical wiring in accordance with Refer to Section 26 05 19 – 600 Volt or Less Wire and Cable and Section 26 27 26 – Wiring Devices. Electrical material and installation shall be in accordance with appropriate requirements of Division 26 Electrical.

3.03 MANUFACTURER'S FIELD SERVICES

- A. Section 01 45 16.13 – Contractor's Quality Control Program: Manufacturers' field services.
- B. Start and commission systems. Allow sufficient time for startup and commissioning prior to placing control systems in permanent operation.
- C. Provide service engineer to instruct Owner's representative in operation of systems plant and equipment for a period of one day.

3.04 DEMONSTRATION AND TRAINING

- A. Upon completion of the Work, furnish the services of a competent technician regularly employed by the DDC manufacturer to provide a two (2) hour training walk through of the new DDC system for the new project with SeaTac Airport's lead DDC technician.
- B. Furnish a written test plan and training schedule for approval 15 days prior to instructing operating personnel including the following:
 - 1. Recommended training schedule for standalone DDC controllers and field components.
 - 2. Qualification of instructors.
 - 3. List of all training materials, aids, etc.
- C. Provide all training materials necessary for a minimum of three facility personnel, including:
 - 1. Operations and maintenance manual.
 - 2. As-built control diagrams.
 - 3. Detailed description of the system.
 - 4. Complete listing, graphical logic diagrams of all software programs required to perform the sequence of operation.
 - 5. Commands, operating, and troubleshooting instruction, and routine maintenance procedures.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.
- B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support

Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

End of Section

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of “Heating and Cooling Pipe” Work is shown in the Contract Documents. Section includes systems, accessories, valves, pipe and pipe fittings for: heating water, chilled water, steam and steam condensate, condenser water, glycol, refrigerant and engine exhaust

1.02 GOVERNING CODES, STANDARDS AND REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.
1. ASME (American Society of Mechanical Engineers)
 - a. ASME - Boiler and Pressure Vessel Codes, SEC IX - Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.
 - b. ASME B31.5 - Refrigeration Piping and Heat Transfer Components.
 - c. ASME B31.9 - Building Services Piping.
 - d. ASME SEC VIII-D - Boilers and Pressure Vessels Code, Rules for Construction of Pressure Vessels.
 - e. ASME B16.3 - Malleable Iron Threaded Fittings Class 150 and 300.
 2. ASTM (American Society for Testing and Materials)
 - a. ASTM A53 - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - b. ASTM A234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
 - c. ASTM B32 - Solder Metal.
 - d. ASTM F708 - Design and Installation of Rigid Pipe Hangers.
 3. AWS (American Welding Society)
 - a. AWS A5.8 - Brazing Filler Metal.
 - b. AWS D1.1 - Structural Welding Code.
 4. MSS (Manufacturers Standardization Society of the Valve and Fittings Industry)
 - a. MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacture.
 - b. MSS SP69 - Pipe Hangers and Supports - Selection and Application.
 - c. MSS - Pipe Hangers and Supports - Fabrication and Installation Practices.

1.03 SYSTEM DESCRIPTION

- A. Where more than one piping system material is specified, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.
- B. Use unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Use non-conducting dielectric connections whenever joining dissimilar metals in open systems. Do not use direct welded or threaded connections to valves, equipment or other apparatus.
- C. Provide pipe hangers and supports in accordance with ASTM B31.9 unless indicated otherwise.
- D. Use ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- E. Use plug cocks for throttling service. Use non-lubricated plug cocks only when shut-off or isolating valves are also provided.
- F. Use 3/4-inch ball valves with cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment.

1.04 SUBMITTALS

- A. Submit materials data in accordance with of Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.
- B. Submittals shall include the following:
 - 1. Shop Drawings: Indicate schematic layout of refrigeration system, including equipment, critical dimensions, and sizes.
 - 2. Product Data: Submit data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalogue information. Indicate valve data and ratings.
 - 3. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
 - 4. Welders' Certificate: Include welders' certification of compliance with ASME/SEC 9.

1.05 QUALITY ASSURANCE

- A. Perform Work in accordance with ASME B31.9 code for installation of piping systems and ASME SEC IX for welding materials and procedures.
- B. Maintain one copy of each document on site.

1.06 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years.
- B. Fabricator or Installer: Company specializing in performing Work of this section with minimum three years experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system Protect
- D. Dehydrate and charge refrigeration components such as piping and receivers, seal prior to shipment, until connected into system.

1.08 ENVIRONMENTAL REQUIREMENTS

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

1.09 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.10 EXTRA MATERIALS

- A. Spare and extra parts shall be identified for all products, but not provided. Include spare parts information in Operation and Maintenance Manuals.

PART 2 PRODUCTS

2.01 CHILLED WATER PIPING, ABOVE GRADE

- A. Piping:
 - 1. Chilled Water Piping 2-inch and Smaller: ASTM B88 Type “L” hard drawn copper.
 - 2. Chilled Water Piping 2-1/2-inch and Larger: ASTM A53, Standard weight (Schedule 40), Grade B, electric resistance welded or seamless, black steel.
- B. Fittings:
 - 1. 2-inch and Smaller: Wrought copper solder fittings and screwed adapters, ANSI B16.22. Cast bronze solder joint fittings and screwed adapters, ANSI B16.18. 95 percent tin, 5 percent antimony solder, ASTM B32.
 - 2. 2 1/2-inch and Larger: Wrought-Steel, ASTM A 234/A 234M, butt weld or flanged.
 - 3. Joints: Threaded or AWS D1.1 welded.
 - 4. Dielectric Couplings threaded or sweat (unions not allowed) required at dissimilar metal junctures.

2.02 UNIONS, FLANGES, AND COUPLINGS

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

- B. Flanges for Pipe Over 2 inches:
 - 1. Ferrous Piping: 150 psig forged steel, slip-on.
 - 2. Copper Piping: Bronze.
 - 3. Gaskets: 1/16 inch thick preformed neoprene suitable for the intended service.
- C. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.03 BALL VALVES

- A. Manufacturers: Crane, Stockham, Apollo, Milwaukee, Or Approved Equal.
- B. Up To and Including 3 inches: ASTM B584 Bronze two piece body, full port, stainless steel ball, [PTFE seats and stuffing box ring, lever handle with balancing stops, and solder or threaded ends.
- C. Over 3 inches: Cast steel body, chrome plated steel ball, Teflon seat and stuffing box seals, lever handle, flanged.

2.04 FLEXIBLE CONNECTORS

- A. Manufacturers: Mason, Metraflex, Keflex, Flexonics, Or Approved Equal.
- B. Corrugated stainless steel, bronze hose with single layer of stainless steel exterior braiding, minimum 9 inches long with copper tube ends; for maximum working pressure 300 psig.

PART 3 EXECUTION

3.01 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment with flanges or unions.
- D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.
- E. After completion, fill, clean, and treat systems.

3.02 INSTALLATION

- A. Install chilled water piping in conformance with ASME B31.5.
- B. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- C. Provide hangers and supports.
- D. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
- E. Provide access where valves and fittings are not exposed.
- F. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.
- G. Install valves with stems upright or horizontal, not inverted.

- H. Use grooved mechanical couplings and fasteners only in accessible locations.
- I. Install unions downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.
- J. Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- K. Use 3/4 inch ball valves with cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment.

3.03 FIELD QUALITY CONTROL

- A. Section 01 45 16.13 - Contractor's Quality Control Program.
- B. All hydronic piping systems shall meet ASME B31.1 and ASME B31.3.
- C. Pressure test hydronic piping for minimum of 2 hours at 1-1/2 times design working pressure or 150 psig, whichever is greater.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.
- B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

End of Section

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of “Hydronic Pumps” Work is shown in the Contract Documents. Section includes cooling condensate removal pumps and base-mounted pumps.

1.02 GOVERNING CODES, STANDARDS, AND REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.
 - 1. HI (Hydraulic Institute)
 - a. HI-01 – Standards for Centrifugal, Rotary, and Reciprocating Pumps.
 - 2. UL (Underwriters Laboratories, Inc.)
 - a. UL 778 – Motor Operated Water Pumps.

1.03 SUBMITTALS

- A. Submit materials data in accordance with Section 01 33 00 – Submittals. Furnish manufacturers’ technical literature, standard details, product specifications, and installation instructions.
- B. Submittals shall include the following:
 - 1. Product Data: Submit certified pump curves showing performance characteristics with pump and system operating point plotted. Include net positive suction pressure required (NPSH) curve when applicable. Include electrical characteristics and connection requirements. Submit also, manufacturer model number, dimensions, service sizes, and finishes.
 - 2. Manufacturer’s Installation Instructions: Submit application, selection, and hookup configuration with pipe and accessory elevations. Submit hanging and support requirements and recommendations.
 - 3. Manufacturer’s Certificate: Certify that products meet or exceed specified requirements.

1.04 PERFORMANCE REQUIREMENTS

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

1.05 DELIVERY, STORAGE, AND HANDLING

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

1.06 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.07 EXTRA MATERIALS

- A. Spare and extra parts shall be identified for all products, but not provided. Include spare parts information in Operation and Maintenance Manuals.

PART 2 PRODUCTS

2.01 COOLING CONDENSATE REMOVAL PUMPS

- A. Manufacturers:
 - 1. Little Giant Pumps, Franklin Electric Company.
 - 2. Liberty Pumps Inc.
 - 3. Or approved equal.
- B. Construction: Commercial grade, nonferrous pump with stainless steel shaft, integral discharge check valve, integral float switch, safety switch, thermoplastic reservoir, motor assembly, and power cord with ground.
- C. Safety: UL 778.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install Work in accordance with the specifications.
 - 1. Provide electrical interlocking from cooling condensate pump safety switch to associated HVAC unit(s) furnished under other Sections.
- B. Install long radius reducing elbows or reducers between pump and piping. Support piping adjacent to pump such that no weight is carried on pump casings. For close-coupled or base-mounted pumps, provide supports under elbows on pump suction and discharge line sizes 4 inches and over.
- C. Provide line-sized shutoff valve and strainer pump suction fitting on pump suction, and line-sized soft seat check valve and balancing valve combination pump discharge valve on pump discharge.
- D. Provide air cock and drain connection on horizontal pump casings.
- E. Provide drains for bases and seals.
- F. Check, align, and certify alignment of base-mounted pumps prior to startup.
- G. Install close-coupled and base-mounted pumps on concrete housekeeping base, with anchor bolts, set and level, and grout in place. Refer to Section 03 30 00 – Cast-in-Place Concrete.
- H. Lubricate pumps before startup.
- I. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. Provide supports under elbows on pump suction and discharge line sizes 4 inches and over.
- J. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, do not overload in parallel or individual operation, and operate within 25% of midpoint of published maximum efficiency curve.
- K. Inline pumps must be mounted on concrete pads.

3.02 FIELD QUALITY CONTROL

- A. Section 01 45 16.13 – Contractor's Quality Control Program,
- B. Inspect for alignment of base-mounted pumps.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.
- B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

End of Section

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of “Ducts” Work is shown in the Contract Documents. Section includes metal ductwork, nonmetallic ductwork, casing and plenums, and combination fire-and-smoke dampers. These standards apply to the installation of supply, return, outdoor, and exhaust air ductwork, accessories, and terminal units.

1.02 GOVERNING CODES, STANDARDS, AND REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.
1. ASTM (American Society for Testing and Materials)
 - a. ASTM A36 – Carbon Structural Steel
 - b. ASTM A90 – Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles.
 - c. ASTM A653 – Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
 2. NFPA (National Fire Protection Association)
 - a. NFPA 90A – Installation of Air Conditioning and Ventilating Systems.
 - b. NFPA 90B – Installation of Warm Air Heating and Air Conditioning Systems.
 - c. NFPA 92A – Smoke Control Systems.
 3. SMACNA (Sheet Metal and Air Conditioning Contractors’ National Association)
 - a. SMACNA (DCS) – HVAC Duct Construction Standards – Metal and Flexible.
 4. UL (Underwriters Laboratories, Inc.)
 - a. UL 33 – Heat Responsive Links for Fire Protection Service.
 - b. UL 555 – Safety Fire Dampers
 - c. UL 555S – Safety Smoke Dampers

1.03 PERFORMANCE REQUIREMENTS

- A. No variation of duct configuration or sizes other than those of equivalent or lower loss coefficient is permitted except by written authorization from the Engineer. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE Fundamentals table of equivalent rectangular and round ducts.

1.04 SUBMITTALS

- A. Submit materials data in accordance with Section 01 33 00 – Submittals. Furnish manufacturers’ technical literature, standard details, product specifications, and installation instructions.

- B. Submittals shall include the following:
 - 1. Product Data: Submit data for duct materials, duct liner and duct connectors.
 - 2. Manufacturer's Installation Instructions: Submit for fire dampers and fire smoke dampers.
- 1.05 QUALITY ASSURANCE
 - A. Perform Work in accordance with SMACNA (DCS).
 - B. Construct ductwork to NFPA 90A and NFPA 90B.
- 1.06 DELIVERY, STORAGE, AND HANDLING
 - A. Protect ductwork from damage, dirt, moisture, etc. at all times.
- 1.07 ENVIRONMENTAL REQUIREMENTS
 - A. Do not install duct sealant when temperatures are less than those recommended by sealant manufacturers.
 - B. Maintain temperatures during and after installation of duct sealant.
- 1.08 FIELD MEASUREMENTS
 - A. Verify field measurements prior to fabrication.

PART 2 PRODUCTS

2.01 DUCTWORK FABRICATION

- A. Fabricate and support in accordance with SMACNA (DCS), and as indicated. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.
- B. Construct tees, bends, and elbows with minimum radius 1-1/2 times centerline duct width. Where not possible and where rectangular elbows are used, provide turning vanes. Where acoustical lining is indicated, provide turning vanes of perforated metal with glass fiber insulation.
- C. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- D. Cross-breaking shall be outward for all supply ducts and inward for all return or exhaust ducts. All ductwork over 12-inches in either direction shall be cross-broken.
- E. No turning vanes shall be installed upstream of any fans.

2.02 DUCT MATERIALS SHEET METAL MATERIALS

- A. Galvanized Steel Ducts: ASTM A653 and ASTM A653M galvanized steel sheet, lock-forming quality, having G60 zinc coating in conformance with ASTM A90.
- B. Fasteners: Rivets, bolts, or sheet metal screws.
- C. Hanger Rod: ASTM A36; steel, galvanized, threaded both ends, threaded one end, or continuously threaded.

2.03 ACOUSTICAL TREATMENT (DUCT LINING)

- A. One-inch-thick, 1-1/2-pound density, semi-rigid fiberglass duct liner attached with fire-resistant adhesive and welded pin fasteners with NC-1 nylon stop clips and adhesive strips at all butt joints. Duct dimensions shown are net air side face-to-face of attenuation material. Manville, CertainTeed, Owens Corning, Or Approved Equal.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify sizes of equipment connections before fabricating transitions.

3.02 INSTALLATION

- A. Install and seal ducts in accordance with SMACNA (DCS).
- B. Seal ductwork seams and joints per SMACNA Seal Class 'B'. Seal transverse joints per Seal Class 'D.'
- C. Ducts shall conform accurately to dimensions indicated, which are net dimensions. Make proper allowances for thickness of sound insulation where called for on the inside of ducts.
- D. Drawings do not attempt to show all offsets in ductwork. Make such offsets, as necessary for installation of Work, without additional cost.
- E. Ducts passing through partitions or floors shall have either one-inch clearance or shall be insulated from structure with a minimum 1/4-inch, fire-resistant cloth. Where required to prevent noise transmission, openings shall be sealed with fire-resistant cloth. Provide flanged sheet metal enclosure. Refer to Section 20 07 00 – Mechanical Insulation for other insulation requirements.
- F. Provide lining on all fresh-air ductwork, mixed-air plenums, the initial 20 feet of supply duct from fans, the initial 15 feet from the inlet of return fans, and as otherwise indicated on the drawings. Glue and pin in accordance with manufacturer's recommendations.
- G. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
- H. Use double nuts and lock washers on threaded rod supports.
- I. Use only non-combustible sealants and tapes.
- J. Isolate joints between dissimilar metals with a fiber gasket.
- K. Provide combination fire and smoke dampers at locations indicated on contract drawings. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion-resistant springs, bearings, bushings, and hinges.
- L. Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92A.9.

3.03 INTERFACE WITH OTHER PRODUCTS

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

3.04 CLEANING

- A. Section 01 74 00 – Cleaning.
- B. Clean duct system and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment that may be harmed by excessive dirt with temporary filters, or bypass during cleaning.

3.05 TESTS

- A. Functionally test ductwork and permanently seal leaks.
- B. Demonstrate resetting of fire/smoke dampers to the Engineer.

3.06 BALANCING

- A. Section 23 05 93 – Testing, Adjusting, and Balancing.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.
- B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

End of Section

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of “Duct Accessories” Work is shown in the Contract Documents Section includes combination fire-and-smoke dampers, duct access doors, volume control dampers, flexible duct connections, and duct test holes.

1.02 GOVERNING CODES, STANDARDS, AND REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.
 - 1. ANSI (American National Standards Institute)
 - 2. ASTM (American Society for Testing and Materials)
 - 3. NFPA (National Fire Protection Association)
 - a. NFPA 90A – Installation of Air Conditioning and Ventilating Systems.
 - b. NFPA 92A – Smoke Control Systems.
 - 4. SMACNA (Sheet Metal and Air Conditioning Contractors’ National Association)
 - a. SMACNA (DCS) – HVAC Duct Construction Standards – Metal and Flexible.
 - 5. UL (Underwriters Laboratories, Inc.)
 - a. UL 33 – Heat Responsive Links for Fire Protection Service.
 - b. UL 555 – Fire Dampers and Ceiling Dampers.
 - c. UL 555S – Leakage Rated Dampers for Use in Smoke Control Systems.

1.03 SUBMITTALS

- A. Submit materials data in accordance with Section 01 33 00 – Submittals. Furnish manufacturers’ technical literature, standard details, product specifications, and installation instructions.
- B. Submittals shall include the following:
 - 1. Shop Drawings: Submit drawings for shop fabricated assemblies including volume control dampers, duct access doors and duct test holes.
 - 2. Product Data: Submit data for shop fabricated assemblies including volume control dampers, duct access doors, duct test holes, and hardware used. Include electrical characteristics and connection requirements.
 - 3. Manufacturer’s Installation Instructions: Submit for Fire and Combination Smoke and Fire Dampers.
 - 4. Manufacturer’s Certificate: Certify that products meet or exceed specified requirements.

1.04 QUALIFICATIONS

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

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Protect dampers from damage to operating linkages and blades.

1.06 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.07 EXTRA MATERIALS

- A. Spare and extra parts shall be identified for all products, but not provided. Include spare parts information in Operation and Maintenance Manuals.

PART 2 PRODUCTS

2.01 COMBINATION FIRE AND SMOKE DAMPERS

- A. Fabricate and install in accordance with NFPA 90A, UL 555, and UL 555S.
- B. Multiple-Blade Dampers: Fabricate with 16-gauge galvanized steel frame and blades. Provide oil-impregnated bronze or stainless-steel sleeve bearings and plated steel axles, stainless steel jamb seals, 1/8-inch x 1/2-inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock, and 1/2-inch actuator shaft.
- C. Operators: UL listed and labeled spring return electric type suitable for 120 volts, single phase, 60 Hz. Locate damper operator on exterior of duct and link to damper operating shaft.
- D. Electro Thermal Link: Fusible link melting at 165°F; 120 volts, single phase, 60 Hz; UL listed and labeled.

2.02 DUCT ACCESS DOORS

- A. Fabricate in accordance with SMACNA (DCS), and as indicated.
- B. Fabrication: Rigid and close fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ductwork, install minimum 1-inch-thick insulation with sheet metal cover.
 - 1. Less than 12-inches square, secure with sash locks.
 - 2. Up to 18-inches Square: Provide two (2) hinges and two (2) sash locks.
 - 3. Up to 24 x 48-inches: Three (3) hinges and two (2) compression latches with outside and inside handles.
 - 4. Larger Sizes: Provide an additional hinge.
 - 5. Access panels with sheet metal screw fasteners are not acceptable.

2.03 VOLUME CONTROL DAMPERS

- A. Fabricate in accordance with SMACNA (DCS), and as indicated.
- B. Dampers shall be single blade for ducts up to 12-inches high, opposed for over 12-inches high.

- C. Multi-Blade Damper: Fabricate of opposed blade pattern with 22-gauge minimum galvanized blade, maximum sizes 8 x 72-inch. Assemble center and edge crimped blades in prime coated or galvanized frame channel with suitable hardware. Blades shall have neoprene gasketed edges.
- D. End Bearings: Except in round ductwork 12-inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon or sintered bronze bearings. Provide closed end bearings on all ducts having a pressure classification over 2-inches w.g.
- E. Quadrants:
 - 1. Provide locking, indicating quadrant regulators on single- and multi-blade dampers.
 - 2. On insulated ducts, mount quadrant regulators on standoff mounting brackets, bases, or adapters.
 - 3. Where rod lengths exceed 30-inches, provide regulator at both ends.

2.04 REMOTE DAMPER OPERATOR

- A. 3/8-inch concealed adjustable cover regulator, chrome-plated cover.

2.05 FLEXIBLE DUCT CONNECTIONS

- A. Fabricate in accordance with SMACNA (DCS), and as indicated.
- B. Connector: Fabric crimped into metal edging strip.
 - 1. Fabric: UL-listed fire-retardant neoprene-coated woven glass fiber fabric conforming to NFPA 90A, minimum density 30 oz. per sq. yd. Ventfabrics, Thermaflex Type M-KC, Manville, Micro-Aire J/FLX, Or Approved Equal.
 - 2. Net Fabric Width: Approximately 3-inches wide.
 - 3. Metal: 3-inch wide, 24-gauge galvanized steel.

2.06 DUCT TEST HOLES

- A. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.
- B. Permanent Test Holes: Factory fabricated, airtight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

2.07 MANOMETER

- A. Combination inclined/vertical, molded plastic construction, leveling vial, zero-set adjustment, and fill reservoir. –0.05-inch to 7-inch water gauge.
- B. Inclined for up to 2-inch water gauge, vertical over 2-inch water gauge. Acrylic plastic body mounted on steel mounting panel, adjustable reflective chrome finish scales with locking screw. Scale indication to 125% of filter pressure.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify rated walls are ready for fire damper installation.
- B. Verify ducts and equipment installation are ready for accessories.

3.02 INSTALLATION

- A. Install in accordance with NFPA 90A and follow SMACNA (DCS).
- B. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.
- C. Install flexible connections at inlet and discharge of fans not internally isolated.
- D. Provide duct access doors for inspection and cleaning before and after filters, combination fire and smoke dampers, and elsewhere as indicated. Review locations prior to fabrication.
- E. Provide duct test holes where indicated and required for testing and balancing purposes.
- F. Provide combination fire and smoke dampers such that the actuator is on the exterior of any electrical room and at an accessible location. All concealed locations shall be provided with an access hatch.
- G. Provide combination fire and smoke dampers at locations indicated on contract drawings. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion-resistant springs, bearings, bushings, and hinges.
- H. Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92A.9.

3.03 DEMONSTRATION AND TRAINING

- A. Demonstrate resetting of fire dampers to the Engineer.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by a Subcontractor (of any tier) or Supplier.
- B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

End of Section

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of “Air Terminal Units” Work is shown in the Contract Documents. Section includes, variable volume terminal units, fan powered terminal units, variable volume regulators, integral sound attenuation, integral heating coils, integral damper motor operators, integral controls.

1.02 GOVERNING CODES, STANDARDS AND REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.
 - 1. Air Conditioning and Refrigeration Institute (ARI)
 - a. ARI 410 – Forced-Circulation Air-Cooling and Air-Heating Coils (with Addenda 1, 2, and 3)
 - 2. ASHRAE (American Society of Heating, Refrigerating and Air Conditioning Engineers)
 - a. ASHRAE Guideline 36 – High-Performance Sequences of Operation for HVAC Systems.
 - 3. NEMA (National Electrical Manufacturers Association)
 - 4. NFPA (National Fire Protection Association)
 - a. NFPA 90A – Installation of Air Conditioning and Ventilation Systems.
 - 5. UL (Underwriters Laboratories, Inc.)
 - a. UL 181 – Factory-Made Air Ducts and Connectors.

1.03 SUBMITTALS

- A. Submit materials data in accordance with Section 01 33 00 – Submittals. Furnish manufacturers’ technical literature, standard details, product specifications, and installation instructions.
- B. Submittals shall include the following:
 - 1. Product Data: Submit data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings that indicate airflow, static pressure, and NC designation. Include electrical characteristics and connection requirements. Include schedules listing discharge and radiated sound power level for each of second through sixth octave bands at inlet static pressures of 1 inch to 4 inches w.g.
 - 2. Manufacturer’s Installation Instructions: Submit support and hanging details, and service clearances required.
 - 3. Manufacturer’s Certificate: Certify that products meet or exceed specified requirements.

1.04 QUALIFICATIONS

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

- B. Installer: Company specializing in performing Work of this section with minimum three years' experience.
- 1.05 DELIVERY, STORAGE, AND HANDLING
 - A. Protect air terminal units from damage, dirt, moisture, etc. at all times.
- 1.06 FIELD MEASUREMENTS
 - A. Verify field measurements prior to fabrication.
- 1.07 COORDINATION
 - A. Coordinate Work with Section 23 09 23 – Direct Digital Controls.
- 1.08 EXTRA MATERIALS
 - A. Spare and extra parts shall be identified for all products, but not provided. Include spare parts information in Operation and Maintenance Manuals.

PART 2 PRODUCTS

2.01 AIR TERMINAL UNITS

- A. Manufacturers: Titus, Enviro-Tec, Nailor, Or Approved Equal.
- B. Ceiling mounted variable air volume, constant, fan powered supply air control terminals for connection to single, dual duct, central air systems, with pneumatic or electric system powered electronic variable volume controls, pneumatic, mechanical system powered constant volume control, electric hot water heating coils.
- C. Identify each terminal unit with a clearly marked identification label and airflow indicator. Include unit nominal airflow, maximum factory-set airflow and minimum factory-set airflow and coil type.
- D. Unit to have access panel on bottom.

2.02 SINGLE DUCT VARIABLE VOLUME UNITS

- A. Manufacturer and Type: Titus, Enviro-Tec, Nailor, Or Approved Equal, single duct, variable air volume air terminal unit. System pressure independent constant volume control; velocity pressure sensor and volume damper on inlet, and a minimum two-row heating coil on unit discharge.
- B. Basic Assembly:
 - 1. Casings: Minimum 22 gauge galvanized steel with brackets suitable for attachment on hanger straps, bottom access panel for servicing heating coil. Casing leakage shall not exceed 10 CFM at 1 inch w.c. pressure differential.
 - 2. Lining: Minimum 1/2 inch thick neoprene or vinyl coated fibrous glass insulation, 1-1/2 lb./cu. ft. density, meeting NFPA 90A requirements and UL 181 erosion requirements.
 - 3. Plenum Air Inlets: Round stub connections, S slip and drive connections for duct attachment.
 - 4. Plenum Air Outlets: S slip-and-drive connections.
- C. Basic Unit:

1. Configuration: Air volume damper assembly inside unit casing. Locate control components inside protective metal shroud.
 2. Volume Damper: Construct of galvanized steel with peripheral gasket and self-lubricating bearings; maximum damper leakage: 2% of design airflow at 1 inch inlet static pressure.
 3. Mount damper operator to position damper normally open, normally closed as indicated.
 4. Flow measuring taps and flow curves shall be supplied with each terminal unit for field balancing airflow. Pneumatic tubing shall be UL Listed, fire retardant type.
- D. Hot Water Heating Coil:
1. Construction: ARI 410, 1/2 inch copper tube mechanically expanded into aluminum plate fins, leak tested under water to 200 psig pressure, 10 fins per inch, minimum two-row coil, factory installed.
 2. Capacity: Based on 130 degree F entering water, 85 degree F leaving water and 100% total air volume.
- E. Automatic Damper Operator:
1. Electric Actuator: 24 volt with high limit and with remote temperature read and reset capability.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify ductwork is ready to receive Work.

3.02 INSTALLATION

- A. Connect to ductwork in accordance with Section 23 31 00 – Ducts.
- B. Provide ceiling access doors or locate units above easily removable ceiling components.
- C. Support units individually from structure. Do not support from adjacent ductwork.
- D. Select mounting frame style for type of construction and module of ceiling or wall in which they are mounted.
- E. Provide minimum of 5 feet of 1 inch thick lined ductwork downstream of units.

3.03 ADJUSTING

- A. Reset volume with damper operator attached to assembly allowing flow range modulation from 100% of design flow to 50% full flow. Set units with heating coils for minimum 50% full flow.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within

the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.

B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

End of Section

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of “Air Outlets and Inlets” Work is shown in the Contract Documents. Section includes grilles, filter grilles, and louvers.

1.02 GOVERNING CODES, STANDARDS, AND REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.
 - 1. ADC (Air Diffusion Council)
 - a. ADC 1062 – Certification, Rating and Test Manual.
 - 2. AMCA (Air Movement and Control Association)
 - a. AMCA 500 – Test Method for Louvers, Dampers and Shutters.
 - 3. ASHRAE (American Society of Heating, Refrigerating and Air Conditioning Engineers)
 - a. ASHRAE 70 – Method of Testing for Rating the Airflow Performance of Outlets and Inlets.
 - 4. NFPA (National Fire Protection Association)
 - 5. SMACNA (Sheet Metal and Air Conditioning Contractors’ National Association)
 - a. SMACNA – HVAC Duct Construction Standard – Metal and Flexible.
 - 6. UL (Underwriters Laboratories, Inc.)

1.03 SUBMITTALS

- A. Submit materials data in accordance with of Section 01 33 00 – Submittals. Furnish manufacturers’ technical literature, standard details, product specifications, and installation instructions.
- B. Submittals shall include the following:
 - 1. Product Data: Submit data outlets and inlets sizes, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.
 - 2. Test Reports: Rating of air outlet and inlet performance.
 - 3. Manufacturer’s Certificate: Certify that products meet or exceed specified requirements.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Protect air inlets and outlets from damage, dirt, moisture, etc. at all times.

1.05 EXTRA MATERIALS

- A. Spare and extra parts shall be identified for all products, but not provided. Include spare parts information in Operation and Maintenance Manuals.

PART 2 PRODUCTS

2.01 GENERAL

- A. Manufacturers
 - 1. Diffusers, Grilles, and Registers – Price, Titus, Nailor, Krueger, Or Approved Equal.
 - 2. Maximum flow rates, lengths, and slot direction for all products shall be as indicated in the schedules noted on the drawings.

2.02 REGISTERS AND GRILLES

- A. Grilles and registers shall be extruded aluminum with 1-inch border, blades at 3/4-inch spacing and horizontal blades.
- B. Wall Supply
 - 1. Type: Streamlined and individually adjustable blades, 3/4-inch minimum depth, 3/4-inch maximum spacing with spring or other device to set blades, horizontal face, single deflection.
 - 2. Frame: 1-inch margin with countersunk screw mounting and gasket.
 - 3. Fabrication: Aluminum with 20-gauge minimum frame, or aluminum extrusions, with factory clear lacquer.
 - 4. Damper: Integral, gang-operated opposed blade type with removable key operator, operable from face.
- C. Wall Exhaust and Return
 - 1. Type: Streamlined blades, 3/4-inch minimum depth, 3/4-inch maximum spacing, with spring or other device to set blades, horizontal face.
 - 2. Frame: 1-inch margin with countersunk screw mounting.
 - 3. Fabrication: Aluminum with 20-gauge minimum frame, or aluminum extrusions, with factory clear lacquer finish.
 - 4. Damper: Integral, gang-operated, opposed-blade type with removable key operator, operable from face.

2.03 DIFFUSERS

- A. Diffusers shall be aluminum construction.
- B. The diffuser shall consist of an outer frame assembly to facilitate mounting and shall include an integral collar to allow for duct connection.
- C. The diffuser core shall consist of fixed louver directional modules that may be field adjusted from the diffuser face.
- D. The core's blade spacing shall be 1-inch on center.
- E. Damper: Integral, gang-operated, opposed-blade type with removable key operator, operable from face.

2.04 LOUVERS

- A. General: AMCA licensed, high performance louver.
- B. Nominal Free Area: 45 to 55 percent.

- C. Maximum Pressure Drop: 0.10-inch w.g.
- D. Type: 4-inches deep with extruded aluminum blades on 45-degree slope, heavy channel frame.
- E. Fabrication: 12-gauge thick extruded aluminum, welded assembly, with factory anodized finish, color to be selected.
- F. Mounting: Furnish with exterior angle flange for installation.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify inlet/outlet locations.
- B. Verify ceiling and wall systems are ready for installation.

3.02 INSTALLATION

- A. Install ductwork with airtight connection.
- B. Select air terminals for the type of construction and the module of ceiling and wall in which they are mounted.
- C. Sizes shown on drawings indicate duct connection with minimum 60% net free area.
- D. Provide balancing dampers on duct take-off to diffusers, and grilles and registers.

3.03 INTERFACE WITH OTHER PRODUCTS

- A. Check location of outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.
- B. Ceiling mounted units to mate with ceiling system.

3.04 TESTING

- A. Performance tests in accordance with ADC Standard 1062 R2, Test Code, with ASHRAE Standard 36B.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.
- B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and

specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

End of Section

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of “Air Handling Units” Work is shown in the Contract Documents. The section includes all accessories.

1.02 GOVERNING CODES, STANDARDS, AND REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.
 - 1. ARI (Air Conditioning and Refrigeration Institute)
 - a. ARI 430 – Standard for Central-Station Air-Handling Units.
 - 2. AMCA (Air Movement and Control Association)
 - a. AMCA 99 – Standards Handbook.
 - b. AMCA 210 – Laboratory Methods of Testing Fans for Rating.
 - c. AMCA 300 – Reverberant Room Method for Sound Testing of Fans.
 - d. AMCA 301 – Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
 - 3. NFPA (National Fire Protection Association)
 - a. NFPA 90A – Standard for the Installation of Air Conditioning and Ventilating Systems.
 - 4. UL (Underwriters Laboratories, Inc.)
 - a. UL 900 – Standard for Air Filter Units.
 - b. UL – Fire Resistance Directory.

1.03 SUBMITTALS

- A. Submit materials data in accordance with Section 01 33 00 – Submittals. Furnish manufacturers’ technical literature, standard details, product specifications, and installation instructions.
- B. Submittals shall include the following:
 - 1. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.
 - 2. Indicate DDC control panel and variable frequency drives’ locations.
 - 3. Product Data, Submit:
 - a. Published Literature: Indicate capacities, ratings, and finishes of materials, and electrical characteristics and connection requirements.
 - b. Fans: Performance and fan curves with specified operating point clearly plotted, power, RPM.
 - c. Sound Power Level Data: Fan outlet and casing radiation at rated capacity.

- d. Electrical Requirements: Power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.
- 4. Manufacturer's Installation Instructions: Submit.
- 1.04 QUALITY ASSURANCE
 - A. Provide materials in accordance with the specifications.
- 1.05 QUALIFICATIONS
 - A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
 - B. Installer: Company specializing in performing Work of this section with minimum three years' documented experience approved by manufacturer.
- 1.06 DELIVERY, STORAGE, AND HANDLING
 - A. Accept units and components on site in factory protective containers, with factory shipping skids and lifting lugs. Inspect for damage
 - B. Protect units from weather and construction traffic by storing in a dry, roofed location.
- 1.07 ENVIRONMENTAL REQUIREMENTS
 - A. Do not operate units until ductwork is clean, filters are in place, bearings lubricated, and fan has been test-run under observation.
- 1.08 FIELD MEASUREMENTS
 - A. Verify field measurements prior to fabrication.
- 1.09 EXTRA MATERIALS
 - A. Spare and extra parts shall be identified for all products, but not provided. Include spare parts information in Operation and Maintenance Manuals.

PART 2 PRODUCTS

2.01 FAN-COIL UNITS

- A. Manufacturers: Liebert, Haakon, Temtrol, Daikin or approved equal.
- B. Performance Data and Safety Requirements:
 - a. Coils rated and tested in accordance with AHRI 410.
 - b. Provide products listed, classified, and labeled by Underwriters Laboratories Inc. (UL) or Intertek (ETL) as suitable for the purpose indicated.
 - c. Equipment wiring to comply with requirements of NFPA 70.
 - d. Insulation to comply with NFPA 90A requirements for flame spread and smoke generation.
- C. Unit Casing:
 - a. Fabricate from heavy gauge galvanized steel sheet, inner and outer panels with 1 inch aluminum frame.

- b. Insulate inside walls with 1-inch-thick, expanded foam insulation for thermal and acoustical control.
 - c. Provide hinged access panels allowing servicing of coils, drain pan, fan, motor, and drive.
 - d. Provide knockouts or hanger rod holes at all four corners for suspended units.
- D. Air Coils:
 - a. Aluminum fins mechanically expanded or bonded to copper tubes having standard sweat connections.
 - b. Water: Manual, automatic or self-venting, designed to a working pressure and temperature of not less than 250 psig and 200 degrees F.
- E. Fans: Unhoused plenum blower, dynamically balanced, direct drive with 1 inch deflection spring isolators.
- F. Drain Pan: Cleanable, one-piece construction of polymer, galvanized steel, or stainless steel; with drain connection and sloped for positive drainage.
- G. Filters: Fully accessible, 2-inch filter rack with MERV-8 filters.
- H. Motors: Open drip proof, single speed with ball bearings, 1750 rpm.
- I. Electrical Controls:
 - a. Adjustable Frequency Drive.
 - b. Terminal strip for connection of field wiring.
 - c. Disconnecting means for main incoming power.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with ARI 430.
- B. Verify all surfaces and openings at unit location can suitably accommodate unit(s).
- C. Install in accordance with manufacturer's recommendations.
- D. General piping installation requirements are specified in other Sections and drawings indicate general arrangement of piping, fittings, and specialties.
- E. Connect hydronic, condensate drain, and overflow drain piping to unit.

3.02 FIELD QUALITY CONTROL

- A. Section 23 05 93 – Testing, Adjusting, and Balancing.

3.03 PROTECTION OF INSTALLED CONSTRUCTION

- A. Do not permit unit operation without air filters.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

A. For incidental work:

1. No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.

B. For Work separately paid:

1. The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

End of Section

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of “Variable Frequency Drives” work is shown in the Contract Documents. This Section includes requirements for design, fabrication, supply, and delivery of all variable frequency drives.

1.02 GOVERNING CODES, STANDARDS, AND REFERENCES

- A. ANSI (American National Standards Institute)
- B. IEEE (Institute of Electrical and Electronics Engineers)
 - 1. IEEE 519 – IEEE Recommended Practice and Requirements for Harmonic Control in Electric Power Systems
 - 2. IEEE C62.41 – IEEE Guide on the Surge Environment in Low-Voltage (1000 V and less) AC Power Circuits
- C. NEMA (National Electrical Manufacturers Association)
 - 1. NEMA ICS 2 – Industrial Control and Systems: Drives, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC
 - 2. NEMA ICS 3.1 – Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable – Speed Drive Systems
 - 3. NEMA ICS 7 – Industrial Control and Systems: Adjustable Speed Drives
 - 4. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum)
 - 5. NEMA KS 12 – Heavy-Duty Enclosed and Dead-Front Switches (600 Volts Maximum)
 - 6. NEMA MG 1 – Motors and Generators
- D. NFPA (National Fire Protection Association)
 - 1. NFPA 70 – National Electrical Code (NEC)
- E. UL (Underwriters Laboratories)
 - 1. UL 486A/UL 486B – Wire Connectors
- F. Related Documents
 - 1. The provisions and intent of the Contract, the General and Supplementary Conditions, and Division 1 Specification Sections, apply to the Work as if specified in this Section.

1.03 SUBMITTALS

- A. Product Data: For each type of variable frequency drive (VFD), provide dimensions; mounting arrangements; location for conduit entries; shipping and operating weights; and manufacturer’s technical data on features, performance, electrical ratings, characteristics, and finishes.

- B. Shop Drawings: For each VFD:
 - 1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Each installed unit's type and details.
 - b. Nameplate legends.
 - c. Short-circuit current ratings of integrated unit.
 - d. UL listing for series rating of overcurrent protective devices in combination with drives.
 - e. Features, characteristics, ratings, and factory settings of each motor-control center unit.
 - 2. Wiring Diagrams: Power, signal, and control wiring for each type of VFD.
- C. Field Test Reports: Written reports specified in Part 3.
- D. Manufacturer's field service report.
- E. Operations and Maintenance Data: For VFDs, all installed devices, and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1, Section "Operations and Maintenance Data," include the following:
 - 1. Routine maintenance requirements for VFDs and all installed components.
 - 2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.
- B. Listing and Labeling: VFDs shall be UL Listed and Labeled as a complete unit, and shall conform to NEMA ICS 2, IEEE 519, and ANSI standards.
- C. Comply with NFPA 70, as adopted and administered by the Authority Having Jurisdiction.
- D. Manufacturer Limitations
 - 1. All VFDs shall be supplied by one manufacturer.
 - 2. To ensure quality, the complete VFD shall be tested by the manufacturer.
 - a. All optional features shall be functionally tested at the factory for proper operation.
- E. Product Selection for Restricted Space: VFD Schedule on E0.05 indicates dimensions for VFD enclosures as the basis of design. Contractor shall

incur all costs related to installing VFDs that exceed these dimensions, including additional engineering review or calculations.

- F. Product Selection for existing installations: VFD Schedule on E0.05 indicates weights for VFD enclosures as the basis of design. Contractor shall incur all costs related to installing VFDs that exceed these weights, including providing additional engineering and structural review or calculations.

1.05 DEFINITIONS

- A. IGBT: Insulated gate bipolar transistor.
- B. LAN: Local area network.
- C. PID: Control action, proportional plus integral plus derivative.
- D. PWM: Pulse-width modulated.
- E. VFD: Variable frequency drive.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver VFDs in shipping splits of lengths that can be moved past obstructions in delivery path as indicated.
- B. Store VFDs indoors in clean, dry space with uniform temperature to prevent condensation. Protect VFDs from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- C. If stored in areas subject to weather, cover (shrink wrap) VFDs to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside drives; install electric heating of sufficient wattage to prevent condensation.

1.07 COORDINATION

- A. Coordinate layout and installation of VFDs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate equipment supports, roof penetrations, and installation of roof curbs.
- C. Coordinate features of VFDs, installed units, and accessory devices with pilot devices and control circuits to which they connect.
- D. Coordinate features, accessories, and functions of each VFD and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.08 EXTRA MATERIALS

- A. There are no recommended spare parts.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with requirements, provide products by one of the following:
 - 1. Yaskawa (18-pulse, 6-pulse, or Z1000U Matrix).
 - 2. Siemens (Up to 250 HP).
 - 3. Allen Bradley.
 - 4. Or approved equal.

2.02 VARIABLE FREQUENCY DRIVES

- A. Description: NEMA ICS2, IGBT, PWM, VFD; listed and labeled as a complete unit and arranged to provide variable speed of a NEMA MG-1, Design B, 1.15 service factor, three-phase, premium-efficiency induction motor by converting input voltage and frequency to a variable output voltage and frequency via a two-step operation.
- B. Compliance: Meet all requirements of the latest edition of IEEE 519 for current and voltage harmonic standards.
 - 1. Point of Common Coupling: Motor Control Center or supply panelboard shall be used as the Point of Common Coupling for all harmonic calculations and field measurements for voltage and current distortion.
 - 2. IEEE 519, Table 10.2 Requirements: Individual or simultaneous operation of VFDs at full load and speed shall not add more than 3% total harmonic voltage distortion during operation from the utility source, or 5% during operation from a standby generator.
 - 3. IEEE 519, Table 10.3 Requirements: Total harmonic current distortion during individual or simultaneous operation of VFDs at full load and speed shall meet table 10.3 IEEE 519 as calculated and measured at the Point of Common Coupling.
 - 4. VFD Requirements by Size and Total HP on PCC
 - a. VFDs 40 hp and above shall be 18-pulse or Yasakawa Z1000U Matrix.
 - b. VFDs 30 hp or less shall be 6-pulse or higher and meet IEEE 519 2014 Table 10.2 and have 12% maximum TDD.
 - c. VFDs under 7.5 HP shall comply to IEEE 519 2014 Table 10.2 only.
 - d. If the total horsepower for a group of VFDs under 30 hp on a common PCC as documented in the project electrical drawings and defined in 2.02.C.1 exceeds 75 hp, the drives shall each have 5%-line impedance. No active or passive harmonic filters shall be used.
- C. Drive System Design: Space vector sine-coded pulse-width modulated (PWM).

1. Match load type such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power- transmission connection.
 - a. VFD shall maintain a 0.95 minimum true power factor throughout the entire speed range.
 - b. Drive system shall be 96% efficient at full load and full speed, and 95% efficient at 50% load and 80% speed.
2. Rated Input Power: 460 Volts, 60 Hertz.
 - a. AC Line Frequency Variation: ± 3 -Hertz.
 - b. Power Unit Rating Basis: 100% rated current continuous, 110% rated current for one minute, at rated temperature.
 - c. Voltage Dip Ride-Through: Capable of sustaining continued operation with a 40% dip in nominal line voltage.
 - d. Power Loss Ride-Through: Capable of a minimum 3-cycle power loss without fault activation.
 - e. When power is restored after a complete power outage, the VFD shall be capable of 'catching' the motor while it is still spinning and restoring it to proper operating speed without use of an encoder.
3. Ambient Temperature: 32 degrees F to 104 degrees F.
4. Atmosphere: Non-condensing relative humidity to 95%.
5. Starting Torque: 100% of rated torque or as indicated.
6. Speed Regulation: $\pm 1\%$.
- D. Drive System Components: Integral to unit, factory-wired and tested as a complete system, including:
 1. For 18-pulse, an input rectifier-grade phase-shifting transformer with no additional components.
 2. Minimum fifth, seventh, and eleventh harmonic filtering, meeting IEEE 519 requirements.
 3. Output inverter.
- E. Isolated Control Interface shall allow the drive to follow a 4 to 20mA electrical signal at 24V, over a 10:1 speed range.
- F. Self-Protection and Reliability Features
 1. Undervoltage and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
 2. Electronic motor overload protection.
 3. Instantaneous line-to-line and line-to-ground overcurrent trips.
 4. Loss-of-phase protection.
 5. Reverse-phase protection.

6. Three-phase short-circuit protection on VFD output terminal.
 7. Power unit over-temperature alarm and trip.
 8. Motor winding temperature detectors or thermostatic switches. Include normally closed dry contact input to the VFD for alarm and shutdown.
 9. Input transient protection by means of surge suppressors, IEEE C62.41, selected for exposure category.
- G. Status Lights: Door-mounted LED indicators or keypad message display shall indicate the following conditions:
1. Power on.
 2. Running.
 3. Overvoltage.
 4. Line fault.
 5. Overcurrent.
 6. External fault.
- H. Automatic Reset and Restart: To attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bi-directional auto speed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to drive, motor, or load.
- I. Panel-Mounted Operator Station: Door-mounted keypad with integral digital display, capable of controlling the VFD and setting drive parameters.
1. Include mode selector switch labeled “Hand/Off/Remote,” and manual speed control device.
 2. Digital display shall present all diagnostic messages and parameter values in English engineering units.
 3. Keypad shall allow operator to enter exact numerical settings in English engineering units.
 4. Keypad shall selectively display the following:
 - a. Speed demand in percent.
 - b. Output current in amperes.
 - c. Output frequency in Hertz.
 - d. DC Bus Voltage.
 - e. Output Voltage.
 - f. Total 3-phase kW.
 - g. Kilowatt-hour meter.
 - h. Motor speed (RPM).

- J. Control Signal Interface: Provide VFD with the following:
 - 1. Electric Input Signal Interface: A minimum of two (2) analog inputs (0 to 10V DC or 4-20 mA) (switchable) and six (6) programmable digital inputs.
 - 2. Remote Signal Inputs: Capability to accept any of the following speed- setting input signals:
 - a. 0 to 10V DC.
 - b. 4-20 mA.
 - c. Potentiometer using up/down digital inputs.
 - d. Fixed frequencies using digital inputs.
 - e. RS 485.
 - f. Keypad display for local “Hand” operation.
 - 3. Output Signal Interface: A minimum of 1 analog output signal (4-20 mA), which can be programmed to any of the following:
 - a. Output frequency (Hz).
 - b. Output current (Load).
 - c. DC-link voltage (VDC).
 - d. Motor torque (%).
 - e. Motor speed (RPM).
 - f. Set-point frequency (Hz).
 - 4. Remote Indication Interface: A minimum of two (2) dry circuit relay outputs (120V AC, 1A) for remote indication of the following:
 - a. Motor running.
 - b. Set-point speed reached.
 - c. Fault and warning indication (over temperature or overcurrent).
 - d. PID high or low speed limits reached.
 - 5. Power (Kilowatt) Monitoring Interface. Provide analog or digital output interface to collect and record kilowatts and kilowatts per hour from each VFD.
- K. Communications: Provide RS 232, RS 422, or RS 485 communications port and integral Apogee and BACnet communications capability.
 - 1. Interface shall allow all VFD parameter settings, fault log and diagnostic log to be externally downloaded.
 - 2. Provide capability for VFD to retain settings within nonvolatile memory.
- L. Integral Disconnecting Means: NEMA KS 1, fusible switch or breaker with lockable handle or a 100KAIC circuit breaker if the VFD package can be labeled and rated 100KAIC without fuses.

- M. Output Line Reactor: Provide output line reactor if cable lengths exceed three hundred feet between VFD and motor.
- N. Current Switch: Provide On/Off Current Monitoring Switch on motor feeder conductor or bus bar inside VFD enclosure.
 - 1. UL 508 Listed.
 - 2. Rated for 600V at 60Hz, -40 to 122°F (to 200A).
 - 3. Normally open switch that closes when motor is energized.
 - 4. Connected to field terminals for DDC Proof CT I/O Point.
- O. Arc Flash Protection Labeling: Variable Frequency Drives shall be marked to warn personnel of potential arc flash hazards.
 - 1. The marking shall be located to be clearly visible to qualified personnel before examination, adjustment, servicing, or maintenance of the equipment.
 - 2. The vendor shall provide a 3.5-inch x 5-inch thermal transfer type label of high adhesion polyester for each VFD.
 - 3. The label shall have an orange header with the wording "WARNING," a sub-header with the wording "ARC FLASH AND SHOCK HAZARD APPROPRIATE PPE REQUIRED," and shall include the following information, which shall be provided by the POS Project Manager upon request:
 - a. Location designation.
 - b. Nominal voltage.
 - c. Flash protection boundary.
 - d. Hazard risk category.
 - e. Incident energy.
 - f. Working distance.
 - g. Engineering report number, revision number and issue date.
 - h. Labels shall be machine printed, with no field markings.
 - i. Labels shall be field installed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.

2.03 ENCLOSURES

- A. NEMA 12, dead-front, grounded enclosure with factory mounted and wired components and with adequate ventilation openings for air circulation.

2.04 ACCESSORIES

- A. Include current transformers as required to interface with incoming power, and control power transformers as required for drive circuitry.

2.05 FACTORY FINISHES

- A. Finish: Manufacturer's standard color paint applied to factory-assembled and -tested VFDs before shipping.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Anchor each VFD assembly according to manufacturer's written instructions and anchoring requirements specified in Division 26, Section "Seismic Controls for Electrical Work."

3.02 CONNECTIONS

- A. Ground equipment.
- B. Power connection between drive and motor shall be isolated and separate from any other loads and shall include full sized stranded grounded conductor between drive and motor.
- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- D. Mark lugs after torquing with red paint such that paint will be visibly disturbed if lugs are disturbed.

3.03 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Test insulation resistance of connecting supply, feeder, and control circuit for each VFD. This shall include existing circuits that are being reused. Refer to 26-05-19 section 3.07 for requirements.
 - 2. Test continuity of each circuit.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including pretesting and adjusting VFDs.
 - 1. Utilize Fluke 41 or equivalent harmonic analyzer to display individual and total harmonic currents and voltages. Verify that specified input harmonic voltage and current distortion limits are not exceeded and record results. At minimum, results shall comply with section 2.02-B.
 - 2. VFD supplier shall take corrective action, at no additional expense to the Port, until compliance with requirements has been achieved.
- C. Test Reports: Prepare a written report to record the following:
 - 1. Test procedures used.
 - 2. Verify and record drive model number and rating. Record motor nameplate ratings, line voltage of each and ground. Record amperage running under load.

3. Test results that do not comply with requirements and corrective action.
- D. Contractor is responsible to perform the measurements outlined in Section 2.02.
 1. Confirm per IEEE 519, Table 10.2 Requirements: Individual or simultaneous operation of VFDs at full load and speed shall not add more than 3% total harmonic voltage distortion during operation from the utility source, or 5% during operation from a standby generator.
 2. Confirm per IEEE 519, Table 10.3 Requirements: Total harmonic current distortion during individual or simultaneous operation of VFDs at full load and speed shall meet Table 10.3 IEEE 519 as calculated and measured at the Point of Common Coupling.
 3. Confirm Drive system are 96% efficient at full load and full speed, and 95% efficient at 50% load and 80% speed.

3.04 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Complete installation and startup checks according to manufacturer's written instructions.
- C. Document all parameter settings on existing VFDs prior to cutover. Programming of new VFDs shall match existing ones as closely as possible.
- D. VFD startup personnel shall coordinate with and assist Siemens for controls and functional testing of VFD.
- E. Provide written documentation from startup of each VFD to include all setup parameters and any limits, such as maximum frequency settings.

3.05 IDENTIFICATION

- A. Identify VFD, components, wiring, and controls according to the Mechanical Design Standards "Mechanical Equipment ID System" and Division 26 Electrical Identification.

3.06 WARRANTY

- A. Provide three-year written warranty with authorized startup.

3.07 DEMONSTRATION AND TRAINING

- A. Engage a factory-authorized service representative to train Port maintenance personnel to adjust, operate, and maintain VFDs for a minimum of eight (8) hours.
 1. Train Port maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
 2. Review data in maintenance manuals. Refer to Division 1, Section "Operations and Maintenance Data."

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.

B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

End of Section

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of "Electrical Work" Work is shown in the Contract Documents. This Section includes general requirements for accomplishing electrical Work as specified herein and indicated on the Drawings.
- B. The airport is a 24-hour, 365-day operational facility. Electrical hot Work may be required to be performed on portions of the electrical power distribution and utilization equipment. The Contractor and its subcontractors shall provide personal protection equipment (PPE), training, authority having jurisdiction (AHJ) safety compliance and all necessary tools for the execution of such Work.

1.02 GOVERNING CODES, STANDARDS AND REFERENCES

- A. FAA (Federal Aviation Administration)
- B. NFPA 70: National Electrical Code (NEC)
- C. NFPA 70 E: Standard for Electrical Safety in the Workplace
- D. Port of Seattle Construction Health & Safety Manual Confined Space Entry Program
- E. Port of Seattle Construction Health & Safety Manual Energized Electrical Work plan
- F. Port of Seattle Construction Health & Safety Manual Lock-out Tag-out Policy
- G. Port of Seattle Electric Shop
- H. Port of Seattle Electrical Safety Rules
- I. Port of Seattle Electrical Supervisor
- J. Port of Seattle Health & Safety Manuals
- K. Port of Seattle for highway signage, flagging, and re-routing traffic
- L. Power Company
- M. State of Washington Dept. of Labor & Industries.
- N. Underwriters Laboratories, Inc.
- O. WAC 296-45
- P. State requirements for highway signage, flagging, and re-routing traffic
- Q. State of Washington safety rules and health standards

1.03 SUBMITTALS

- A. Submit materials data in accordance with of Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions.
- B. Submittals shall include the following:
 - 1. Review of Shop Drawings and Brochures shall not relieve the Contractor of responsibility for dimensions and/or errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood that the noting of some errors, but the overlooking of others

does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings and Brochures, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the review of the Shop Drawings and Brochures.

2. Manufacturer Approval Drawings: Equipment that is laid out, configured, or designed by manufacturer based on performance specifications only shall be submitted to the Engineer for approval prior to release of drawings for manufacturing.
- C. Ordering Materials: Order materials within two (2) weeks of receiving reviewed submittals from the Engineer. Provide proof of order placement upon request. Failure to comply will be considered non-performance and progress payments will be suspended until proof of order placement is reviewed and accepted by the Engineer.
- D. Operations and Maintenance Data: shall comply with requirements specified in Division 1.

1.04 DRAWINGS

- A. The electrical drawings are diagrammatic and are not intended to show all raceway, wiring, exact locations of equipment, terminations, or number or types of fittings required by the electrical system. Provide all related electrical Work which is specified herein, diagrammed or scheduled on the electrical drawings, required by code enforcing agencies and as indicated on other details or elevations for complete and operating electrical systems. Since the drawings of floor, wall, and ceiling installation are made at a small scale, outlets, devices, equipment, etc. are indicated only in their approximate location unless dimensioned or otherwise indicated. Locate outlets and apparatus symmetrically on floors, walls and ceilings where not dimensioned and coordinate such locations with the Work of other trades to prevent interferences. Verify all dimensions on the job. Do not scale the electrical drawings. Refer to Architectural and Mechanical shop drawings and project drawings for dimensions as applicable.

1.05 PRODUCTS

- A. General: Products are specified by manufacturer name, description, and/or catalog number to show intended function and quality. Report discrepancies, such as discontinued equipment or catalog numbers, to the Engineer prior to bidding. If the Contractor is unable to interpret any part of the plans and/or specifications, he shall notify the Engineer, who will issue interpretation and/or additional clarifications to Bidders before the project is bid.
- B. Manufacturers: Provide only equipment specified in the Contract Documents or approved by addendum. Manufacturers' catalog numbers and descriptions establish the quality of product required.
- C. Warranty: Comply with Section 01 78 36 - Warranties and Bonds. Warranty shall be manufacturer's standard or a minimum of one year unless noted otherwise in Division 26 Electrical Sections.

1.06 SUBSTITUTIONS

- A. Comply with Section 01 25 00 - Substitutions.

1.07 QUALITY ASSURANCE

- A. All materials shall be new, unless noted otherwise. Properly store all materials and equipment for protection from physical damage or damage due to corrosion.
- B. Review accessibility of equipment for operation, maintenance and repair prior to installation. Proceed with installation only after unsatisfactory conditions have been corrected
- C. Equipment Manufacturer Qualifications: Equipment manufacturers shall have at least 10 years experience in manufacturing products and accessories similar to those for this Project, with a record of successful in-service performance.

1.08 COORDINATION AND SCHEDULING

- A. Comply with Section 01 32 16 - Bar Chart Schedule.
- B. Coordinate and schedule electrical Work with the Work of other trades. Every reasonable effort shall be made to prevent conflicts as to space requirements, dimensions, locations, code required working spaces, access openings, drawout and removal spaces or other matters tending to obstruct or delay the Work of other trades. All changes caused by failure to coordinate shall be made at the Contractor's expense.

1.09 SAFETY AND PROTECTION

- A. Safety Measures To Be Taken: The Engineer has not been retained or compensated to provide design and construction review services relating to the Contractor's safety precautions or to the means, methods, techniques, sequences or procedures required for the Contractor to perform his Work. The Contractor will be solely and completely responsible for conditions of the job site, including safety of all persons and property during performance of the Work. This requirement will apply continuously and not be limited to normal working hours. The duty of the Engineer to conduct construction observations of the Contractor's performance is not intended to include review of the adequacy of the Contractor's safety measures, in, on or near the construction site. It shall be the Contractor's responsibility to comply with applicable safety and health regulations for construction. The Contractor shall consult with the state or federal safety inspector for interpretation whenever in doubt as to whether safe conditions do or do not exist or whether they are or are not in compliance with state or federal regulations.
- B. Protection: The Contractor shall take whatever measures are required to ensure that electrical safety and protection are maintained, including the proper covering, signage, and securing of "live" circuits.
- C. Comply with Section 01 35 13.13 - Operational Safety on Airports During Construction, Port of Seattle Construction Health & Safety Manuals and with applicable State of Washington safety rules and health standards, including WAC-294-45, and the Port of Seattle "Electrical Safety Rules." Any violation shall result in a warning citation.
- D. The Port of Seattle "Electrical Safety Rules" are as follows:
 - 1. Work on Electrical circuits operating at over 50 volts, phase to ground, or greater shall be conducted in accordance with Port of Seattle Construction Health & Safety Manual Energized Electrical Work plan.

2. Power Outages: Any essential outages required in the course of construction, whether for temporary services, cutovers, or testing, shall be closely coordinated with the Engineer and shall occur at times approved by the Port by means of shutdown notification request. Contractor to identify all systems affected and provide copy of panel schedules of panelboards affected by shutdown notification request.
3. Electrical circuits operating at over 300 volts phase to ground, or circuits serviced by a transformer over 150 kVA, shall be de-energized before proceeding with the Work.
4. Electrical circuits shall be considered de-energized only after compliance with the Port of Seattle Construction Health & Safety Manual Lock-out Tag-out Policy and under the following conditions:
 - a. Switches connecting subject circuit to the energy supply are observed in the "open" position, with an air break, and locked and tagged out in accordance with Port of Seattle Construction Health & Safety Manual Lock-out Tag-out Policy.
 - b. Electrically operated switches are visibly "open", blocked or racked in the "open" position, and locked and tagged out "open".
 - c. If the supply circuit break is not visible and clearly identified, the circuit shall be grounded. If the ground connection is not within sight of the Work area, the ground connection shall be locked and tagged out before proceeding with the Work.
 - d. Oil switches are observed "open" in a sight window and locked and tagged out "open," or fuse carrier is removed in oil fuse cutouts and locked and tagged out "open."
5. Use of Red Safety Tags
 - a. For protection of personnel working on circuits, safety tags shall be filled out and attached to any opened switch or equipment.
 - b. Safety tags shall be removed only the by the Port of Seattle employee who placed the tag, or by another Port of Seattle employee who has been authorized to remove the tag in writing by the employee who placed the tag. The Port of Seattle Maintenance Electrical Systems Manager or his designated representative may authorize removal of a safety tag placed by an employee who is not available to remove the tag at the time of need only after carefully checking that the circuit is ready to be energized.
 - c. Equipment with a safety tag attached shall not be operated, and connections with a safety tag attached shall not be changed.
6. Insulated cables, operated at over 300 volts to ground, shall be handled when energized only with rubber gloves tested to 22,000 volts by a Washington State approved testing laboratory.
7. Insulated cables that have been in operation shall be cut only with grounded cable shears, or shall be grounded by driving a grounded sharp tool through the shielding and the conductors before cutting.

8. All personnel working around energized electrical equipment shall comply with NFPA 70 E per equipment labels. If no label is present personnel shall wear standard insulated, non-conducting hard hats and shall wear fire retardant garments with no metallic zipper fasteners.
 9. Ladders used in any electrical Work shall be of wood or fiberglass construction.
 10. All panelboards, junction boxes, electrical devices and other similar equipment which is being worked on and which have exposed live wires, bus bars, or terminals operating above 50 volts shall be covered adequately for the voltage with an electrical insulating material and labeled with a "Caution" sign when Contractor personnel are not present. The Caution sign shall advise that exposed electrical parts are behind the temporary protective cover.
 11. Contractors engaged on Port of Seattle projects or working on Port of Seattle property shall be governed by Port of Seattle rules. The Contractor shall place their lock and tag only after Port of Seattle Electric Shop or designee has placed a lock and tag. The Contractor shall designate a supervisor for all contract personnel and operations. This supervisor shall be on the job whenever contract operations are in progress.
- E. Comply with the following procedures for medium-voltage manhole access:
1. Contact Port Electrical Shop at (206) 787-5311 prior to entering any manhole.
 2. All switching of the medium-voltage system must be approved in advance and coordinated through the Electrical Shop.
 3. Schedule requests for Electrical Shop assistance a minimum of seven (7) days in advance.
 4. Comply with Port of Seattle Construction Health & Safety Manual Confined Space Entry Program, lock and tag out procedures, and all other applicable State safety requirements.
 5. Complete a confined space entry permit for each entry. Submit to the Engineer.
 6. Ventilate and monitor the confined space. A top man is required at all times.
 7. Complete lock and tag out once line clearance has been given, and attach locks and tags to any opened switch or equipment. Submit tags to Electrical Shop upon completion of the Work.
 8. Provide effective barriers to prevent others from falling into the open vault. Close and secure vaults when not attended.
 9. Comply with Port of Seattle and State requirements for highway signage, flagging, and re-routing traffic. (Refer to Section 01 55 26 - Traffic Control.)
- F. Before entry is made into energized electrical cable vaults or manholes, an infrared tester shall be used to scan the cables and connector components. If a temperature difference of 10 degrees Fahrenheit is detected between the cable and connector components, or any reading greater than 140 degrees Fahrenheit is

detected from the cables or components the entry shall not be made! The Contractor shall notify the Engineer and the POS Electrical Shop.

1.10 ELECTRICAL SERVICE

- A. Temporary Electrical Construction Service: Comply with Section 01 50 00 - Temporary Facilities and Controls.
- B. Continuity of Service: Provide temporary service to existing systems as required to maintain continuous operation without reducing equipment efficiency. Coordinate the extent of temporary services with the Engineer.
- C. Power Outages: Outages shall be kept to an absolute minimum. Any essential outages required in the course of construction, whether for temporary services, cutovers, or testing, shall be closely coordinated with the Engineer and shall occur at times approved by the Port.

1.11 DEMOLITION

- A. General: De-energize circuits in demolition areas to ensure a safe condition.
- B. Existing material that is not to be reused or is not requested by the Port to be retained shall be removed from the site and shall become the property of the Contractor for salvage. All materials removed from the site shall be disposed of at facilities licensed for the material.
- C. In areas of where alterations are to be done, existing conduits may be reused, with the approval of the Engineer, in their original location, unless noted otherwise.
 - 1. Wiring that is discovered with damaged or deteriorating insulation shall be replaced with new.
 - 2. No existing conduit or wiring once removed may be reused, unless noted otherwise.
- D. Remove all unused exposed conduit except where located in or above existing construction, which is not being altered and would require removal and replacement of the existing construction.

1.12 ELECTRICAL EQUIPMENT INSTALLATION

- A. Comply with Division 1 General Requirements Sections for environmental regulatory requirements, quality control, construction facilities and temporary controls, traffic control, access control, and signage requirements.
- B. National Electrical Code Compliance: Comply with applicable portions of National Electrical Code as to the type of products used and provisions for electrical power connections.
- C. Underwriters Laboratories acceptance: All material and equipment within the scope of the UL Re-examination service shall be approved by Underwriters Laboratories, Inc. for the purpose for which they are used and shall bear their label.
- D. Cutting and Patching: Provide and coordinate the locations of all openings required in the building construction for installation of the Work.
 - 1. Drill penetrations required through existing concrete slabs or walls with a diamond core drill. In no case shall any structural member be cut.

2. Provide approved sleeves as required for electrical penetrations through floors and walls. Seal all openings around conduits in sleeves with a material of equal fire rating as the surface penetrated.
 3. Obtain written approval from a Structural Engineer licensed in the State of Washington prior to cutting any reinforcing bars.
 4. Provide weekly updated Submittal Log of all penetrations and cuts performed.
- E. Equipment Bases and Fastening: Comply with seismic anchorage and bracing requirements of Section 26 05 48 - Structural Loading Controls for Electrical and Communication Work.
- F. Equipment Accessibility: Comply with applicable codes and install equipment to be accessible for operation, maintenance or repair. Equipment deemed inaccessible shall be reported to the Engineer, and relocated as directed.
- G. Electrical Work Exposed to Weather: Provide weatherproof enclosures and corrosion protection for all ferrous metal portions of electrical Work exposed to weather, including conduit, clamps, supports, and hardware.
1. All galvanized electrical equipment exposed to the weather shall be painted to prevent leaching of zinc into the stormwater system. Paint coating shall be a minimum of 3 mils thick, and application as part of the manufacturing process is preferred over painting in the field.

1.13 PROJECT FINALIZATION

- A. Fully test and adjust all equipment installed under this specification and demonstrate its proper operation.
1. Testing that involves use of instruments other than meggers and volt-ohm meters shall be performed by an independent testing agency according to the requirements of Section 26 08 00 - Acceptance Testing.
- B. Where circuits have been added, removed or relocated on panelboards and switchboards, the Contractor shall provide to the Port as-built panel and switchboard schedules in Port standard excel format. Coordinate submittal of schedules with Port Construction Manager.
- C. Present the Port with Certificate of Inspection from the Authorities Having Jurisdiction upon completion of the Work stating that all Work complies with all applicable Codes and Ordinances.
- D. Comply with Division 1 General Requirements for cleaning, closeout procedures, commissioning, training, operations and maintenance manuals, and record drawings.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.

B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

End of Section

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of “600 Volt or Less Wire and Cable” Work is shown in the Contract Documents. This section includes requirements for insulated copper stranded conductors and associated connections for general power and control use at voltages below 600 volts, for sizes #14 AWG through 750 kcmil.

1.02 GOVERNING CODES, STANDARDS AND REFERENCES

- A. ASTM B3 (American Society for Testing and Materials) – Standard Specification for Soft or Annealed copper Wire
- B. ASTM B8 (American Society for Testing and Materials) – Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
- C. NECA (National Electrical Contractors Association) - National Electrical Installation Standards
- D. ANSI/NEMA WC 70/ICEA S-95-658 – Power Cables Rated 2,000V or Less for the Distribution of Electrical Energy
- E. NFPA 70 (National Fire Protection Association) – National Electrical Code
- F. NETA (International Electrical Testing Association) – Acceptance Testing Specifications
- G. UL 44 (Underwriters Laboratories) – Thermoset-Insulated Wires and Cables
- H. UL 62 (Underwriters Laboratories) – Flexible Cords and Cables
- I. UL 82 (Underwriters Laboratories) – Electric Gardening Appliances
- J. UL 854 (Underwriters Laboratories) – Service-Entrance Cables
- K. UL 1277 (Underwriters Laboratories) – Standard for Electrical Power and Control Tray Cables with Optional Optical-Fiber Members
- L. UL 1685 (Underwriters Laboratories) – Standard for Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables

1.03 SUBMITTALS

- A. Submit materials data in accordance with of Section 01 33 00 - Submittals. Furnish manufacturers’ technical literature, standard details, product specifications, and installation instructions for each type of product.
- B. Submittals shall include the following:
 - 1. Product Data: For each type of product.
 - 2. Field Test Reports: Submit reports on tests required in Part 3.
 - 3. Operations and Maintenance Data: shall comply with requirements specified in Division 1.

1.04 QUALITY ASSURANCE

- A. All wire and cable shall be new and made of copper. No aluminum wire and cable allowed, unless otherwise noted.

- B. Listing and Labeling: Provide wire and cable that are Listed and Labeled as defined in NFPA 70, Article 100 and marked for specific types, sizes, and combinations of conductors and connected items.
 - C. Comply with NFPA 70.
- 1.05 DELIVERY, STORAGE, AND HANDLING
- A. Deliver wire and cables according to NEMA WC 26.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Allied Wire and Cable
 - 2. Brand-Rex Division of Leviton.
 - 3. General Cable: Carol Brand.
 - 4. Southwire Company.
 - 5. Or Approved Equal

2.02 PRODUCTS

- A. Provide wire and cable with conductor material and insulation type as specified in Part 3.
- B. Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.
- C. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for Type THW-2, Type THHN-2-THWN-2, Type XHHW-2, Type UF, Type USE, and Type SO.
- D. Multiconductor Cable: Comply with NEMA WC 70/ICEA S-95-658 for, mineral-insulated, metal-sheathed cable, Type MI, Type SO and, Type USE with ground wire.
- E. Flexible Metal Clad (Type MC) wiring shall be permitted for use on emergency feeders that require a 2-hr fire rating.

2.03 CONNECTORS AND SPLICES

- A. UL listed, factory-fabricated wiring connectors of size, ampacity rating, material, type, and class for application and service indicated. Comply with Project's installation requirements and as specified in Part 3 "Wire and Insulation Applications" Article.
- B. For #14 through #10 AWG wire sizes, provide insulated spring wire connectors or insulated compression connectors.
- C. For #8 AWG wire, use solderless pressure connectors with insulating sleeves.
- D. For #6 AWG and larger cable, use split bolt connectors with manufactured insulation covers or tape sufficient to provide 150% insulation level. As an option, compression connectors are acceptable using compression dies designed for the exact connector being used. Provide insulating sleeves manufactured specifically for the connector being used.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine raceways and building finishes, to receive wire and cable for compliance with requirements for installation tolerances and other conditions affecting performance of wire and cable. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 WIRE AND INSULATION APPLICATIONS

- A. Use THHN/THWN stranded copper for all wet and dry interior locations.
- B. Use XHHW stranded copper for all exterior locations.
- C. Use RHW/USE stranded copper for all underground lighting applications.
- D. Service Entrance: Type SE or Type USE multiconductor cable.
- E. Exposed Feeders: SE, USE sunlight exposed rated conductors.
- F. Grounding conductors: #6 AWG and larger shall be stranded copper, bare soft drawn. #8 and smaller shall be stranded copper with green insulation.
- G. Provide plenum and/or tray rated cable where required by the application.
- H. NO ALUMINUM WIRE ALLOWED.
- I. Provide lead-free jacketing and/or insulation where available.

3.03 INSTALLATION

- A. Remove existing wire from raceway before pulling in new wire and cable.
- B. Install wire and cable as indicated and according to manufacturer's recommendations. Use NECA's "National Electrical Installation Standards" where applicable.
- C. As standard practice, route control conductors in separate raceways from power conductors. When dictated in contract document, control conductors may be routed in power raceway under the following conditions:
 - 1. All conductor insulation shall have a voltage rating for the highest voltage in the raceway.
 - 2. The largest power conductor in the raceway is #4 or smaller.
- D. Pull Conductors: Use manufacturer-approved pulling compound or lubricant where necessary. Compound used must not deteriorate conductors or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- E. Use pulling means including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.
- F. For parallel conductors of a single phase, insure that conductor lengths are equal by actual length comparison before installation.
- G. Minimum conductor size for lighting and power circuits shall be #12 AWG, and for control circuits #14 AWG.

- H. Provide dedicated neutrals for branch circuits. Shared neutrals shall not be allowed.
- I. Provide separate raceways for 480/277V feeders/circuits and 208/120V feeders/circuits.
- J. Provide phase testing for proper rotation of all motors.
- K. All cables shall have their ends protected during installation.
- L. Support cables according to Section 26 05 29 - Hangers and Supports for Electrical Systems.
- M. Seal around cables penetrating fire-rated elements according to Division 7 Thermal and Moisture Protection, Section 07 84 00 - Firestopping.
- N. Restricted Conductors: Contractors in possession of aluminum conductors or solid copper conductors in their vehicles, storage or work areas may be removed from the site until such material is no longer on the premises.

3.04 CONNECTIONS

- A. Splices in raceways are not allowed. Splice only in junction or outlet boxes in accessible locations.
- B. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B (per the National Electrical Code Handbook Article 110.14).
 - 1. For bolted connections in equipment, mark lugs after torquing with red paint such that paint will be visibly disturbed if lugs are disturbed. Use copper lugs only on main circuit breakers and feeder breakers. No CU/AL lugs allowed.
- C. Connect outlets and components to wiring and to ground as indicated and instructed by manufacturer.
- D. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- E. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.05 COLOR CODING AND PHASING

- A. Provide colored insulation for wires #4 AWG or smaller.
- B. Color code conductors for all feeders as indicated in subparagraphs below. Provide a 2" wide minimum band of colored plastic tape, at terminations when colored insulation is not available. Tape shall be UL listed, flame retardant, with a maximum temperature withstand of at least 220°F, UV resistant, all weather vinyl plastic tape manufactured specifically for the purpose of electrical conductor identification.

1. 480Y/277-Volt, 3-phase, 4-wire systems:

Phase A (left or top)	Brown
Phase B (center)	Orange
Phase C (right or bottom)	Yellow
Neutral	Gray
Ground	Green
Travelers	Pink

2. 208Y/120-Volt, 3-phase, 4-wire systems:

Phase A (left or top)	Black
Phase B (center)	Red
Phase C (right or bottom)	Blue
Neutral	White
Ground	Green
Isolated ground	Green with yellow or orange stripe
Travelers	Pink

3. 120/240-Volt, 1-phase, 3-wire systems (non-standard):

Phase A	Black
Phase B	Red
Neutral	White
Ground	Green

4. 575V, 3-phase, 4-wire systems:

Phase A (left or top):	Brown with purple stripe
Phase B (center):	Orange with purple stripe
Phase C (right or bottom):	Yellow with purple stripe
Neutral:	Gray with purple stripe
Ground	Green

5. For 240-volt delta systems (obsolete) the color of the high leg (approximately 200-Volts to ground) shall be red. Label the interior of panel as follows:

- a. "CAUTION - HIGH LEG (RED) IS OVER 120V TO GROUND. DO NOT USE HIGH LEG FOR 120V CIRCUITS"

- C. Control system color coding:

120 VAC Control	Red
120 VAC Control Neutral	White
DC Control (+)	Blue
DC Control (-)	Blue/White
Ground	Green

3.06 IDENTIFICATION

- A. Identify wires and cables according to Section 26 05 53 - Electrical Identification.
- B. Provide wire markers on each conductor in pull boxes, junction boxes and at all load connections.

3.07 FIELD QUALITY CONTROL

- A. Coordinate installation and final testing with the Engineer.
- B. Wire and Cable Tests: Test feeder and control circuits before they are placed in service.
1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA Standard ATS, Section 7.3.2. Certify compliance with test parameters.
2. 600-Volt Power Cable: Perform a continuity test for all cables. Megger testing for one half minute is required for all 600-volt insulated wire #2 AWG and larger using a 500-volt megger for 208- and 240-volt systems, and a 1000-volt megger for 480-volt systems. Test between phase

conductors and from each conductor to ground before energizing service equipment, switchgear, switchboards, MCC's (including all connected motors) and panelboards. Determine the values with cable disconnected at both ends. Megger wire and cable only after installation, not on the cable reel. Replace cables that do not meet Port insulation resistance requirements.

- a. Provide phasing tests:
 - (1) Test and make all changes necessary to assure proper rotation of all motors.
 - (2) Correct phasing and phase sequence of all circuits susceptible to being paralleled.
 - (3) Perform other such phasing tests as may be required for the equipment being connected under this Contract.
 - b. Using a volt/ohm meter, test all power conductors below #2 AWG for possible continuity to ground.
3. Check all control wiring for tightness of terminal contacts and continuity (especially current transformer leads) through each "run" of control circuiting. Thoroughly verify all wiring by means of battery-powered lights, buzzers, bells, or telephones. After completing these continuity checks and tests on a given control circuit, attach a temporary cardboard tag on each end of cable tested which bears the date and name of Contractor's representative responsible for checking. Follow this procedure for each control circuit cable.
 4. Correct deficiencies and retest to demonstrate compliance.
 5. Record test information for all cables tested, and provide Engineer with a copy.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.

B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the

Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

End of Section

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of “Grounding and Bonding for Electrical Systems” Work is shown in the Contract Documents. This section includes grounding of electrical systems and equipment. Grounding requirements specified in this section may be supplemented by special requirements of systems described in other Sections.

1.02 GOVERNING CODES, STANDARDS AND REFERENCES

- A. American Welding Society (AWS)
 - 1. AWS A3.0 - Standard Welding Terms and Definitions
 - 2. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding
 - 3. AWS B2.1 - Specification for Welding Procedure and Performance Qualification
- B. American Society for Testing and Materials (ASTM)
 - 1. B3 - Standard Specification for Soft or Annealed Copper Wire.
 - 2. B8 - Standard Specification for Concentric-Lay-Stranded Copper conductors, Hard, Medium-Hard, or Soft.
 - 3. B187 - Standard Specification for Copper, Bus Bar, Rod and Shapes and General Purpose Rod, Bar and Shapes.
- C. Institute of Electrical and Electronics Engineers (IEEE)
 - 1. IEEE 81 - Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.
 - 2. IEEE C2 - National Electrical Safety Code.
- D. National Electrical Manufacturers Association (NEMA)
 - 1. ANSI/NEMA GR 1 – Grounding Rod Electrodes and Grounding Rod Electrode Couplings.
- E. National Fire Protection Association (NFPA) -
 - 1. NFPA 70 National Electrical Code.
 - 2. ANSI/NFPA 780 - Standard for the Installation of Lightning Protection Systems.
- F. MIL-STD-889 Dissimilar Metals
- G. Underwriters Laboratories (UL)
 - 1. UL 467 - UL Standard for Safety Grounding and Bonding Equipment
 - 2. UL 546 – UL Outline of Investigation for Conductor Termination Compounds
 - 3. ANSI/UL 96 - Lightning Protection Components.
 - 4. ANSI/UL 467 - Grounding and Bonding Equipment.

1.03 SUBMITTALS

- A. Submit materials data in accordance with of Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, calibration reports, and installation instructions for all products.
- B. Submittals shall include the following:
 - 1. Submit product data for the following:
 - a. Grounding conductors and cables.
 - b. Grounding connectors.
 - c. Grounding electrodes.
 - d. Ground bus.
 - e. Test wells.
 - f. Exothermic weld kit.
 - 2. Grounding plans and calculations for Contractor's designed ground system.
 - 3. Submittal log of locations where Contractor will bond grounding conductors to structural steel.
 - 4. Field Test Reports: Submit written test reports to include the following:
 - a. Test procedures used.
 - b. Test Equipment product data and calibration certification
 - c. Test results that comply with requirements.
 - d. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
 - e. Soil types and conditions where ground tests were performed.
 - 5. As-Built Data: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article, including the following:
 - a. Test wells.
 - b. Ground rods.
 - c. Ground rings.
 - d. Grounding arrangements and connections for separately derived systems.

1.04 QUALITY ASSURANCE

- A. Listing and Labeling: Provide electrical components, devices, and accessories that are Listed and Labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to the Authority Having Jurisdiction, and marked for specific types, sizes, and combinations of conductors and connected items.
- B. Testing Agency Qualifications: Member company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.
- C. Comply with IEEE 837 and UL 467.
- D. Comply with IEEE Std. 142 (Green Book).

- E. Comply with NFPA 70.
- F. Comply with IEEE C2 for overhead-line construction and medium-voltage underground construction.
- G. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Grounding Conductor Fittings:
 - a. nVent Erico
 - b. Chance/Hubbell.
 - c. Copperweld.
 - d. Burndy Electrical; Division of Hubbell.
 - e. Ideal Industries, Inc.
 - f. ILSCO.
 - g. Kearney/Cooper Power Systems.
 - h. Lyncole XIT Grounding; Division of VFC.
 - i. O-Z/Gedney Co.
 - j. Raco; Division of Hubbell.
 - k. Thomas & Betts, Electrical; Division of ABB.
 - l. Or Approved Equal.
 - 2. Grounding Connectors and Rods:
 - a. Harger
 - b. Galvan Electrical
 - c. nVent Erico.
 - d. ILSCO.
 - e. Lyncole XIT Grounding; Division of VFC.
 - f. O-Z/Gedney.
 - g. Raco, Inc.; Division of Hubbell.
 - h. Thomas & Betts; Division of ABB.
 - i. Or Approved Equal.
 - 3. Ground Bars
 - a. Harger GBI series.
 - b. Erico EGBA series.
 - c. Or Approved Equal.

2.02 GROUNDING CONDUCTORS

- A. For insulated conductors, comply with Section 26 05 19 - 600 Volt or Less Wire and Cable.
- B. Material: Stranded Copper. ASTM B 8
- C. Equipment Grounding Conductors: Insulated with green-colored insulation in sizes available.
- D. Isolated Ground Conductors: Insulated with green-colored insulation with yellow stripe. On feeders with isolated ground, use colored tape, alternating bands of green and yellow tape to provide a minimum of three bands of green and two bands of yellow.
- E. Grounding Electrode Conductors: Stranded cable.
- F. Underground Conductors: Bare, tinned, stranded, except as otherwise indicated.
- G. Bare Copper Conductors: Assembly of stranded conductors, ASTM B8.
- H. Copper Bonding Conductors:
 - 1. Bonding Conductor: #4 or #6 AWG, stranded copper conductor, sized per drawings.
 - 2. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
 - 3. Provide two inch band of green plastic marking tape at each termination.
- I. Bonding Straps: Soft copper.

2.03 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to Authority Having Jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Exothermic Welds: Ensure the molds, materials and powder charges used to make exothermic welds are the standard product of a single manufacturer and listed by the manufacturer for use on the specific type, size, quantity and configuration of conductors to which the weld is applied.
- C. Irreversible Compression Lugs: Provide irreversible compression lug type connectors manufactured from tin-plated copper and installed using a hydraulic compression tool and die to apply correct, uniformly distributed, circumferential pressure. Ensure tools and dies are as recommended by the irreversible compression lug type connector manufacturer. Use an embossing die code or other standard method to provide visible indication that a connector has been adequately compressed onto the conductor. Apply irreversible compression lug type connectors in strict accordance with the manufacturer's written instructions and published installation instructions. Use 2-hole lug type connectors for connections to NEMA cable pads and bus bars, and single-hole connectors otherwise.
- D. Mechanical: Provide split bolt and clamp style mechanical type connectors manufactured from copper listed by the manufacturer as suitable for direct burial use. Ensure mechanical type connectors are applied in strict accordance with the manufacturer's published installation instructions.

- E. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2.04 GROUNDING ELECTRODES

- A. Ground Rods: Solid copper clad steel, 3/4-inch diameter by 10-feet length.
- B. Plate Electrodes: Copper, 0.10 inch thick minimum.

2.05 GROUND BUS

- A. Ground bus: predrilled rectangular bars of annealed copper, 1/4 inch x 4 inches in cross section and 12" long with 9/32-inch holes spaced 1-1/8 inches apart arranged to allow for two-point termination of ground lugs. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V. Size and location as shown on drawings.

PART 3 EXECUTION

3.01 APPLICATION

- A. Comply with NEC Article 250
 - 1. Provide grounding system as required to obtain the resistance noted in NEC Article 250-56 as a minimum.
- B. Copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone and similar materials.
- C. In raceways, use insulated equipment grounding conductors.
- D. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections.
- E. Irreversible Compression Lugs/Mechanical Connections: Use for exposed connections inside manholes and test wells.
- F. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.
- G. Ground Rod Clamps at Manholes: Use bolted pressure clamps with at least two bolts.
- H. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Use insulated spacer; space 1 inch from wall and support from wall 6 inches above finished floor, unless otherwise indicated.
- I. Underground Grounding Conductors: Install bare stranded copper conductor, size as indicated on drawings.
 - 1. Copper conductor, #2/0 AWG minimum. Bury per NEC minimum depth requirements or project drawings whichever is more stringent. .
 - 2. Ductbank Ground Conductors: Install a #4/0 AWG bare copper conductor embedded in concrete of each medium voltage ductbank. To avoid sag during install secure conductor to rebar cage. Provide a ground conductor with each medium voltage feeder circuit sized per the NEC.

3.02 EQUIPMENT GROUNDING CONDUCTORS

- A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.
- B. Install equipment grounding conductors in raceways with all feeders and branch circuits unless otherwise noted.
- C. Provide an exterior personal safety ground bus bar on the back side of all medium voltage switchgear.
- D. Busway Supply Circuits: Install insulated equipment grounding conductor from the grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
- E. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal.
 - 1. Isolate grounding conductor from raceway and from panelboard grounding terminals.
 - 2. Terminate at equipment grounding conductor terminal of the applicable derived system or service.
- F. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for data cables.
- G. Air-Duct Equipment Circuits: Install an insulated equipment grounding conductor to duct-mounted electrical devices operating at 120V and higher, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- H. Water Heater, Heat-Tracing, and Anti-frost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater, heat-tracing, and anti-frost heating cable. Bond conductor to heater units, piping, connected equipment, and components.
- I. Signal and Communication Systems: For alarm, voice and data, and other communication systems, provide #4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, cable tray and central equipment location. All segments of cable tray shall be bonded together with ground conductor or flexible ground straps.
 - 1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4 inch x 4 inch x 12 inch grounding bus.
 - 2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
- J. Metal Poles Supporting Outdoor Lighting Fixtures: Provide a grounding electrode in addition to installing a separate insulated equipment grounding conductor with supply branch-circuit conductors. Reference Section 26 56 00 - Exterior Lighting.

3.03 BUILDING PERIMETER GROUND

- A. Ground the steel framework of buildings with a driven ground rod at the base of every corner column and at intermediate exterior columns at distances not more than 60 feet apart, or not to exceed 10 ohms.
- B. Provide a perimeter grounding conductor (counterpoise), electrically connected to each ground rod and to each steel column, extending around the perimeter of the building. Bury counterpoise per current NEC requirements or 30 inches below grade and 24 inches from building foundation whichever is more stringent. Install tinned-copper conductor not less than No.2/0AWG for ground ring and for taps to building steel.

3.04 INSTALLATION

- A. Ground Rods: Drive ground rods until tops are 2 inches below finished floor or final grade. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except as otherwise indicated. Make connections without exposing steel or damaging copper coating.
- B. Grounding Conductors: Route along shortest and straightest paths possible. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- C. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment.
 - 1. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp.
 - 2. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts.
 - 3. Install straps only in locations accessible for maintenance.
- D. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding clamp connectors.
- E. Gas Piping: Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- F. Metallic Fence and Railing: Comply with the requirements of IEEE C2, current edition.
 - 1. Comply with details shown on the contract drawings.
 - 2. Metal fences around electrical equipment shall be bonded to the ground system with touch potential compliant with NESC.
 - 3. Grounding conductor shall be bare copper not less than 8 AWG.
 - 4. Gates shall be bonded to grounding conductor with flexible bonding jumper.
 - 5. Barbed wire shall be bonded to the grounding conductor.
- G. Bollards: Bond bollards to ground system per details shown on the contract drawings.

3.05 CONNECTIONS

- A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
 - 1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
 - 2. Make connections with clean, bare metal at points of contact.
 - 3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
 - 4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
 - 5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
 - 6. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values.
- B. Exothermic-Welded Connections: Weld using the exothermic process with procedures conforming to AWS A3.0M/A3.0, AWS B2.1/B2.1M, and manufacturer's recommendation. Where dissimilar metals are to be joined via exothermic weld, follow the weld kit manufacturer's recommendations and published instructions. Ensure connections between dissimilar metals do not produce galvanic action in accordance with MIL-STD-889. Use welding processes of the exothermic fusion type that makes a connection without corroding or loosening. Ensure process joins all strands and does not cause the parts to be damaged or weakened. Completed connection or joint is equal or larger in size than the conductors joined and has the same current-carrying capacity as the largest conductor
- C. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on the grounding conductor.
- D. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.
- E. Equipment Grounding Conductor Terminations: For #8 AWG and larger, use pressure-type grounding lugs. #10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.
- F. Non-contact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Provide flexible grounding strap mounted to raceway exterior where raceway crosses a seismic joint.
 - 1. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing.
 - 2. Bond electrically non-continuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

- G. Connections at Ground Rods
 - 1. Exposed: Mechanical Type Connection
 - 2. Buried: Exothermic Welded Connection
- H. Connections at Test Wells: Use compression-type connectors on conductors and make bolted- and clamped-type connections between conductors and ground rods.

3.06 UNDERGROUND DISTRIBUTION SYSTEM GROUNDING

- A. Ductbanks: Install a #4/0 AWG bare copper system grounding conductor embedded in the concrete of each medium-voltage ductbank. To avoid sagging during concrete pour, tie copper ground conductor to rebar with wire ties.
 - 1. Provide a ground conductor with each medium-voltage feeder circuit sized per NEC.
- B. Ground Vaults, Manholes, Handholes and Pull boxes in accordance with Section 26 05 43 - Underground Ducts and Raceways for Electrical Systems.
 - 1. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, non-shrink grout.
- C. Connections to Vault and Manhole Components: Connect all exposed-metal parts, such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or vault to ground loop conductors.
 - 1. Make connections with #2 AWG minimum, stranded, hard-drawn copper conductor.
 - 2. Train conductors level or plumb around corners and fasten to vault or manhole walls.
 - 3. Make connection to cable shield as recommended by manufacturer of splicing and termination kits.
 - 4. Connect continuous ground cable in duct bank and equipment grounding conductor in each conduit to ground loop.
- D. Pad-Mounted Transformers and Equipment: Install four ground rods and Ground Ring circling pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install copper conductor not less than #2 AWG for counterpoise and for taps to equipment ground pad. Bury counterpoise not less than NEC minimum distance below grade and 6 inches from the foundation.

3.07 IDENTIFICATION

- A. Identify grounding system components as required by the Authority Having Jurisdiction and as specified in Section 26 05 53 - Electrical Identification.

3.08 FIELD QUALITY CONTROL

- A. All ground system tests shall be performed in the presence of the Resident Engineer.

- B. Test and inspect grounding systems in accordance with NETA Standard ATS, Section 7.13.
- C. Measure ground resistance no fewer than two full days after last trace of precipitation and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
- D. Test Requirements:
 - 1. Equipment Rated 500 kVA and Less: 10 ohms.
 - 2. Equipment Rated 500 to 1000 kVA: 5 ohms.
 - 3. Equipment Rated More Than 1000 kVA: 2 ohms.
 - 4. Power Distribution Units or Panelboards Serving Electronic Equipment: 2 ohms.
 - 5. Substations, substation manholes, and Pad-Mounted Switching Equipment: 1 ohms.
 - 6. Manhole Grounds: 10 ohms.
- E. Excessive Ground Resistance: If resistance to ground exceeds specified values at any single ground location and as a collective ground system, notify Resident Engineer promptly and include recommendations to reduce ground resistance.
 - 1. Record test results. Provide bi-weekly Ground Resistance Test Report results to Resident Engineer.
- F. Provide drawings locating each ground rod and ground rod assembly and other grounding electrodes.
 - 1. Identify each ground rod by letter in alphabetical order, and key to the record of tests and observations.
 - 2. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontrator (of any tier) or Supplier.
- B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of “Hangers and Supports for Electrical Systems” Work is shown in the Contract Documents. This Section includes the following:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.
- B. Definitions
 - 1. EMT: Electrical metallic tubing.
 - 2. IMC: Intermediate metal conduit.
 - 3. RMC: Rigid metal conduit.

1.02 GOVERNING CODES, STANDARDS, AND REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.
 - 1. ASTM (American Society for Testing and Materials)
 - a. ASTM A325 – Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
 - b. ASTM A36/A36M – Carbon Structural Steel
 - c. ASTM A780 – Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
 - d. ASTM A1011/A1011M – Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
 - 2. AWS (American Welding Society)
 - a. AWS D1.1/D1.1M – Structural Welding Code – Steel
 - 3. MSS (Manufacturers Standardization Society of the Valve and Fittings Industry)
 - a. MSS SP-58 Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application and Installation
 - 4. MFMA (Metal Framing Manufacturers Association)
 - a. MFMA-4 Metal Framing Standards Publication
 - 5. NECA (National Electrical Contractors Association)
 - a. NECA 1 – Standard Practice of Good Workmanship in Electrical Construction
 - b. NECA 101 – Standard for Installing Steel Conduits (Rigid, IMC, EMT)
 - 6. NFPA (National Fire Protection Association)

- a. NFPA 70 (National Fire Protection Association) – National Electrical Code
- 7. OSHA (Occupational Safety & Health Administration)
 - a. OSHA 29 CFR 1910.7 – Occupational Safety and Health Standards – Definition and requirements for a nationally recognized testing laboratory
- 8. SSPC (The Society for Protective Coatings)
 - a. SSPC-PA 1 – Shop, Field, and Maintenance Painting of Steel

1.03 SUBMITTALS

- A. Submit materials data in accordance with Section 01 33 00 – Submittals. Furnish manufacturer's technical literature, standard details, project specifications, and installation instructions for all products.
- B. Submittals shall include the following:
 - 1. Product Data: For the following:
 - a. Steel slotted support systems.
 - b. Nonmetallic slotted support systems.
 - 2. Shop Drawings: Signed and sealed by a qualified Professional Engineer registered in the State of Washington. Show fabrication and installation details and include calculations for the following:
 - a. Trapeze hangers. Include Product Data for components.
 - b. Steel slotted channel systems. Include Product Data for components.
 - c. Nonmetallic slotted channel systems. Include Product Data for components.
 - d. Equipment supports.
 - 3. Field quality-control reports.

1.04 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory as defined by OSHA in 29 CFR 1910.7 and that is acceptable to authority having jurisdiction.
- B. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Comply with NFPA 70.

1.05 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together in Division 3 Concrete.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

1.06 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- C. Wind-Restraint Loading:
 - 1. Basic Wind Speed: 85mph.
 - 2. Building Classification Category: [I] [II] [III] [IV], depending on project parameters

PART 2 PRODUCTS

2.01 SUPPORT ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper B-Line, Inc.
 - 2. ERICO International Corporation.
 - 3. Thomas & Betts Corporation.
 - 4. Unistrut; Atkore International.
 - 5. G-Strut; Gregory Industries.
 - 6. Or Approved Equal.
- B. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 1. 1-5/8 inch x 1-5/8 inch cross section.
 - 2. Formed from 0.1046 inch thick steel.
 - 3. Slots at maximum of 2 inches on center in webs, and flange edges turned toward web.
 - 4. Materials: ASTM A1011/A1011M, Grade 33
 - 5. Finish: Baked, rust inhibiting, acrylic enamel paint applied after cleaning and phosphate treatment, unless otherwise indicated.
 - 6. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 - 7. Channel Dimensions: Selected for applicable load criteria.
- C. Nonmetallic Slotted Support Systems: Structural grade, factory formed, glass-fiber-resin channels and angels with 9/16-inch diameter holes at a maximum of 8 inches o.c., in at least 1 surface.
 - 1. Fittings and Accessories: Products of channel and angles manufacturer, designed for use with those items and of the same materials.
 - 2. Rated Strength: selected to suit applicable load criteria.

- D. Raceway and Cable Supports: As described in NECA 1 and NECA 101. All raceway and cable supports for both interior and exterior applications shall be galvanized.
- E. Conduit Support Devices: Galvanized steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- F. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of 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 supported. Body shall be malleable iron.
- G. Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.
- H. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - 1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - 2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened Portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - (1) Cooper B-Line, Inc.
 - (2) Empire Tool and Manufacturing Co., Inc.
 - (3) Hilti, Inc.
 - (4) ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - (5) MKT Fastening, LLC.
 - (6) Or Approved Equal
 - 3. Clip type conduit fasteners are NOT allowed. All fasteners and clamps for conduit raceway support shall use mechanical bolted type hardware.
 - 4. Concrete Inserts: Steel or malleable-iron, slotted support system units; complying with MFMA-4 or MSS SP-58.
 - 5. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 - 6. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A325.
 - 7. Toggle Bolts: All-steel springhead type.
 - 8. Hanger Rods: Threaded galvanized steel.

2.02 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: All raceway, box and cable supports shall be galvanized steel.

PART 3 EXECUTION

3.01 GENERAL

- A. Coordinate concrete bases with building structural system

3.02 APPLICATION

- A. Locations:
 - 1. Indoor Dry Locations: Steel, zinc plated materials.
 - 2. Outdoors and Damp Locations: Galvanized steel products.
 - 3. Corrosive Locations: Stainless Steel.
- B. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- C. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT and RMC as required by NFPA 70. Minimum rod size shall be 3/8 inch in diameter.
- D. Multiple Raceways or Cables: Install trapeze-type supports fabricated with 3/8 in rod minimum and 1-5/8 inch square preformed steel slotted channel support system, sized so conduit capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with two-bolt conduit clamps approved for application by an agency acceptable to the authority having jurisdiction.
- E. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future loads within specified loading limits.

3.03 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified by applicable Engineer of Record.
- C. Raceways shall not be supported from ducts, pipes or other systems foreign to the electrical installation. The entire electrical installation shall be kept independent from any other trade.
- D. Raceway Support Methods: In addition to methods described in NECA 1, EMT and RMC may be supported by openings through structure members, as permitted in NFPA 70.
 - 1. Raceways shall be supported with heavy-duty on-hole pressed steel straps on interior surfaces.

2. Support pendent mounted raceways on 3/8 inch rod with pear shaped hanger or trapeze type hanger with 3/8 inch rod minimum and 1-5/8 inch square pre-formed channel and pipe clamps.
 3. Parallel surface mounted raceways shall be supported from 1-5/8 inch pre-formed channel and pipe clamps.
 4. Multiple conduit runs shall be grouped and neatly racked on trapeze hangers with spare room for minimum (2) 3/4 inch future conduits.
 5. Refer to Section 26 05 48 - Seismic Controls for Electrical and Communication Work.
- E. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Determination shall be weight of supported components plus 200 lb.
- F. Equipment and Hanger Restraints:
1. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
- G. Install cables so they do not bend across edges of adjacent equipment or building structure.
- H. 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. 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.
 2. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
 3. Attachment to New Concrete: Bolt to channel type concrete inserts or use expansion anchors.
 4. Attachments to Existing Concrete: Use expansion anchors.
 5. Holes for Expansion Anchors in Concrete: Drill at locations and to depths that avoid reinforcing bars.
 6. To Metal Stud Structures: Fasten with sheet metal screw or bolted fasteners.
 7. To Structural Walls or Slabs: Fasten with steel expansion shells and bolts. Provide flush concrete insert for multiple raceway support system.
 8. Structural Steel: Bolt to heavy duty beam clamps on flanges of beams and columns, or on upper truss chords or bar joists.
 9. Architectural Walls or Masonry Walls: Fasten with toggle bolts or molly screws.
 10. Provide flush concrete insert for multiple raceway support system.
 11. Attachments to Wood Structural Members: Install bolts through members.

12. Attachments to Hollow Walls: Bolt to slotted steel channels fastened to wall with expansion anchors.
 - I. Drilled-in Anchors:
 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the Structural Engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
 5. Set anchors to manufacturer's recommended torque using a torque wrench.
 6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.
- 3.04 INSTALLATION OF FABRICATED METAL SUPPORTS
- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
 - B. Field Welding: Comply with AWS D1.1/D1.1M.
- 3.05 CONCRETE BASES
- A. Construct concrete bases of dimensions indicated. Concrete bases must not be less than [4"] larger in both directions than supported unit to insure anchors will be a minimum of 10 bolt diameters from edge of the base.
 - B. Use [3000-psi], 28-day compressive-strength concrete.
 - C. Anchor equipment to concrete base.
 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
- 3.06 ADJUSTING
- A. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.07 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.
- B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of "Raceways and Boxes" Work is shown in the Contract Documents. This section includes raceways, fittings and boxes for electrical wiring.
 - 1. Raceways include the following:
 - a. Rigid Metal Conduit (RMC).
 - b. Electrical Metallic Tubing (EMT).
 - c. Flexible Metal Conduit (FMC).
 - d. Liquidtight Flexible Metal Conduit (LFMC)
 - e. Rigid Nonmetallic Conduit (RNC).
 - f. Metal Wireway.
 - 2. Boxes include the following:
 - a. Device boxes.
 - b. Floor boxes.
 - c. Outlet boxes.
 - d. Pull and junction boxes.

1.02 GOVERNING CODES, STANDARDS AND REFERENCES

- A. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated
- B. ANSI C80.3 - Electrical Metallic Tubing, Zinc Coated
- C. ANSI C80.5 - Rigid Aluminum Conduit
- D. NECA (National Electrical Contractors Association) - National Electrical Installation Standards
- E. NEMA FB 1 (National Electrical Manufacturers Association) - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing (EMT) and Cable.
- F. NEMA OS 1 (National Electrical Manufacturers Association) - Sheet-steel Outlet Boxes, Device Boxes, Covers, and Box Supports
- G. NEMA OS 2 (National Electrical Manufacturers Association) - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports
- H. NEMA TC 3 (National Electrical Manufacturers Association) - PVC Fittings for Use with Rigid PVC Conduit and Tubing
- I. NEMA 250 (National Electrical Manufacturers Association) - Enclosures for Electrical Equipment (1000 Volts Maximum)
- J. NFPA 70 (National Fire Protection Association) - National Electrical Code

1.03 SUBMITTALS

- A. Submit materials data in accordance with of Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.

- B. Submittals shall include the following:
1. Product Data: For surface raceways, Conduit, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
 2. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.
 3. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
 - a. Structural members in paths of conduit groups with common supports.
 - b. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
 4. Qualification Data: for Professional Engineer.
 5. Seismic Qualification Certificates: For enclosures, cabinets, and conduit racks and their mounting provisions, including internal components, from manufactures.
 - a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - b. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
 - c. Detailed description of conduit support devices and interconnections on which the certification is based and their installation requirements.

1.04 QUALITY ASSURANCE

- A. Listing and Labeling: Provide raceway and boxes that are 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 for the location and environment in which they are installed.
- B. Comply with NECA's "National Electrical Installation Standards."
- C. Comply with NFPA 70, as adopted and administered by the Authority Having Jurisdiction.

1.05 COORDINATION

- A. Raceway and boxes are shown on drawings in approximate locations unless dimensioned. Locate raceway and boxes as shown and at other locations where required for splices, taps, wire pulling, equipment connections, and compliance with regulatory requirements. Coordinate layout and installation of raceways and boxes with other construction elements to ensure adequate headroom, working clearance, and access, and to complete the wiring system.
- B. Galvanized electrical equipment installed exposed outdoors shall be painted with a minimum 3 mil coating of paint to prevent zinc runoff to the stormwater system. Paint application by manufacturer is preferred to field painting for coverage and quality.

PART 2 PRODUCTS

2.01 METAL CONDUIT AND TUBING

- A. Rigid Steel Conduit (RMC): ANSI C80.1.
- B. Rigid Aluminum Conduit (RMC): ANSI C80.5. For use with 400Hz systems only.
- C. Electrical Metallic Tubing (EMT): ANSI C80.3.
- D. Intermediate Metallic Conduit (IMC) is not allowed.
- E. Flexible Metal Conduit (FMC): Zinc-coated non-reduced wall steel.
- F. Liquidtight Flexible Metal Conduit (LFMC): Flexible steel conduit with PVC jacket.
- G. Fittings: NEMA FB 1; compatible with conduit/tubing materials.
 - 1. Fittings for EMT: Steel Compression type. Setscrew type is not allowed.

2.02 NONMETALLIC CONDUIT AND TUBING

- A. Rigid Nonmetallic Conduit (RNC/PVC): NEMA TC 2, Schedule 40 or 80 PVC.
- B. RNC Fittings: NEMA TC 3; match to conduit or conduit/tubing type and material.

2.03 METAL WIREWAYS

- A. Material: Sheet metal size and shape as indicated on drawings. Comply with UL 870 and NEMA 250, Type 1 unless otherwise indicated.
 - 1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70 (NEC).
- 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 a complete system.
- C. Select features, where not indicated, as required to complete wiring system and to comply with NFPA 70 (NEC).
- D. Wireway Covers: Hinged type.
- E. Finish: Manufacturer's standard enamel finish, ANSI 61 gray color.

2.04 NONMETALLIC WIREWAYS

- A. Description: PVC plastic extruded and fabricated to size and shape indicated, with snap-on cover and mechanically coupled connections using plastic fasteners.
- 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 a complete system.
- C. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70 (NEC).

2.05 SURFACE RACEWAYS

- A. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Finish with manufacturer's standard rust inhibiting prime coating and standard enamel finish in color selected by Architect.

- B. Surface Nonmetallic Raceways: 2-piece construction, complying with UL 5A, manufactured of rigid PVC compound with matte texture and manufacturer's standard enamel finish in color selected by Architect.
- C. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways.

2.06 OUTLET AND DEVICE BOXES

- A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover and threaded hubs.
- D. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- E. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb. shall be listed and marked for the maximum allowable weight.
- F. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- G. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.

2.07 FLOOR BOXES

- A. Metal Floor Boxes – for new concrete floors:
 - 1. Material: Cast metal.
 - 2. Type: Fully adjustable.
 - 3. Shape: Rectangular.
 - 4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70 (NEC), by a qualified testing agency, and marked for intended location and application.

2.08 PULL AND JUNCTION BOXES

- A. Small Sheet Metal Boxes: NEMA OS 1, galvanized steel.
- B. Cast-Metal Boxes: NEMA FB 1, cast aluminum with gasketed cover, ground flange and stainless steel cover screws.
- C. Sheet Steel Gauge Requirements (Any Direction):
 - 1. Less than 24": 14 USS gauge.
 - 2. 24" to 36": 12 USS gauge.
 - 3. 36" or larger: 10 USS gauge.

2.09 ENCLOSURES AND CABINETS

- A. Hinged 110° Swing Opening Cover Enclosures:
 - 1. Comply with UL 50 and NEMA 250, Type 1 for interior applications and NEMA 3R, 4 or 4X for exterior applications or as indicated in contract documents.

2. For pullboxes and enclosures larger than 24" x 24":
 - a. Indoor: cover shall have continuous hinge with flush latch unless otherwise indicated. 110° swing opening.
 - b. Outdoor: cover shall have three-point hinge with flush latch.
- B. Cabinets:
 1. NEMA 250, Type 3R, 4X or 12 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 2. Hinged door in front cover with flush latch and concealed hinge.
 3. Key latch to match panelboards.
 4. Metal barriers to separate wiring of different systems and voltage.
- C. Panelboard Enclosures: Panelboard enclosure criteria are addressed separately. Refer to Criteria Section 26 24 16 - Panelboards.
- D. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
- E. Interior Panels: Steel; all sides finished with manufacturer's standard enamel [for with radio-frequency paint].

2.10 TERMINAL BLOCKS

- A. Minimum 600-volt rating for 480-volt circuits
- B. Clamp or screw terminals sized for maximum conductor size
- C. Separate connection point for each conductor
- D. 10% spare terminal points
- E. Individual identification for each terminal block
- F. Phenolic block separators or barriers shall be used to isolate low-voltage and control terminations from analog and DC circuits.

2.11 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

- A. Description:
 1. General Requirements for Handholes and Boxes:
 - a. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70 (NEC), for intended location and application.
 - b. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70 (NEC), by a qualified testing agency, and marked for intended location and application.
 - c. Comply with handhole requirements in Section 26 05 43 Underground Ducts and Manholes.
 2. Fiberglass Handholes and Boxes: Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with frame and covers of reinforced concrete or cast iron.

- a. Standard: Comply with SCTE 77.
 - b. Color of Frame and Cover: Gray.
 - c. Configuration: Designed for flush burial with closed bottom unless otherwise indicated.
 - d. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
 - e. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - f. Cover Legend: Molded lettering, "ELECTRIC."
 - g. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
 - h. Handholes 18 Inches Wide by 24 Inches Long and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.
3. Manufacturers:
- a. Armorcast Products Company.
 - b. Carson Industries LLC.
 - c. NewBasis.
 - d. Nordic Fiberglass, Inc.
 - e. Oldcastle Precast, Inc.; Christy Concrete Products.
 - f. Quazite: Hubbell Power System, Inc.; Hubbell Power Systems.
 - g. Or Approved Equal.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine surfaces to receive raceways and boxes for compliance with installation tolerances and other conditions affecting performance of raceway installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 EXISTING WORK

- A. Remove exposed abandoned raceway, including abandoned raceway above accessible ceiling finishes. Cut raceway flush with walls and floors and patch surfaces.
- B. Remove concealed abandoned raceway to its source.
- C. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if raceway servicing them is abandoned and removed. Provide blank cover for abandoned outlets which are not removed.
- D. Ensure access to existing boxes and other installations which remain active and which require access. Modify installation or provide access panel as appropriate.

- E. Extend existing raceway and box installations using materials and methods as specified.
- F. Clean and repair existing raceway and boxes which remain or are to be reinstalled.

3.03 WIRING METHODS

- A. Outdoors: Use the following wiring methods:
 - 1. Exposed: Rigid steel conduit (RMC).
 - 2. Concealed: PVC Schedule 40 is the standard for use in rebar reinforced duct banks. Aluminum is excluded. Rigid steel conduit (RMC) shall be used under roadways in non-reinforced duct banks.
 - 3. Underground: See Section 26 05 43 – Underground Ducts and Manholes.
 - 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): Liquidtight flexible metal conduit (LFMC).
 - 5. Boxes: Type shall be as specified in the drawings. NEMA 3R in non-corrosive, non-dusty outdoor locations, NEMA 4 in interior or exterior dusty or dirty locations, NEMA 4X in interior and exterior corrosive locations.
- B. Indoors: Use the following wiring methods:
 - 1. Exposed: Rigid steel conduit (RMC) or electrical metallic tubing (EMT).
 - a. Rigid steel conduit shall be used up to 8 feet above finish floor in traffic areas subject to damage, such as in the conveyor, shop and ramp areas.
 - 2. Concealed: Rigid steel conduit (RMC) or electrical metallic tubing (EMT).
 - a. Use EMT in sizes 1/2" to 1-1/2" only, except larger EMT may be used for communications wiring such as telephone or fire alarm systems.
 - b. Power raceways 2-inches and larger shall be rigid steel conduit.
 - 3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): Flexible metal conduit (FMC), except in wet or damp locations, use liquidtight flexible metal conduit (LFMC).
 - 4. Damp or Wet Locations: Rigid steel conduit (RMC).
 - 5. Boxes: NEMA 250, Type 1, except as follows:
 - a. Damp or Wet Locations: NEMA 250, Type 4, stainless steel.
 - b. Indoor Dusty Locations: NEMA 12
 - c. Damp or Wet and Corrosive Locations: NEMA 250, Type 4X, stainless steel.
 - d. Hazardous Locations: NEMA 250, Type 7.

3.04 INSTALLATION

- A. Install raceways and boxes as indicated, according to manufacturer's written instructions. Use raceway fittings compatible with raceways and suitable for use and location.
- B. Seal all conduits which pass through the building roof, through outside walls of the building above or below grade, and through floor slabs on grade. Seal on the end inside the building using a pliable duct-sealing mastic, non-hardening compound packed around the wire in the conduit. Compound shall be a type specially designed for such service on electrical wiring systems, shall be non-combustible and shall have the approval of the code-enforcing agency.
- C. Install raceways to preserve the fire resistance rating of partitions and other elements using materials and methods as specified in Section 07 84 00 - Firestopping. Apply firestopping to cable and raceway penetrations of fire-rated floor and wall assemblies as required to reestablish the original fire-resistance rating.
- D. Clip type conduit fasteners are not allowed. All fasteners and clamps for conduit and raceway support shall be bolted mechanical hardware type.
- E. Raceways:
 - 1. Minimum Raceway Size:
 - a. 1/2" trade size for end use devices and communications.
 - b. 3/4" trade size for homeruns, conduit embedded in slabs, and for outdoor applications.
 - 2. Cut conduit square using a saw or pipe cutter and ream to remove burrs.
 - 3. Use hydraulic one-shot conduit bender or factory elbows for bends in conduit larger than 2-inch size.
 - 4. Conceal conduit and EMT, unless otherwise indicated, within finished walls, ceilings, and floors.
 - a. Run concealed raceways, with a minimum of bends, in the shortest practical distance considering the type of building construction and obstructions, unless otherwise indicated.
 - 5. Conveyor areas should be considered a NEMA 12 installation because of dust. Conduit shall be RMC up to 10' AFF or within a 10' radius of conveyors.
 - a. Device and pull boxes within 10' of conveyors shall be gasketed.
 - 6. Conduits shall not be supported from ducts, pipes or other systems foreign to the electrical installation. The entire electrical installation shall be kept independent from any other trade.
 - 7. Provide separate conduits for 480/277V, 208/120V and low voltage and controls cabling.
 - 8. Planning: the layout of all raceways shall be carefully planned by the Contractor to ensure an installation which is neatly done and workmanlike. Any Work showing improper care in planning will be ordered removed by

- the Engineer, and shall be replaced in a neat and proper manner, without any additional cost to the Port.
9. Run concealed raceways with a minimum of bends, in the shortest practical distance considering type of building construction and obstructions. Install no more than the equivalent of four 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.
 10. Expansion-Joints:
 - a. Provide Liquid tight flex conduit at expansion joints with sufficient slack to accommodate seismic movement, unless Structural Engineer requires expansion joint fitting. Wrap flex conduit with ground wire, connected to steel fittings at either end of flex.
 11. Flexible Conduit: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed and semi-recessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors. Flexible conduit is also allowed at expansion joints. Any other use of flexible conduit must be approved by the Engineer. Install a separate external ground connector across flexible connections. See Section 26 05 26 – Grounding.
 - a. Use LFMC in damp or wet locations subject to severe physical damage.
 12. Install raceways parallel and perpendicular to structure and at proper elevations. Group multiple conduit runs and neatly rack and support from the structure. Provide adequate headroom.
 - a. Maintain 6-inches minimum clearance between raceways and mechanical piping and 12-inches minimum to heat sources such as flues, steam piping and heating appliances. Install horizontal raceway runs above water and steam piping.
 - b. Give right of way to raceways and piping systems installed at a required slope.
 - c. Keep electrical conduits free from contact with other dissimilar metals.
 13. Raceways Embedded in Slabs: Install in middle third of slab thickness where practical, and leave at least 1-inch concrete cover.
 - a. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
 - b. Space raceways laterally to prevent voids in concrete.
 - c. Run conduit larger than 1-inch trade size parallel to or at right angles to main reinforcement.
 - d. Transition from nonmetallic tubing to Schedule 80 nonmetallic conduit or rigid steel conduit at all bends and before rising above floor.
 14. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment.

- a. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portion of bends is not visible above the finished slab.
 - b. Install with an adjustable top or coupling threaded inside for plugs set flush with the finished floor.
 - c. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches above the floor.
 - d. Install screwdriver-operated, threaded flush plugs flush with floor for future equipment connections.
15. Flexible Connections:
- a. Use a maximum of 6 feet of flexible conduit for recessed and semi-recessed lighting fixtures. Use a maximum of 18" for equipment subject to vibration, noise transmission or movement, and for all motors. Use liquidtight flexible conduit in wet or damp locations.
 - b. Install combination deflection/expansion fittings, including bonding jumper, where raceway system crosses building seismic, control or expansion joints.
16. Sleeves: Install for cable and raceway penetrations of concrete slabs and walls, except where core-drilled holes are used. Install for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.
17. Avoid moisture traps. Provide junction box with drain fitting at low points in conduit system.
18. Install raceway sealing fittings according to manufacturer's written instructions. Locate fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
- a. Where conduits pass from warm to cold locations, such as the boundaries of refrigerated spaces.
 - b. Where otherwise required by NFPA 70 (NEC).
19. Terminations: Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against the box.
- a. 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.
20. Use temporary closures to prevent foreign matter from entering raceways.
21. Complete raceway installation before starting conductor installation.

22. In public areas, exposed raceways shall be painted to match surroundings. In other exposed areas of the Terminal, raceways may be painted to match existing finishes.
23. Install pull-ropes in empty raceways except at sleeves and nipples. Use #14 AWG zinc-coated steel or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of the pull wire.
24. Surface Conduits: Install a separate, green, ground conductor in conduits from junction box supplying the conduits to receptacle or fixture ground terminals.
 - a. Select each surface raceway outlet box, to which a lighting fixture is attached, of sufficient diameter to provide a seat for the fixture canopy.
 - b. Where a surface raceway is used to supply a fluorescent lighting fixture having central-stem suspension with a backplate and a canopy (with or without extension ring), no separate outlet box is required.
 - c. Provide surface metal raceway outlet box, and the backplate and canopy, at the feed-in location of each fluorescent lighting fixture having end-stem suspension.
 - d. Where a surface metal raceway extension is made from an existing outlet box on which a lighting fixture is installed, no additional surface-mounted outlet box is required. Provide a backplate slightly smaller than the fixture canopy.

F. Outlet Box Installation:

1. Provide cast outlet boxes in exterior or wet locations.
2. Provide recessed outlet boxes in finished areas.
 - a. Do not install boxes back-to-back in walls.
 - b. Provide 6-inch minimum separation; 24-inch in acoustic rated walls.
3. Sectional boxes are not permitted.
4. Provide knockout closures for unused openings.
5. Where receptacle boxes and telecom devices are adjacent to one another, install receptacles not closer than 6" to and not greater than 12" from telecom device.
6. Support boxes independently of raceway. Mount device boxes to wall studs using blocking material behind the box to insure that the box will remain square to the finished wall surface.
7. Outlet and device boxes mounted in masonry walls shall be set at the bottom or top of a masonry unit course.
8. Use multiple-gang boxes where more than one device is mounted together; do not use sectional boxes.

9. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
 10. Provide cast outlet boxes in exterior or wet location. Conduit shall not enter the top or sides of exterior wall outlet boxes. Conduit shall enter bottom only.
 11. Coordinate location and mounting height of outlets mounted above counters, benches, and backsplashes.
 12. Mount outlets at the following heights above finished floor, unless otherwise noted on drawings:
 - a. Wall Switches: 48"
 - b. Convenience Outlets – Utility areas: 48"
 - c. Convenience Outlets – other areas: 18"
 - d. Above Counter Outlets: 48" or 6" above counter or backsplash
 - e. Telephone outlets : 18"
 - f. Wall phone outlets: 54"
 - g. Thermostats: 60"
- G. Pull and Junction Box Installation:
1. Provide as required to facilitate installation of the Work or as required by NFPA 70 (NEC).
 2. Locate so that covers are accessible at all times.
 3. Support boxes independently of raceway. Fasten junction and pull boxes to or support from building structure.
- H. Floor Box Installation:
1. Set floor boxes level and adjust to finished floor surface.
 2. Use cast iron floor boxes for installations in slab on grade.
- 3.05 GROUNDING
- A. Provide grounding connections for raceway, boxes, and components as specified in Section 26 05 26 - Grounding and as required by NFPA 70 (NEC).
- 3.06 SUPPORT
- A. Support raceways as specified in Section 26 05 48 - Structural Loading Controls for Electrical and Communication Work.
- 3.07 IDENTIFICATION
- A. Provide labels for raceway, boxes, and components as specified in Section 26 05 53 - Electrical Identification.
- B. Raceways for medium-voltage circuits:
1. Apply self-adhesive labels on raceways leaving equipment and at 25-foot intervals indicating system voltage. Use 1-1/4" minimum black letters on yellow background.

2. Label raceways entering concealed locations from exposed locations as to the destination via the concealed area.
 3. Apply self-adhesive labels on exterior door or cover of enclosures indicating system voltage. Use 1-1/4" minimum black letters on orange background.
- C. Raceways for low-voltage circuits:
1. System Identification Color-Coding Bands for Raceways: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.
 2. 208/120V Blue
 3. 480/277V Yellow
 4. Controls Black
 5. Accessible Raceways, More Than 600 V: Self-adhesive vinyl labels. Install labels at all conduit penetrations and along length of exposed conduit run at 25 foot maximum intervals.
 6. Accessible Raceways within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage.
 7. Provide labels on all raceways, junction and pull boxes indicating panel designation and circuit number for all circuits in raceway or box, and conduit destination.
 8. Conduit Label Example: B2-P4-23G-1/1,3,5, B-2601-9.
 9. Provide labels at all locations where conduit penetrates walls, floors and ceilings, on both sides of penetration.
 10. Provide labels at all ends or breaks in conduit runs such as electrical rooms, junction boxes, pull boxes, cabinets, maintenance holes, fire penetrations, etc.
 11. Provide labels on each conduit entering junction or pull box within 12" of junction or pull box.
 12. Provide labels at 25 foot maximum intervals along conduit runs.
 13. Provide labels on all junction and pullboxes, including in accessible ceiling spaces and exposed in unfinished areas. Refer to specification sections for identification requirements for systems contained within.
 14. Install labels parallel to equipment lines.
 15. Labels in unfinished locations, including in accessible ceiling spaces and exposed unfinished areas shall be plain colored vinyl adhesive tape, minimum 1/2 inch high, handwritten in black indelible ink.
 16. Labels in finished locations shall be adhesive-backed plastic machine printed labels, minimum 3/8 inch high, white with black letters.

17. Lettering shall be a minimum of ¼" high.
18. In finished locations, provide labels on inside of junction or pull box cover.
19. Provide red lettering when served by an emergency source.
20. Label power junction and pull boxes with power source and circuit numbers.
21. Label raceways entering concealed locations from exposed locations as to the destination via the concealed area.

3.08 PROTECTION

- A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and installer that ensure coatings and finishes are without damage or deterioration at the time of Substantial Completion.
 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.09 CLEANING

- A. On completion of installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.
- B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

End of Section

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of "Cable Trays" Work is shown in the Contract Documents. This section includes requirements for materials, equipment, tests for cable tray systems, including straight sections, bends, tees, elbows, dropouts, supports and accessories.

1.02 GOVERNING CODES, STANDARDS AND REFERENCES

- A. ASTM A 123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
- B. NEMA FG 1 (National Electrical Manufacturers Association) - Fiberglass Cable Tray Systems
- C. NEMA VE 1 (National Electrical Manufacturers Association) - Metallic Cable Tray Systems
- D. NEMA VE 2 (National Electrical Manufacturers Association) - Metallic Cable Tray Installation Guidelines
- E. NFPA 70 (National Fire Protection Association) - National Electrical Code

1.03 SUBMITTALS

- A. Submit materials data in accordance with of Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.
- B. Submittals shall include the following:
 - 1. Product Data: Include data indicating dimensions and finishes for each type of cable tray.
 - 2. Manufacturer's Installation Instructions: Include instructions for storage, handling, protection, examination, preparation, and installation.
 - 3. 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, but not limited to clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, drop-offs, sweeps, and fittings.
 - 4. Seismic Qualification Certificates: For cable trays, accessories, and components, from manufacturer. Move this to action submittals article
 - a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
 - 5. Design Calculations: Verify loading capacities for supports.

6. Coordination Drawings: Include floor plans and sections drawn to scale. Include scaled cable tray layout, support points, and relationships between components and adjacent structural and mechanical elements, vertical and horizontal offset and transitions, clearances for access above and to side of cable trays, and vertical elevation of cable trays above the floor or below bottom of ceiling structure.
7. Factory-certified test reports of specified products, complying with NEMA VE 1.
8. Field Test Reports: Provide grounding test locations and results.
9. Maintenance Data: For cable trays to include in the maintenance manuals specified in Division 1 General Requirements.

1.04 QUALITY ASSURANCE

- A. Source Limitations: Obtain cable tray components through one source from a single manufacturer.
- B. Listing and Labeling: Provide cable trays and accessories that are 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 for the location and environment in which they are installed.
- C. Comply with NEMA VE 1, "Metal Cable Tray Systems," for materials, sizes, and configurations.
- D. Comply with NFPA 70, as adopted and administered by the Authority Having Jurisdiction.

1.05 COORDINATION

- A. Coordinate layout and installation of cable tray with other installations.
- B. Revise locations and elevations from those indicated as required to suit field conditions and as approved by the Engineer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Cooper B-Line
 2. MP Husky
 3. Legrand Cablofil.
 4. Or Approved Equal.

2.02 MATERIALS AND FINISHES

- A. Cable Trays, Fittings, and Accessories for Exterior Installations: Steel, complying with ASTM A570, Grade 33 for 14 gauge and heavier, and hot-dip galvanized after fabrication complying with ASTM A123.
- B. Cable Trays, Fittings, and Accessories for Interior Installations: Aluminum, complying with Aluminum Association's alloy 6063 for rails, rungs, and cable trays, and alloy 5052 for fabricated parts.

- C. Protect steel hardware against corrosion by galvanizing according to ASTM B633 or cadmium plating according to ASTM B766.
- D. Fabricate cable tray products with rounded edges and smooth surfaces.
- E. Sizes and Configurations: Refer to Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.

2.03 CABLE TRAY SCHEDULE

- A. Run Designation: Emergency MC Cable runs
 - 1. Ladder type:
 - a. Configuration: Two I-beam side rails with transverse rungs welded to side rails.
 - b. Rung Spacing: 12 inches for power cables on center.
 - c. Rung cable bearing surface: $\frac{3}{4}$ inch with radiused edges.
 - d. Radius-Fitting Rung Spacing: 9 inches at center of tray's width.
 - e. No portion of the rungs shall protrude below the bottom plane of side rails.
 - f. Structural Performance of Each Rung: Capable of supporting a 200-lb concentrated load, when tested according to NEMA VE 1.
 - 2. Material and Finish: Aluminum.
 - 3. Width: 18 inches.
 - 4. Minimum Fitting Radius: 24 inches.
 - 5. Inside Depth: 4 inches.
 - 6. Structural Performance: Capable of supporting a maximum cable load of 200lbs per rung or 800lbs per foot.
 - 7. Length: 12 feet.
 - 8. Splice Plates: 6063-T6 aluminum with 4 square-neck bolts and serrated flange locknuts.
 - 9. Cover: None

2.04 MATERIALS AND FINISHES

- A. Aluminum:
 - 1. Indoor Applications: Alloy 6063- according to ANSI H35.1/H 35.1M for extruded components, and Alloy 5052 according to ANSI H35.1/H 35.1M for fabricated parts.
 - 2. Splice Plates:
 - a. Bolted type, Aluminum alloy 6063-T6 with four square neck bolts and serrated flange locknuts each.
 - 3. Hardware: Chromium-zinc-plated steel, ASTM F 1136.
- B. Fabricate cable tray products with rounded edges and smooth surfaces.

2.05 CABLE TRAY ACCESSORIES

- A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.
- B. Cable tray supports and connectors, including bonding jumpers, as required to install, support, and protect the cable tray system.

2.06 FIRESTOPPING

- A. Flame-Safe compound capable of passing a one-hour or two-hour fire test per UL requirements.
- B. Use Halon-free material that does not generate hydrogen gas while curing as manufactured by Thomas & Betts Corporation, 3M Corporation, Or Approved Equal.

2.07 WARNING SIGNS

- A. 3/4" high, black letters on yellow laminated plastic nameplate, engraved with "WARNING! DO NOT USE AS WALKWAY, LADDER, OR SUPPORT FOR LADDERS OR PERSONNEL – CABLES ADDED AFTER INITIAL INSTALLATION REQUIRE POS/F&I APPROVAL".

2.08 SOURCE QUALITY CONTROL

- A. Perform design and production tests according to NEMA VE 1.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of cable trays. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.
- B. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.
- C. Join aluminum cable tray with splice plates; use four square-neck carriage bolts and locknuts.
- D. Install cable tray level and plumb according to manufacturer's written instructions, Coordination Drawings, original design, and referenced standards.
- E. Remove burrs and sharp edges from cable trays.
- F. Fasten cable tray supports securely to building structure as specified in Section 20 05 29 – Hangers and Supports and Section 26 05 48 - Seismic Controls for Electrical and Communication Work, unless otherwise indicated.
 - 1. Locate and install supports according to NEMA VE 2.
- G. Install expansion connectors where cable tray crosses a building expansion joint and in cable tray runs that exceed 100 feet. Space connectors and set gaps according to NEMA VE 2.

- H. Place supports so that spans do not exceed maximum spans on schedules and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.
- I. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.
- J. Support bus assembly to prevent twisting from eccentric loading.
- K. Install center-hung supports for single-rail trays designed for 60 versus 40 percent eccentric loading condition, with a safety factor of 3.
- L. Make cable tray connections and changes in direction or elevation using standard fittings.
- M. Install only cables approved for use as tray cable in cable tray.
- N. Locate cable tray above piping where practical.
- O. Seal penetrations through fire and smoke barriers, including walls, partitions, floors and ceilings, after cables are installed, according to Section 07 84 00 - Firestopping.
- P. Sleeves for Future Cables: Install capped sleeves for future cables through firestopping-sealed cable tray penetrations of fire and smoke barriers.
- Q. Workspace: Install cable trays with sufficient space to permit access for installing cables.
- R. Install barriers to separate cables of different voltage systems or to separate normal and emergency system cables.
- S. When terminating a conduit to cable tray, use appropriate ground bushing to bond the conduit to the tray.

3.03 CONNECTIONS

- A. Use anti-oxidant compound to prepare aluminum contact surfaces before assembly.
- B. Tighten electrical connectors and terminals 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.
- C. Ground cable trays according to manufacturer's instructions.
 - 1. Provide #2 AWG minimum bare copper stranded cable, or larger as required by NFPA 70, for the entire length of cable tray and bond every section with F & I approved grounding clamps designed for cable trays. Connect ground conductor to building steel or ground grid.
 - 2. Provide grounding bushing where conduit terminates at cable tray and bond conduit to tray.
 - 3. When steel or aluminum tray are used as equipment grounding conductors, cable tray sections and fittings shall be marked to show minimum cross-sectional area in accordance with Article 318 of the NEC.
 - 4. Connect ground conductor to building steel or ground grid.

3.04 CABLE INSTALLATION

- A. Install cables only when each cable tray run has been completed and inspected.
- B. Fasten cables on horizontal runs with cable clamps or cable ties according to NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.
- C. Fasten cables on vertical runs to cable trays every 18 inches.
- D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 48 inches.
- E. Tie MI cables down every 36 inches where required to provide a 2-hour fire rating and every 72 inches elsewhere. MI cable not allowed in Port standard, but if provided in OEM equipment.
- F. In existing construction, remove inactive or dead cables from cable trays.

3.05 IDENTIFICATION

- A. After installation of cable trays is completed, install warning signs as specified in Section 26 05 53 - Electrical Identification at 25-foot intervals in visible locations on cable trays, both sides of tray if both sides are visible.

3.06 FIELD QUALITY CONTROL

- A. Grounding: Test cable trays to ensure electrical continuity of bonding and grounding connections. Maximum allowable resistance is 1 ohm.
- B. Perform the following tests and inspections[with the assistance of a factory-authorized service representative]:
 - 1. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
 - 2. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are installed separated cable trays from power circuits.
 - 3. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
 - 4. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
 - 5. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
 - 6. Check for improperly sized or installed bonding jumpers.
 - 7. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
 - 8. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test

entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

3.07 CLEANING

- A. Upon completion of cable tray installation, including fittings, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

3.08 PROTECTION

- A. Protect installed cable trays and cables.
- B. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over
- C. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
- D. Remove dirt and construction debris and repair damage to paint finishes including chips, scratches and abrasions with matching touchup coating recommended by cable tray manufacturer.
- E. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer that ensure cable tray is without damage or deterioration at the time of Substantial Completion.
- F. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.

B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of “Seismic Controls for Electrical and Communication Systems” Work is shown in the Contract Documents. This section includes seismic and structural load restraints and other loading-damage-reduction measures for electrical components.
- B. Definitions
 - 1. Load Restraint: A fixed device such as a seismic brace, an anchor bolt or stud, or a fastening assembly used to prevent vertical or horizontal movement, or both vertical and horizontal movement, of an electrical system component from external loading.
 - 2. Mobile Structural Element: A part of the building structure such as a slab, floor structure, roof structure, or wall that may move independent of other mobile structural elements during an earthquake.

1.02 GOVERNING CODES, STANDARDS, AND REFERENCES

- A. ACI 318 (American Concrete Institute) - Building Code Requirements for Structural Concrete.
- B. ASCE 7 (American Society for Testing of Civil Engineers) - Minimum Design Loads for Buildings and Other Structures.
- C. ASTM - American Society for Testing and Materials.
- D. ICBO - International Conference of Building Officials.
- E. IBC - International Building Code as adopted by the Seattle-Tacoma International Airport Building Department
- F. NFPA 70 (National Fire Protection Association) - National Electrical Code.

1.03 SUBMITTALS

- A. Submit materials data in accordance with Section 01 33 00 - Submittals. Furnish manufacturers’ technical literature, standard details, product specifications, and installation instructions for all products.
- B. Submittals shall include the following:
 - 1. Plan: Provide layout and details of seismic bracing assemblies, including relevant information about supporting structure and supported electrical system. Show attachment locations, methods, and spacings, and identifying components.
 - 2. Calculations: Provide structural calculations for all load restraint assemblies, including calculation of loads for assembly design and reactions applied to supporting structure.
 - a. Calculations shall include sufficiency and arrangement of supports as needed.
 - b. Coordinate design calculations for seismic, wind, or flood load calculations required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.

3. Product Data: For each component used, provide the following:
 - a. Illustration of component and its place in the associated assembly
 - b. Type and style, including model number if applicable.
 - c. Size.
 - d. Material.
 - e. Strength, including maximum working or ultimate loads in all applicable directions.
 - f. Fastening provisions.
 - g. Finish.
 - h. Limits of use as applicable, indicating suitability for specified application.
 - i. Additional Information for Cast-in-Place Anchor Bolts, Post-Installed Concrete Anchors, Studs, and other Anchors: In addition to characteristics listed above, provide the International Code Council Evaluation Services (ICC-ES) report. All anchors shall be certified for use in seismic systems.
4. Shop Drawings: For anchorage and bracing not defined by details and charts on Drawings. Indicate materials, and show designs and calculations signed and sealed by a Professional Engineer licensed in the State of Washington.
5. Details: Detail fabrication and arrangement. Detail attachment of restraints to both structural and restrained items. Show attachment locations, methods, and spacings, identifying components and listing their strengths. Indicate direction and magnitude of all forces and moments transmitted to the structure during seismic events.
 - a. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
6. Pre-approval and Evaluation Documentation: By the ICC-ES, showing maximum ratings of restraints and the basis for approval (tests or calculations).
7. Coordination Drawings: Plans and sections drawn to scale and coordinating seismic bracing for electrical components with other systems and equipment, including other load restraints, in the vicinity.
8. Product Certificates: For each type of load restraint system, provide a product certificate signed by manufacturer certifying that products furnished comply with requirements.
9. Qualification Data: Provide evidence of current licensure for firms and persons specified in "Quality Assurance" section.

1.04 QUALITY ASSURANCE

- A. Comply with the International Building Code and ASCE 7 unless requirements in this section are more stringent.
- B. Professional Engineer Qualifications:
 - 1. All required calculations shall be provided by a Professional Engineer who is licensed in the State of Washington and who is experienced in providing seismic engineering services.
 - 2. Certification by a Professional Engineer licensed in a state other than Washington, if requested, may be approved by the Engineer.

1.05 PROJECT CONDITIONS

- A. In accordance with Section 1605, “Load Combinations” of the International Building Code, shall be used for design.
- B. In accordance with Section 1604.5, “Risk Category” of the International Building Code; the Risk Category of the Work Area is “II”.
- C. The Importance Factor, I_p (Seismic), I_w (Wind) shall be selected for each restraint assembly based on the system’s purpose in accordance with applicable section for the design of nonstructural components per ASCE 7.
- D. In accordance with Section 1613, “Earthquake Loads” of the International Building Code the following design values shall be used:

WORK AREA	SEATAC AIRPORT
Site Class	D
S_s	1.45g
S_1	0.498g
S_{DS}	0.967g
S_{D1}	N/A

- E. In accordance with Section 1609, “Wind Loads” of the International Building Code the following design values shall be used:

WORK AREA	Pier 69
Basic Design Wind Speed	98-mph
Wind Exposure	D
Topographical Factor K_{ZT}	1.0

- F. In accordance with Section 1612, “Flood Loads” of the International Building Code the following design values shall be used:

WORK AREA	Pier 69
Flood Design Class	2

- G. Any alternative designs to be considered for substitution shall be per the IBC and ASCE 7 provisions and will be subject to the approval of the Engineer.

1.06 COORDINATION

- A. Coordinate layout and installation of seismic bracing with building structural system and architectural features, and with mechanical, fire-protection, electrical, communication, and other building features in the vicinity.
- B. Coordinate concrete bases with building structural system.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Bracing and attachment: Subject to compliance with requirements, provide bracing and attachment products by one of the following, or other manufacturer with at least 5 years of experience in seismic-specific bracing systems:
1. Cooper B-Line; Division of Eaton.
 2. Erico
 3. GS Metals; Division of Cooper
 4. Hilti
 5. Thomas & Betts; Division of ABB
 6. Unistrut
 7. Or Approved Equal.
- B. Anchorage: Subject to compliance with requirements, provide anchorage products by one of the following, or other manufacturer with at least 5 years of experience in seismic-specific anchorage:
1. Hilti
 2. DeWalt
 3. Red Head
 4. Simpson Strong-Tie
 5. Or Approved Equal.

2.02 MATERIALS

- A. Use the following materials for restraints:

1. Indoor Dry Locations: Steel, zinc plated.
 2. Outdoors and Damp Locations: Galvanized steel.
 3. Corrosive Locations: Stainless steel.
- B. Unless otherwise noted, steel materials shall be per Section 05 12 00 – Structural Steel.

2.03 ANCHORAGE AND STRUCTURAL ATTACHMENT COMPONENTS

- A. All Post-Installed Concrete Anchors shall meet the requirements in Specification 05 05 20 – Post-Installed Concrete Anchors
- B. Strength:
1. Strengths used for anchor design shall be as noted in the ICC-ES reports, including use of anchor design criteria specified in ACI 318.
 - a. Unless otherwise specifically approved by the Engineer, all anchors located in concrete shall be ICC-approved for and designed using “cracked concrete” criteria.
 2. For each load restraint assembly, either Allowable Strength or Ultimate Strength design shall be used. Methodologies shall not be mixed within a single assembly.
- C. Concrete and Masonry Anchor Bolts and Studs: Steel-expansion wedge type.
- D. Concrete Inserts: Steel-channel type.
- E. Through Bolts: Structural type, hex head, high strength. Comply with ASTM A325.
- F. Welding Lugs: Comply with MSS SP-69, Type 57.
- G. Beam Clamps for Steel Beams and Joists: Double sided. Single-sided type is not acceptable.
- H. Bushings for Floor-Mounted Equipment Anchors: Neoprene units designed for seismically rated rigid equipment mountings, and matched to the type and size of anchor bolts and studs used.
- I. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for seismically rated rigid equipment mountings, and matched to the type and size of attachment devices used.

2.04 LOAD RESTRAINT BRACING COMPONENTS

- A. Slotted Steel Channel: 1-5/8-by-1-5/8-inch cross section, formed from 0.1046-inch thick steel, with 9/16-by-7/8-inch slots at a maximum of 2 inches on center in webs, and flange edges turned toward web.
1. Materials for Channel: ASTM A1011, Grade 33.
 2. Materials for Fittings and Accessories: ASTM A575, ASTM A576, or ASTM A36.
 3. Fittings and Accessories: Products of the same manufacturer as channels and designed for use with that product.

4. Finish: Baked, rust-inhibiting, acrylic-enamel paint applied after cleaning and phosphate treatment, unless otherwise indicated.
- B. Channel-Type Bracing Assemblies: Slotted steel channel, with adjustable hinged steel brackets and bolts.
- C. Cable-Type Bracing Assemblies: Zinc-coated, high-strength steel wire rope cable attached to steel thimbles, brackets, and bolts designed for cable service.
 1. Arrange units for attachment to the braced component at one end and to the structure at the other end.
 2. Wire Rope Cable: Comply with ASTM A603.
- D. Hanger Rod Stiffeners: Slotted steel channels with internally bolted connections to hanger rod.

PART 3 EXECUTION

3.01 APPLICATION

- A. Generator Sets: Comply with Section 20 05 48 - Mechanical Sound, Vibration, and Seismic Control.

3.02 INSTALLATION

- A. Install load restraints according to applicable codes and regulations and as approved by authority having jurisdiction, unless more stringent requirements are indicated by manufacturer's recommendation or this section.

3.03 STRUCTURAL ATTACHMENTS

- A. Use bolted connections with steel brackets, slotted channel, and slotted-channel fittings to transmit the design loads.
- B. Attachments to New Concrete: Bolt to channel-type concrete inserts or use expansion anchors.
- C. Attachments to Existing Concrete: Use expansion anchors.
- D. Holes for Expansion Anchors in Concrete: Drill at locations and to depths that avoid reinforcing bars and comply with anchor manufacturer's recommendations.
- E. Attachments to Solid Concrete Masonry Unit Walls: Use expansion anchors.
- F. Attachments to Hollow Walls: Bolt to slotted steel channels fastened to wall with expansion anchors.
- G. Attachments to Wood Structural Members: Install bolts through members.
- H. Attachments to Steel: Bolt to clamps on flanges of beams and columns, or on upper truss chords of bar joists.

3.04 ELECTRICAL AND COMMUNICATION EQUIPMENT ANCHORAGE

- A. Anchor rigidly to a single mobile structural element or to a concrete base that is structurally tied to a single mobile structural element.
- B. All floor-mounted equipment shall be secured to the housekeeping bases with ductile steel anchor bolts, preset in the concrete base. Secure vibration mounts, where required, to the concrete bases such that the equipment is free to vibrate but cannot move from the base.

1. Housekeeping Bases: Provide appropriately sized concrete housekeeping bases for all floor-mounted equipment unless noted otherwise. Size concrete bases so expansion anchors will be a minimum of bolt diameters from the edge of the concrete base, or the minimum required by the anchor manufacturer, whichever is larger. Bases shall be 4" nominal thickness of concrete with #4 reinforcing bars each way on 12" centers and doweled to floor slab unless noted otherwise. Trowel finish with 1" bevel edge all around.
2. Bushings for Floor-Mounted Equipment Anchors: Install to allow for resilient media between anchor bolt or stud and mounting hole in concrete.
- C. Wall-Mounted Equipment Fastening: Rigidly secure all flush- or surface-mounted equipment, such as panelboards or cabinets, to the structure. Use expanding type anchors for concrete or masonry construction.
 1. Anchor Bolt Bushing Assemblies for Wall-Mounted Equipment: Install to allow for resilient media where equipment or equipment-mounting channels are attached to wall.
- D. Torque bolts and nuts on studs to values recommended by equipment manufacturer.
 1. Mark lugs after torquing with red paint such that paint will be visibly disturbed if lugs are disturbed.

3.05 LOAD RESTRAINT BRACING INSTALLATION

- A. Expansion and Contraction: Install all electrical system components to allow for thermal movement of braced components.
- B. Cable Braces: Install snug tight unless otherwise recommended by the manufacturer. Do not exceed the maximum cable slack as recommended by the cable manufacturer.
- C. Attachment to Structure:
 1. All attachment to the structure shall be per the approved details.
 2. If specific attachment is not indicated for cables, conduit or other lightweight elements, anchor bracing to the structure at flanges of beams and columns, upper truss chords of bar joists, or at concrete members.
 3. If specific attachment is not indicated for panels, chases, racks, and other heavier equipment, submit planned attachment detail to the Engineer for specific approval.

3.06 ACCOMMODATION OF DIFFERENTIAL MOTION

- A. Make flexible connections in raceways, cables, wireways, cable trays, and busways where they cross expansion and seismic control joints, where adjacent sections or branches are supported by different structural elements, and where they terminate at electrical equipment anchored to a different mobile structural element from the one supporting them.
 1. Where expansion or control joints are crossed, the flexible connection shall allow for movement in each direction (closing, opening, right, and left) equal to the joint's total width or greater, unless specified otherwise in the

Contract Documents, specified otherwise on the structural drawings for the joint's construction, or approved by the Engineer.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.

B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of "Electrical Identification" Work is shown in the Contract Documents. This section includes identification of electrical materials, equipment, and installations.

1.02 GOVERNING CODES, STANDARDS AND REFERENCES

- A. ANSI/IEEE C2 - National Electrical Safety Code
- B. NFPA 70 (National Fire Protection Association) - National Electrical Code, References

1.03 SUBMITTALS

- A. Submit materials data in accordance with of Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.
- B. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.
- C. Submittals shall include the following:
 - 1. Product Data for each type of product specified.
 - 2. Schedule of identification nomenclature to be used for identification signs and labels.

1.04 QUALITY ASSURANCE

- A. Comply with NFPA 70, as adopted and administered by the Authority Having Jurisdiction.
- B. Comply with ANSI C2, ANSI A13.1., ANSI Z535.4, 29 CFR 1910.144 and 29 CFR 1910.145.
- C. Comply with Port of Seattle standards for electrical equipment identification.
- D. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.05 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 PRODUCTS

2.01 LABEL TYPES

- A. Manufacturer's standard products with colors prescribed by ANSI A13.1, NFPA 70, and these Specifications. Only temporary markings that are removable without damaging finish are permitted on equipment.
1. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Install labels and nameplates parallel to equipment lines. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
 2. Provide engraved laminated phenolic plastic or melamine label for equipment as noted below. Securely attach engraved labels with blunt end, self-tapping stainless steel screws with blunt ends. Sheet metal screws are not allowed. Provide white letters on black background for normal power, white letters on red background for emergency power.
 - a. Provide 5/8-inch minimum height letters on the following equipment:
 - (1) Panelboards, provide labels and warning signs. Secure nameplates to inside surface of door where panel is recessed in finished locations.
 - (2) Switchboards/distribution centers, motor control centers and power centers, padmounted transformers
 - (3) Secondary feeder breakers in distribution equipment
 - (4) Automatic and manual transfer switches. Labels shall include both normal and emergency source and load.
 - (5) Special equipment housed in cabinets, on outside door
 - (6) Terminal junction boxes and data gathering panels
 - (7) Cable trays
 - (8) UPS equipment
 - b. Provide 1/4-inch minimum height letters on the following equipment:
 - (1) Disconnects and starters for motors on fixed appliances and starters in MCCs
 - (2) Motor controllers and VFDs.
 - (3) Enclosed switches and circuit breakers
 - (4) Low voltage transformers
 - (5) Feeder circuit breakers in switchboards, switchgear, and distribution panelboards. Circuit breakers shall be labeled with destination panel name or load.
 - (6) Duplex receptacles (self adhesive labels indicating panel and circuit number)

- (7) Local control panels
- (8) Raceways and junction boxes
- (9) Instrumentation Labels
- c. Refer to table and descriptions in subparagraphs below for acceptable labeling procedure:

SECTION	TITLE	LABEL TYPES															
		B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	
26 05 26	Grounding			5⁄8		X											
26 05 23	Control/Signal Transmission Media	X	X													X	
26 05 19	600-Volt or Less Wire and Cable	X	X			X										X	
26 05 13	Medium-Voltage Cables						X									X	
26 05 33	Raceways and Boxes															X	
26 05 43	Underground Ducts and Manholes						X		X	X	X	X				X	
26 27 16	Cabinets and Enclosures			3⁄8													
26 05 36	Cable Trays			3⁄8							X	X					
26 27 26	Wiring Devices				1⁄4												
no section	Electrical Power Monitoring and Control			3⁄8													
26 32 29	Rotary 400 HZ Converters			1⁄2							X						
26 32 13	Engine Generators			5⁄8							X						
26 33 53	Static Uninterruptible Power Supplies			5⁄8							X						
26 29 23	Variable Frequency Controllers			5⁄8							X						
26 12 00	Medium-Voltage Transformers			5⁄8							X			X			
26 35 33	Low-Voltage Power Factor Correction Capacitors			3⁄8	X										X		
26 13 00	Medium-Voltage Load Interrupter Switchgear			5⁄8							X			X			

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26 13 26	Medium-Voltage Metal-Clad Drawout Circuit Breaker Switchgear	$\frac{5}{8}$	X	X
26 18 39	Medium-Voltage Motor Controllers	$\frac{5}{8}$	X	X
26 13 19	Medium-Voltage Pad-Mounted Vacuum Interrupter Switchgear	$\frac{5}{8}$	X	X
26 11 16	Secondary Unit Substations	$\frac{5}{8}$		
26 28 16	Enclosed Switches and Circuit Breakers	$\frac{5}{8}$		
26 36 00	Transfer Switches	$\frac{5}{8}$		
26 23 00	Low-Voltage Switchgear	$\frac{5}{8}$		
26 24 13	Low-Voltage Switchboards	$\frac{5}{8}$		
26 09 26	Panelboards	$\frac{1}{2}$		
26 24 19	Motor-Control Centers	$\frac{5}{8}$		
26 29 13	Motor Controllers	$\frac{3}{8}$		
26 25 00	Low-Voltage Busway	$\frac{3}{8}$	X	X
26 22 00	Dry-Type Transformers (600-Volt and Less)	$\frac{1}{2}$		
26 28 13	Fuses	X		
26 43 13	Transient Voltage Suppression	$\frac{3}{8}$		
26 51 00	Interior Lighting	X		
26 56 00	Exterior Lighting			
26 09 23	Lighting Controls	$\frac{1}{2}$		
28 31 00	Fire Alarm	$\frac{1}{2}$		
26 08 00	Acceptance Testing			X

- B. Heat-shrink preprinted tubes, flame-retardant polyolefin tube with machine-printed identification label. Sized to suit diameter of and shrinks to fit firmly around cable it identifies. Full shrink recovery at a maximum of 200 degree F. Comply with UL 224.

- C. Preprinted, flexible, self-adhesive vinyl label laminated with a clear weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing ends of legend label.
- D. Engraved melamine plastic laminate flat stock, 1/16-inch minimum thickness for sizes up to 15 square inches. Use 1/8-inch minimum for sizes larger than 15 square inches. Black with white letters for normal power systems and red with white letters for emergency power systems, with height as shown in table above unless specified otherwise. UV-inhibited when used outdoors. Secure with stainless steel drive screws, stainless steel self-tapping screws or stainless steel oval-head 6-32 screws tapped into enclosure, or with stainless steel bolts with elastic stopnut.
- E. Adhesive-backed plastic machine-printed labels, white with black letters. Indicate panel name and circuit number(s).
 - 1. For Raceway at more than 600V, provide black letters on an orange field label with the legend, "HIGH VOLTAGE". Indicate feeder number.
- F. Plain-colored vinyl adhesive tape, 3-mil minimum by 1-inch wide minimum. Apply 1/2-inch minimum over-wrap through 2-inch minimum length. Refer to Section 26 05 19 – 600 Volt or Less Wire and Cable for color.
- G. Engraved plastic melamine laminate flat stock. 1/16 inch minimum thickness for sizes up to and including 15 square inches, 1/8" thick for larger than 15 square inches. White background with black letters for normal power, red background with white letters for emergency power. Holes at each end for attachment with nylon ty-wraps.
- H. Not used
- I. Underground line warning tape with pre-printed warning message identifying type of system. Material shall be pigmented polyolefin, continuous-printed on one side, and compounded for unlimited life when direct buried. 6-inch minimum width by 4-mils thick. Tensile strength of 1750 psi.
 - 2. Inscriptions for Red-Colored Tapes: ELECTRICAL LINE, HIGH VOLTAGE.
 - 3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATION CABLE, OPTICAL FIBER CABLE.
- J. Underground metallic line-warning tape with pre-printed warning message identifying type of system. Material shall be detectable three-layer laminate consisting of printed pigmented polyolefin, a solid aluminum-foil core with a clear protective film that allows inspection of the continuity of the conductive core, and compounded for unlimited life when direct buried. Use when metal-detection of line is required on Medium Voltage Systems. 6-inch minimum width by 4-mils thick.
 - 1. Inscriptions for Red-Colored Tapes: "CAUTION: MEDIUM VOLTAGE ELECTRICAL LINE BELOW"
- K. Warning signs: Baked Enamel on aluminum plate, punched or drilled for fasteners, with colors, legend, and size required for applications. 1/4-inch grommets in corners for mounting. Minimum nominal size of 7 by 10 inches with 0.040-inch minimum thickness. OSHA standard wording where approved. Custom wording if required. Secure with non-corrosive fasteners.

1. Where applicable, provide labels for multiple power source warning:
"DANGER – ELECTRICAL SHOCK HAZARD – EQUIPMENT HAS MULTIPLE POWER SOURCES"
 - L. Warning labels: Self-adhesive, multicolor, flexible pressure-sensitive vinyl conforming to OSHA "Danger" and "Caution" standards. 2½ x1¾" minimum with black letters on yellow background. Label shall read: "WARNING! DO NOT USE AS WALKWAY, LADDER, OR SUPPORT FOR LADDERS OR PERSONNEL - CABLES ADDED AFTER INITIAL INSTALLATION REQUIRE POS/F & I APPROVAL." See Section 26 05 36 – Cable Trays
 1. Where applicable, provide labels for multiple power source warning:
"DANGER – ELECTRICAL SHOCK HAZARD – EQUIPMENT HAS MULTIPLE POWER SOURCES"
 - M. Stencils: Machine-punched patterns, nonfading waterproof paint with color and formulation appropriate for material and location. Minimum letter height shall be 1 inch.
 - N. Adhesive-backed metal labels manufactured with testing agency logo. Punched or engraved with actual settings and date. Label shall be 1/16-inch minimum thickness for sizes up to 15 square inches. Use 1/8-inch minimum for sizes larger than 20 square inches. Black with white letters for normal power systems and red with white letters for emergency power systems, with height as shown in table above unless specified otherwise.
 - O. Stainless-steel machine or hand-stamped wire marker plates with one hole at each end for attachment with non-corrosive fasteners that do 0.010-inch minimum thickness (for outdoor application).
 - P. Adhesive machine-printed plastic tape, cut to length, black with white letters unless specified otherwise. 3/8-inch minimum width of tape in unfinished areas only. Provide white lettering on red background when served by an emergency source.
- 2.02 MISCELLANEOUS IDENTIFICATION PRODUCTS
- A. Floor Marking: Coordinate with the Port Electric Shop for painting working clearances on the floor in front of the equipment.
 - B. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior and interior).

PART 3 EXECUTION

3.01 INSTALLATION

- A. Fasteners for labels and signs: Self tapping, blunt-ended stainless-steel screws, or stainless-steel machine screws with nuts and flat and lock washers. Sheet metal screws are not acceptable. Self-drilling screws are not allowed.
- B. Install identification labels according to manufacturer's written instructions.
- C. Install labels where indicated and as required by the Authority Having Jurisdiction and the Department of Labor and Industries. Locate for optimum viewing and without interference with the operation and maintenance of equipment.
- D. Verify identity of each item before installing identification products.
- E. Labeling abbreviations not permitted without F&I approval.

- F. Temporary markings allowed only if removable without damage to equipment or enclosure finish.
- G. System Identification Color-Coding Bands for Raceways: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.
 - 1. 208/120V Blue
 - 2. 480/277V Yellow
 - 3. Controls Black
- H. Cable Ties: For attaching tags. Use general-purpose type, fungus inert, self-extinguishing, one piece, self-locking Type 6/6 nylon, except as listed below:
 - 1. Outdoors: UV-stabilized nylon.
 - 2. In spaces handling environmental air: Plenum rated.
- I. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.
- J. Coordinate names, abbreviations, colors, graphics and other designations used for electrical identification with corresponding designations used in the Contract Documents or as required by codes and standards. Use consistent designations throughout the Project. Labeling abbreviations are not allowed.
- K. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish Work.
 - 1. Coordinate installing electrical identifying labels prior to installing acoustical ceilings and similar finishes that conceal such items.
- L. Clean surfaces of dust, loose material, and oily films before applying painted or self-adhesive identification products.
- M. Painted Identification Products:
 - 1. Prime surfaces according to manufacturer's instructions prior to applying painted labels:
 - a. For galvanized metal, use single-component, acrylic vehicle coating formulated for galvanized surfaces.
 - b. For concrete masonry units, use heavy-duty, acrylic-resin block filler.
 - c. For concrete surfaces, use clear, alkali-resistant, alkyd binder-type sealer.
 - 2. Apply one intermediate and one finish coat of paint.

3.02 IDENTIFICATION SCHEDULE

- A. Panelboard Schedules:

1. Panelboard schedules shall utilize the POS standard panel schedule in Microsoft Excel format which has provision for totaling all loads and performing demand calculations by load category.
 2. Electronic copies of schedules are available from the Facilities and Infrastructure department. The STIA standard template is available on the Port of Seattle internet site, included with the STIA Electrical Standards. <http://www.portseattle.org/Business/Construction-Projects/Airport-Tenants/Pages/Reference-Documents.aspx>.
 3. This schedule shall be updated with as-built information upon the completion of the project. The contractor shall post a hard copy of the revised panel schedule in any panel modified and submit an electronic copy of the panel schedule in Port standard excel format showing accurate as-built information to F&I.
- B. Instrumentation Labels: Affix permanent type nameplate or tag on all field-mounted instruments, transmitters, pressure gauges, and control valves with proper identification number and service description.
1. Provide 3"x1" aluminum or stainless steel tag stamped with the instrument loop number designation and the calibrated range.
- C. Medium Voltage Raceways: Provide 5/8 inch high stenciled or manufactured letters noting "HIGH VOLTAGE", black letters on yellow background on all exposed feeder conduits where entering or leaving switchboards and along conduit runs at 25 feet on center.
- D. Accessible Raceways, More Than 600 V: Self-adhesive vinyl labels. Install labels at all conduit penetrations and along length of exposed conduit run at 25 foot maximum intervals.
- E. Accessible Raceways within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage.
1. Provide labels on all raceways, junction and pull boxes indicating panel designation and circuit number for all circuits in raceway or box, and conduit destination.
 - a. Conduit Label Example: B2-P4-23G-1/1,3,5, B-2601-9.
 - b. Provide labels at all locations where conduit penetrates walls, floors and ceilings, on both sides of penetration.
 - c. Provide labels at all ends or breaks in conduit runs such as electrical rooms, junction boxes, pull boxes, cabinets, maintenance holes, fire penetrations, etc.
 - d. Provide labels on each conduit entering junction or pull box within 12" of junction or pull box.
 - e. Provide labels at 25 foot maximum intervals along conduit runs.
 - f. Provide labels on all junction and pullboxes, including in accessible ceiling spaces and exposed in unfinished areas. Refer to specification sections for identification requirements for systems contained within.
 - g. Install labels parallel to equipment lines.

- h. Labels in unfinished locations, including in accessible ceiling spaces and exposed unfinished areas shall be machine printed vinyl labels minimum ½ inch high, white with black letters. Labels in finished locations shall be adhesive-backed plastic machine printed labels, minimum 3/8 inch high, white with black letters.
 - i. Lettering shall be a minimum of ¼" high.
 - j. In finished locations, provide labels on inside of junction or pull box cover.
 - k. Provide red lettering when served by an emergency source.
- F. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
 - 1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for feeder and branch-circuit conductors.
 - a. Provide colored insulation when available, typically for wire sized #8 AWG and smaller.
 - b. Provide minimum 2 inch wide band of colored plastic tape at all terminations and splices (where allowed). 3M Scotch No. 35, [], Or Approved Equal Electrical Color Coding Tape.
 - c. Colors for 480/277V 3Ø, 4-wire systems:
 - (1) Phase A (left or top): Brown.
 - (2) Phase B (center): Orange
 - (3) Phase C (right or bottom): Yellow
 - (4) Neutral: Gray
 - (5) Ground: Green
 - d. Colors for 208/120V, 3Ø, 4-wire systems:
 - (1) Phase A (left or top): Black
 - (2) Phase B (center): Red
 - (3) Phase C (right or bottom): Blue
 - (4) Neutral: White
 - (5) Ground: Green
 - (6) Isolated Ground: Green with yellow or orange stripe
 - e. 575V, 3Ø, 4-wire systems
 - (1) Phase A (left or top): Brown with purple stripe
 - (2) Phase B (center): Orange with purple stripe
 - (3) Phase C (right or bottom): Yellow with purple stripe
 - (4) Neutral: Gray with purple stripe
 - (5) Ground: Green

- f. Colors for 120/240V, 1Ø, 3-wire systems: (non-standard)
 - (1) Phase A: Black
 - (2) Phase B: Red
 - (3) Neutral: White
 - (4) Ground: Green
 - g. For 240-delta systems (obsolete) the color of the high leg (approximately 200 volts to ground) shall be red. Label interior of all equipment "CAUTION: HIGH LEG IS OVER 120V TO GROUND. DO NOT USE FOR 120V CIRCUITS".
 - h. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- 2. Provide wire markers on each conductor in panelboards, gutters, pull boxes, outlet and junction boxes and at the load connection. Identify with branch circuit or feeder number for power and lighting circuits.
 - a. Install conductor labeling in panelboards and enclosures to ensure labels are visible.
- G. Power-Circuit Conductor Identification, Medium Voltage: Provide labeling at all accessible locations including each termination or interconnection of wiring, and in vaults, pull and junction boxes, manholes, and handholes. Identify conductors with cloth type, split sleeve or tubing type wire and cable markers.
 - 1. Label each cable with phase designation, operating voltage and circuit number.
 - 2. Color Coding for Phase:
 - a. 4160Y/2400V AC 3Ø, 4-wire:
 - (1) Phase A: Black/Pink
 - (2) Phase B: Red/Pink
 - (3) Phase C: Blue/Pink
 - (4) Neutral: White/Pink
 - b. 4160V Delta AC, 3Ø, 4-wire
 - (1) Phase A: Black/Brown
 - (2) Phase B: Red/Brown
 - (3) Phase C: Blue/Brown
 - c. 12,470V Delta AC, 3Ø, 4-wire
 - (1) Phase A: Black/Orange
 - (2) Phase B: Red/Orange
 - (3) Phase C: Blue/Orange

3. Provide write-on tags or nonmetallic plastic tag holder with adhesive-backed phase tags, and a separate tag with the circuit designation.
- H. Install instructional sign including the color code for grounded and ungrounded conductors using adhesive-film-type labels.
- I. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive vinyl labels with the conductor or cable designation, origin, and destination.
 1. Provide wire markers on each conductor in wire gutters, pull boxes, outlet and junction boxes and at the equipment connection. Identify with control wire number as indicated on schematics and interconnection diagrams or equipment manufacturer's shop drawings for control wiring.
- J. Control-Circuit Conductor Termination Identification: For identification at terminations provide heat-shrink preprinted tubes with the conductor designation
- K. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.
- L. Conductor Identification:
 1. Conductors to Be Extended in the Future: Indicate source and circuit numbers.
 2. Multiple Power or Lighting Circuits in the Same Enclosure: Identify each conductor with source, voltage, circuit number, and phase. Use color coding for voltage and phase indication of secondary circuit.
 3. Multiple Control and Communications Circuits in the Same Enclosure: Identify each conductor by its system and circuit designation. Use a consistent system of tags, color coding, or cable marking tape.
- M. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
 1. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- N. Workspace Indication: Install floor marking tape or paint to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- O. Warning, Caution, and Instruction Signs:
 1. Install warning, caution, and instruction signs where indicated or required to ensure safe operation and maintenance of electrical systems and of items to which they connect. Provide OSHA standard text where approved. Provide text of sufficient clarity and lettering of sufficient size to convey

- adequate information at each location. Mount permanently in an appropriate location. Comply with ANSI A13.1 standard color and design.
2. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
 3. Emergency-Operating Signs: Install engraved laminate signs with white legend on red background with minimum 3/8-inch high lettering for emergency instructions on power transfer, load shedding, and other emergency operations.
- P. Apply equipment identification labels of engraved plastic laminate on each major unit of equipment, including central or master unit of each system. This includes communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification. Except as otherwise indicated, provide a single line of text with 1/4-inch high lettering on 1-inch high label. Use white lettering on black field. Apply labels parallel to equipment lines.
- Q. Outdoor Equipment: Engraved, laminated acrylic or melamine label, to comply with requirements listed above. Provide panel schedule printed on 8.5x11 paper in Port standard format in each panelboard. Insert folded schedule in schedule holder on inside of panel door. Posted panel schedule shall be updated to reflect all new work in panel. Include project completion date on schedule.
- R. Provide self-adhesive tape labels on all receptacle cover plates. Labels shall be machine printed with black lettering on white or clear background.
1. Indicate source panel name and circuit number.
 2. Provide red lettering on white or clear background for devices on emergency circuits.
 3. Where receptacle faceplate is dark color, provide white letters on clear background.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

- A. For incidental work:
- No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.
- B. For Work separately paid:
- The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any

Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of "Acceptance Testing" Work is shown in the Contract Documents. This section includes requirements for acceptance testing by an independent testing agency.
- B. Test, inspect and calibrate electrical equipment and material installed and connected under Division 26. The purposes of these inspections, tests and calibrations are to assure that the installed electrical systems and equipment are:
 - 1. Installed in accordance with design specifications and manufacturer's instructions,
 - 2. Ready to be energized,
 - 3. Operational and within industry and manufacturer's tolerances.
- C. Provide all material, equipment, labor, and technical supervision to perform specified tests, inspections, studies and calibration.
- D. Provide the services of an independent electrical testing firm (ETF) to perform the acceptance testing, inspection and calibration of electrical systems as specified in this Section.
- E. Perform short circuit and coordination studies based on the installed electrical system and equipment.

1.02 GOVERNING CODES, STANDARDS AND REFERENCES

- A. All inspections and tests shall be in accordance with the following applicable standards and codes. These publications form a part of this specification to the extent referenced.
 - 1. American National Standards Institute – ANSI.
 - 2. ASTM D877 – Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes.
 - 3. IEEE 81 – Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.
 - 4. IEEE 400 – Guide for Making High-Direct-Voltage Tests on Power Cable Systems in the Field.
 - 5. NFPA 70 (National Fire Protection Association) – National Electrical Code.
 - 6. ANSI/ICEA S-95-658/NEMA WC70 – Nonshielded 0-2kV Cables.
 - 7. ANSI/ICEA S-96-659/NEMA WC71 – Nonshielded 2001-5kV Cables.
 - 8. ANSI/ICEA S-93-639/NEMA WC74 – Shielded Power Cable 5-46 kV.
 - 9. International Electrical Testing Association – NETA.
 - 10. National Fire Protection Association – NFPA.
 - 11. Occupational Safety and Health – OSHA 29CFR Part 1910.269.

12. State and Local Codes and Ordinances.

1.03 SUBMITTALS

- A. Submit materials data in accordance with of Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.
- B. Submittals shall include the following:
 - 1. Submittals by the Testing Firm:
 - a. Field Test Reports: Maintain a written record of all tests. Assemble and certify a final test report upon completion of the project, showing dates, personnel making tests, equipment used, equipment or material tested, tests performed, and results.
 - b. The field test forms included in the report shall be the original hand-written test results that were recorded and signed by the individual(s) who performed the testing.
 - c. Submit a final report of testing and inspection at the completion of the project. Include the following information:
 - (1) Summary of the project
 - (2) Description of the equipment tested
 - (3) Visual inspection report
 - (4) Description of the tests
 - (5) Test results
 - (6) Conclusions and recommendations
 - (7) Appendix including appropriate test forms
 - (8) Identification of the test equipment used and calibration date
 - (9) Signature of test engineer

1.04 TESTING FIRM REQUIREMENTS AND QUALITY ASSURANCE

- A. The Testing Firm shall be an independent testing organization which can function as an unbiased testing authority, professionally independent of the manufacturers, suppliers and installers of equipment or systems being evaluated, and regularly engaged in the testing of electrical equipment, devices, installations and systems. The Testing Firm shall have been in business for a minimum of 10 years and meet OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907, or shall be a full member company of the International Electrical Testing Association (NETA).
 - 1. Acceptable Testing Firms:
 - a. Electrical-Testing Inc. (ETI)
 - b. Apparatus Service and Engineering Technology. (ASET)
 - c. Siemens
 - d. Cutler-Hammer Engineering Services and Systems.

- e. Or Approved Equal.
- B. Testing Firm's Field Supervisor Qualifications: A person, regularly employed by the firm for testing services, and currently certified by the International Electrical Testing Association to supervise on-site testing specified.
- C. Submit proof of the above qualifications with bid documents, if requested.
- D. General Scope: Engage the services of a recognized independent testing firm for the purpose of performing quality control inspections and tests as herein specified.
 - 1. The Testing Firm shall provide all material, equipment, labor and technical supervision to perform all tests and inspections to determine suitability of equipment for energization and continued reliable operation.
 - 2. The purpose of these tests is to assure that all tested electrical equipment, both Contractor- and Owner-supplied, is operational within industry and manufacturer's tolerances and that equipment is installed and functioning in the system in accordance with design specifications of the Engineer.
 - 3. The Testing Firm (not the Contractor) shall inspect and test the following equipment:
 - a. Low-voltage switchboards.

1.05 DIVISION OF RESPONSIBILITY

- A. Coordinate all testing in accordance with Section 01 91 00 – Commissioning.
- B. The Contractor shall perform routine insulation-resistance, continuity, and rotation tests for all distribution and utilization equipment prior to, and in addition to tests performed by the Independent Testing Firm.
- C. The Contractor shall supply a suitable and stable source of electrical power to each test site. The Testing Firm shall determine the specific power requirements.
- D. The Contractor shall notify the Testing Firm when equipment becomes available for acceptance tests. Coordinate Work to expedite project scheduling.
- E. The Project Electrical Engineer shall supply a short-circuit and protective device coordination study, a protective device setting form, a complete set of electrical drawings and specifications, and any pertinent change orders to the Testing Firm prior to commencement of testing.
- F. Maintain a written record of all tests and, upon completion of project, assemble and submit a certified final test report that includes the test procedures and test results for each system and equipment item.
- G. The Testing Firm shall notify the Port's Representative prior to commencement of any testing.
- H. The following table defines the main responsible parties for the various tests.

DIVISION 26 - ELECTRICAL
Section 26 08 00 - Commissioning Electrical Systems

TEST ITEM	ELECTRICAL ACCEPTANCE TESTING PRIMARY RESPONSIBILITIES				COMMENTS
	Construction Contractor	Independent Testing Firm	Field Service Engineer of Switchgear Manufacturer	Owner (Port)	
Grounding; Substation and Underground Ducts and Manholes		X			
Control/Signal Transmission Media and Power Monitoring		X			
600 Volt or Less Wire and Cable	X	X			Megger testing by Construction Contractor, other tests by Independent Testing Firm.
Medium-Voltage Cable		X			
Wiring Devices		X			
Medium-Voltage Power Factor Correction Capacitors		X			
Medium-Voltage Metal-Clad Switchgear		X	X		Infrared scanning by Independent Testing Firm, all other tests by Field Service Engineer.
Automatic Transfer Switch		X			
Station Battery, Charger and Eyewash		X			
Panelboards		X			
Interior Lighting	X				
Exterior Lighting	X				
Lighting Controls	X				
Security System				X	
Fire Alarm				X	
Miscellaneous (Sump Pumps, HVAC, etc.)		X			

1.06 SAFETY

- A. Adhere to safety procedures as required by the following:
 - 1. Occupational Safety and Health Act.
 - 2. Accident Prevention Manual for Industrial Operations, National Safety Council.
 - 3. ANSI/NFPA 70E, Electrical Safety Requirements for Employee Workplaces.
 - 4. American National Standards for Personnel Protection: Lockout/Tagout.
 - 5. Applicable state and local safety operating procedures.
 - 6. Port of Seattle safety practices.
- B. Perform all tests with apparatus de-energized, except where specifically required.
- C. Designate a Project Safety Representative to supervise operations with respect to safety.

PART 2 PRODUCTS

2.01 TEST EQUIPMENT

- A. Utilize test equipment in good mechanical and electrical condition with shape and frequency output waveforms appropriate for the test and the tested equipment.
 - 1. Accuracy shall be appropriate for the test being performed, but not in excess of 2% of the scale being used.
- B. Field test meters used to check installed power system instrument calibration must have a higher accuracy than that of the instrument being checked.

2.02 TEST INSTRUMENTS AND CALIBRATION

- A. The Testing Firm shall have a calibration program which assures that all applicable test instruments are maintained within rated accuracy as dictated by the National Institute of Standards and Technology (NIST).
 - 1. Instruments calibration schedule:
 - a. Field instruments: Analog, 6 months maximum; Digital, 12 months maximum.
 - b. Laboratory instruments - 12 months.
 - c. Leased specialty equipment - 12 months (where lessor guarantees accuracy).
 - 2. Provide visible dated calibration labels on all test equipment.
 - 3. Maintain up-to-date instrument calibration instructions and procedures for each test instrument.
- B. Provide all testing equipment required including, but not limited to, the following:
 - 1. Wet and dry-bulb thermometer.
 - 2. 500V and 1000V meggers.

3. Battery-powered portable telephone sets.
4. Multimeter (Volts-Ohms-Millimeter) rated 20k ohms per volt or higher.
5. Three-phase rotation meter, 60-Hz.
6. Commercial model three-point earth ground test set that reads directly in ohms.
7. Miscellaneous cable, test leads, jumpers, test lights, buzzers, bells, switches, plugs, receptacles, and other test equipment as required.
8. Insulation Tester (Megger): 2,000 Megohms for 600V and below. Use appropriate rated megger for tests on MV systems prior to Hi- Pot.
9. Dranetz, BMI Model 355, Fluke 41 or F&I approved equivalent recording type harmonic analyzer to display individual and total harmonic currents and voltages.
10. Clamp-on Ammeter.
11. Circuit Breaker Current Injections Test Set.

2.03 TEST REPORT

- A. Include the following:
 1. Summary of Project.
 2. Description of equipment tested.
 3. Description of test.
 4. Test results.
 5. Analysis and recommendations.
 6. Appendix, including appropriate test forms.
 7. List of test equipment used and calibration date.
- B. Furnish 5 copies of the completed report to the Port no later than thirty days after completion of the project.

PART 3 EXECUTION

3.01 TESTING

- A. General requirements: Test all wire, cable, and electrical equipment installed and connected by the Contractor to assure proper installation, setting, connection, and function as indicated or to conform to Contract Documents and manufacturer's instructions. As an exception to requirements stated elsewhere in the Contract, give the Port at least 7 calendar days' notice of the dates and times scheduled for tests (except megger tests) so that Port's Representative may witness the tests. After the installation has been completed, the Contractor shall conduct an operating test demonstrating that all equipment and devices operate in accordance with the requirements of the plans and specifications.
 1. Test, inspect and calibrate the following electrical equipment in strict accordance with applicable sections of NETA ATS-, including applicable optional tests:

- a. Electrical equipment as specified in Division 26.
 - b. Electrical equipment shown on the electrical Drawings.
 - c. Electrical equipment furnished under other Divisions of the Specifications and connected under Division 26.
2. Perform acceptance tests and inspections prior to energizing equipment.
3. Perform tests recommended by the equipment manufacturer.
4. Perform additional tests issued by the Port which are required due to field conditions.
5. Final acceptance will not occur before completion of the electrical acceptance tests, inspections and calibrations specified in this Section.
6. Be responsible for all damage to equipment or material due to improper test procedures or test apparatus handling.
- B. Switchboards and Panelboards
 1. Test and inspect low voltage switchboards and power panelboards in accordance with NETA ATS Section 7.1, and manufacturer's instructions.
 2. Test and inspect 150 ampere and larger circuit breakers and all main circuit breakers in accordance with NETA ATS section 7.6.1.1, and manufacturer's instructions.
- C. Dry-type Transformers
 1. Test and inspect low voltage dry-type transformers in accordance with NETA ATS Section 7.2.1.1, and manufacturer's instructions.
- D. Motor Control Centers
 1. Test and inspect low voltage motor control centers in accordance with NETA ATS Section 7.16.1, and manufacturer's instructions.
 2. Test and inspect 150 ampere and larger circuit breakers and all main circuit breakers in accordance with NETA ATS Section 7.6.1.1, and manufacturer's instructions.
- E. Low Voltage Power Cable
 1. Test and inspect low voltage power cable and terminations in accordance with NETA ATS Section 7.3.2, and manufacturer's instructions.
- F. Grounding System
 1. Test and inspect medium voltage power cable and terminations in accordance with NETA ATS Section 7.13.3.
- G. Control Scheme Tests: Test all electrical controls via trial operation of control equipment after all wiring is completed. Check to see that each interlock and control function operates to conform to the sequence of operation, as indicated in the schematic diagrams and the manufacturer's operating instructions.

3.02 IDENTIFICATION

- A. Upon completion of the tests and inspections noted in these specifications, attach a label to all serviced devices indicating the date serviced and the testing company responsible.

3.03 SYSTEM FUNCTION TESTS

- A. Perform function tests on each system provided in this contract and covered by this Section to ensure total system operation.
- B. Perform the system functional tests upon satisfactory completion of equipment acceptance tests. It is the intent of system functional tests to prove the proper interaction of all sensing, processing, and action devices to effect the designed end product or result.
- C. Test interlocks, safety devices, fail-safe functions, and design functions.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.
- B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of "Dry-Type Transformers" Work is shown in the Contract Documents. This section includes Dry-Type Transformers, under 600-Volt Class, of the following types:
 - 1. Single-Phase, 3-167 kVA
 - 2. Three-Phase, 3-1000 kVA

1.02 GOVERNING CODES, STANDARDS AND REFERENCES

- A. NEMA 250 (National Electrical Manufacturers Association) - Enclosures for Electrical Equipment (1000 Volts Maximum),
- B. NEMA ST 20 (National Electrical Manufacturers Association) - Dry-Type Transformers for General Applications,
- C. NETA ATS (International Electrical Testing Association) - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems,
- D. NFPA 70 (National Fire Protection Association) - National Electrical Code,
- E. UL 1561 - (Underwriters Laboratory) - Dry Type General Purpose and Power Transformers,

1.03 SUBMITTALS

- A. Submit materials data in accordance with of Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.
- B. Submittals shall include the following:
 - 1. Product Data: Submit outline and support point dimensions of enclosures and accessories, unit weight, voltage, kVA, and impedance ratings and characteristics, tap configurations, insulation system type, rated temperature rise, compliance with seismic rating and labeling requirements.
 - 2. Test Reports: Indicate loss data, efficiency at 25, 50, 75 and 100 percent rated load, and sound level.
 - 3. Manufacturer Seismic Qualification Certification: Submit certification that transformers will withstand seismic forces defined in Section 26 05 48 - Seismic Controls for Electrical and Communication Work. Include the following:
 - a. Basis of Certification: Verify whether withstand certification is based on actual test of assembled components.
 - (1) The term "withstand" means the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event.
 - 4. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

5. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.04 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years successful in-service performance.
- B. Listing and Labeling: Provide components, devices, and accessories that are Listed and Labeled as defined in NFPA 70, Article 100 and marked for intended use for the location and environment in which they are installed.
- C. Comply with NFPA 70, as adopted and administered by the Authority Having Jurisdiction.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

1.06 COORDINATION

- A. Coordinate layout and installation of transformers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access and ventilation.
- B. Coordinate size and location of concrete bases with actual equipment supplied. Cast anchor-bolt inserts into bases, in accordance with drawings and Section 26 05 48 - Seismic Controls for Electrical and Communication Work. Refer to Division 3 Concrete for concrete, reinforcement, and formwork requirements.
- C. Coordinate equipment supports, roof penetrations, and installation of roof curbs. Refer to Division 7 Thermal and Moisture Protection for roof accessory requirements.

PART 2 PRODUCTS

2.01 GENERAL PURPOSE TWO-WINDING TRANSFORMERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Eaton.
 2. General Electric Co.
 3. Siemens.
 4. Square D Co.; Division of Schneider Electric.
 5. Or Approved Equal.
- B. Label: UL label required (except 1000 kVA 3-phase).
- C. Construction:

1. Description: Copper, two-winding, dry-type, 3-phase units using 1 coil per phase in primary and secondary, size as indicated.
2. Compliance: Comply with NEMA ST 20 and UL 1561.
3. Insulation Class:
 - a. 15 kVA and smaller - 185°C class.
 - b. Larger than 15 kVA - 220°C class.
4. Insulation Temperature Rise:
 - a. 1-phase - 115°C rise above 40°C ambient.
 - b. 3-phase - 115°C rise above 40°C ambient.
5. Basic Impulse Level:
 - a. 3-300 kVA - 10kV
 - b. Over 300 kVA - 30kV
6. Impedance (%Z): Between 3% and 5% unless otherwise approved by F&I, including K-rated transformers.
7. Taps: 2-2 1/2% FCAN, 2-2 1/2% FCBN
8. Enclosure:
 - a. Indoor, ventilated: NEMA 3R
 - b. Outdoor, ventilated, raintight, NEMA 3R
 - c. Outdoor areas, Ramp and Airfield: NEMA 3R Vacuum Pressure Insulated (VPI) with openings facing toward building.
 - d. Outdoor, other locations: Totally enclosed, non-ventilated, raintight NEMA 3R.
 - e. Finish: ANSI 61 gray.
9. Case temperature: 35°C rise above ambient at warmest point at full load.
10. Sound Level Standards: Sound level standards as defined in NEMA and ANSI.
11. K-Factor transformers: Purpose-designed for high harmonic loads, 200% neutral, electrostatic shield.
12. Nameplate: Include transformer rating, transformer connection data and K-Factor (where applicable).
13. Seismic Rating: Refer to Section 26 05 48 - Seismic Controls for Electrical and Communication Work.

D. Ratings:

1. Single-Phase Transformers (3-167kVA)
 - a. Primary Winding: 240/480 Volts.
 - b. Secondary Winding: 120/240 Volts.
 - c. Taps: 2-2 1/2% FCAN, 2-2 1/2% FCBN

2. Three-Phase Transformers (3-1000kVA).
 - a. Primary Winding: 480 Volts.
 - b. Secondary Winding: 208Y/120 Volts.

2.02 SOURCE QUALITY CONTROL

- A. Production tests each unit according to NEMA ST 20.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine surfaces to receive transformers for compliance with installation tolerances, ventilation requirements and other conditions affecting performance.
 1. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Verify mounting supports are properly sized and located, including concealed support bracing in walls.

3.02 INSTALLATION

- A. Set transformer plumb and level.
- B. Verify continuity and tightness of ground connections.
- C. Provide grounding electrode, grounding electrode conductor, and bonding jumper required for separately derived system per NEC Article 250-30.
- D. Install indoor and outdoor transformers on 3-1/2" minimum housekeeping pad and secure to pad with suitable concrete. Concrete shall be a minimum 3000-psi. See 26 05 48 - Seismic Controls for Electrical and Communication Work.
 1. Concrete bases shall be leveled to no more than 0.25 inches of deviation for every 3 feet in ALL directions.
 2. Contractor shall notify Resident Engineer prior to concrete pour to measure concrete base and assess base's levelness.
 3. Concrete bases shall have smooth finishes. Broom finishes are prohibited.
- E. Use flexible conduit, 2 feet minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.
- F. Anchor transformers according to Section 26 05 48 - Seismic Controls for Electrical and Communication Work.
 1. Mount wall-mounted transformers using integral flanges or accessory brackets furnished by the manufacturer.
 2. Mount floor-mounted transformers on vibration isolating pads suitable for isolating the transformer noise from the building structure.
 3. Trapeze-mounted transformers are not allowed unless specifically detailed on Drawings.
- G. Obtain approval of Structural Engineer licensed in the State of Washington for all transformer installations above floor level.

- H. Provide grounding and bonding for separately derived system in accordance with Section 26 05 26 - Grounding and Article 250-30 of the National Electrical Code.

3.03 IDENTIFICATION

- A. Provide labels for enclosures and components as specified in Section 26 05 53 - Electrical Identification.
- B. Indicate transformer equipment designation, kVA rating, and primary and secondary voltage ratings.
- C. Provide warning and caution signs where indicated or required by the Authority Having Jurisdiction.

3.04 FIELD QUALITY CONTROL

- A. Perform inspections and tests listed in NETA ATS, Section 7.2.1.
- B. Measure primary and secondary voltages and make appropriate tap adjustments.
- C. Adjust buck-boost transformer connections to provide optimum voltage conditions at utilization equipment throughout the normal operating cycle of the facility.
- D. Adjust voltage regulators to provide optimum voltage at equipment served throughout the normal operating cycle of the facility.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.
- B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of "Low-Voltage Switchboards" Work is shown in the Contract Documents. This section includes service entrance and distribution switchboards rated 600V and less, 400 amp through 2000 amp, indoor, outdoor, circuit breaker and fused types.
- B. DEFINITIONS
 - 1. EMI: Electromagnetic interference.
 - 2. GFCI: Ground-fault circuit interrupter.
 - 3. RFI: Radio-frequency interference.
 - 4. RMS: Root mean square.
 - 5. SPDT: Single pole, double throw.
 - 6. TVSS: Transient voltage surge suppressor.

1.02 GOVERNING CODES, STANDARDS AND REFERENCES

- A. NEMA PB 2 (National Electrical Manufacturers Association) - Deadfront Distribution Switchboards,
- B. NEMA 250 (National Electrical Manufacturers Association) - Enclosures for Electrical Equipment (1000 Volts Maximum),
- C. NETA ATS (International Electrical Testing Association) - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems,
- D. NFPA 70 (National Fire Protection Association) - National Electrical Code,
- E. UL 891 (Underwriter's Laboratory) - Dead-Front Switchboards,

1.03 SUBMITTALS

- A. Submit materials data in accordance with of Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.
- B. Submittals shall include the following:
 - 1. Product Data: For each type of switchboard, overcurrent protective device, TVSS device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
 - 2. Shop Drawings: For each switchboard and related equipment.
 - a. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - (1) Enclosure types and details for types other than NEMA 250, Type 1.
 - (2) Bus configuration, current, and voltage ratings.

- (3) Short-circuit current rating of switchboards and overcurrent protective devices.
 - (4) Utility company's metering provisions with indication of approval by utility company.
 - (5) Series rating of installed devices is NOT ALLOWED.
 - (6) Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
- b. Wiring Diagrams: Diagram power, signal, and control wiring and differentiate between manufacturer-installed and field-installed wiring.
- 3. Manufacturer Seismic Qualification Certification: Submit certification that switchboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Section 26 05 48 - Seismic Controls for Electrical and Communication Work. Include the following:
 - a. Basis of Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - b. The term "withstand" means "the unit will remain in place without separation of internal and external parts during a seismic event and the unit will be fully operational after the event."
- 4. Dimensioned Outline Drawings of Equipment Unit: Provide equipment weight, identify center of gravity and locate and describe mounting and anchorage provisions.
- 5. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- 6. Field Test Reports: Submit written test reports and include the following:
 - a. Test procedures used.
 - b. Test results that comply with requirements.
 - c. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- 7. Manufacturer's field service report.
- 8. Maintenance Data: For switchboards and components to include in maintenance manuals specified in Division 1 General Requirements. In addition to requirements specified in Division 1 General Requirements , Section 01 78 23.13 - Operations and Maintenance Data include the following:
 - a. Routine maintenance requirements for switchboards and all installed components.
 - b. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

- c. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.04 QUALITY ASSURANCE

- A. Listing and Labeling: Provide switchboards that are Listed and Labeled as defined in NFPA 70, Article 100 and marked for intended use for the location and environment in which they are installed.
- B. Comply with NEMA 250, NEMA PB 2 and UL 891.
- C. Comply with NFPA 70, as adopted and administered by the Authority Having Jurisdiction. Particular attention is drawn to Article 384, "Switchboards and Panelboards"
- D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards, including clearances between switchboards, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- E. Provide UL service entrance label for all equipment serving as service entrances.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver in sections of lengths that can be moved past obstructions in delivery path. Shipping splits shall not exceed 72-inches.
- B. Store indoors in clean dry space with uniform temperature to prevent condensation. Protect from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- C. Handle switchboards according to NEMA PB 2.1.

1.06 PROJECT CONDITIONS

- A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.
- B. Existing Utilities: Do not interrupt utilities serving facilities occupied by the Port or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify the Engineer not less than seven days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without the Engineer's written permission.
 - 3. Coordinate with requirements specified in Section 01 50 00 - Temporary Facilities and Controls for temporary utilities
 - 4. Field Measurements: Verify dimensions by field measurements.
- C. Environmental Limitations: Rate equipment for continuous operation under the following, unless otherwise indicated:
 - 1. Ambient Temperature: Not exceeding 104°F (40°C).
 - 2. Altitude: Not exceeding 1000 feet.

1.07 COORDINATION

- A. Coordinate layout and installation of switchboards and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required clearances for equipment access doors and panels, workspace clearances, and maintenance clearances for mechanical equipment.
- B. Coordinate size and location of concrete bases. Refer to Section 03 30 00 - Cast-in-Place Concrete for concrete, reinforcement, and formwork requirements.
- C. Provide dedicated electrical equipment space in accordance with NEC 110-26.

1.08 EXTRA MATERIALS

- A. Spare and extra parts shall be identified for all products, but not provided. Include spare parts information in Operation and Maintenance Manuals.
 - 1. Fuses: 3 of each type and rating used. Include spares for the following:
 - 2. Potential transformer fuses.
 - 3. Control-power fuses.
 - 4. Fuses and fusible devices for fused circuit breakers.
 - 5. Fuses for fused switches.
 - 6. Fuses for fused power-circuit devices.
 - 7. Indicating Lights: 2 of each type installed.
 - 8. Touchup Paint: 3 containers of paint matching enclosure finish, each one-half pint.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cutler-Hammer; Division of Eaton.
 - 2. General Electric (only if rated for 40°C ambient operation).
 - 3. Square D Co;
 - 4. Or Approved Equal.

2.02 MANUFACTURED UNITS

- A. Switchboards shall not require side or rear access unless engineering considerations dictate otherwise.
- B. Front-Connected, Front-Accessible Switchboard: Panel-mounted main device, panel-mounted branches, and with sections rear aligned.
- C. Front- and Side-Accessible Switchboard: Fixed, individually mounted main device, panel-mounted branches, and with sections rear aligned.
- D. Front- and Rear-Accessible Switchboard: Front and rear aligned, with features as follows:
 - 1. Main Devices: Panel mounted.

- 2. Branch Devices: Panel mounted through 800 amps.
- 3. Branch Devices: Fixed, individual compartments above 800 amps.
- E. Nominal System Voltage: 480Y/277 Volts, 3-phase, 4-wire.
- F. Seismic Rating: Refer to Section 26 05 48 – Seismic Controls for Electrical and Communication Work.
- G. Operating Temperature: The entire switchboard shall be designed for continuous operation at nameplate rated values in an ambient temperature of 40°C.
 - 1. Maximum bus temperature shall not exceed 65°C rise over 40°C ambient.
- H. Main-Bus Continuous: 1200A rating.

2.03 FABRICATION AND FEATURES

- A. Enclosure: Steel: NEMA 250, TYPE 1
- B. Enclosure Finish for Outdoor Units: Factory-applied finish in manufacturer's standard color, including undersurfaces treated with corrosion-resistant undercoating.
- C. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.
- D. Barriers: Between adjacent switchboard sections.
- E. Insulation and isolation for main bus of main section and main and vertical buses of feeder sections.
- F. Utility Metering Compartment: Fabricated compartment and section complying with utility company's requirements. If separate vertical section is required for utility metering, match and align with basic switchboard.
- G. Metering: Make provisions for remote monitoring and revenue metering of main and feeder breakers that are compatible with EATON PXM 3000 metering over airport-wide TCP/IP Ethernet backbone. All metering shall be revenue grade, .5% accuracy, in compliance with WAC and RCW requirements.
- H. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
- I. Buses and Connections: Three-phase, four-wire, unless otherwise indicated. Include the following features:
 - 1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity with feeder circuit-breaker line connections.
 - 2. Load Terminals: Insulated, rigidly braced, silver-plated, copper runback bus extensions equipped with pressure connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full ampere rating of circuit-breaker position.
 - 3. Ground Bus: 1/4-by-2-inch minimum size, drawn-temper copper of 98 percent conductivity, equipped with pressure connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

4. Contact Surfaces of Buses: Silver plated. NO ALUMINUM BUS WILL BE ALLOWED.
 5. Main Phase Buses, Neutral Buses, and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
 6. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.
 7. Neutral Buses: 100 percent of the ampacity of the phase buses, unless otherwise indicated, equipped with pressure connectors for outgoing circuit neutral cables. Bus extensions for busway feeder neutral bus are braced.
- J. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.
- K. Bus-Bar Insulation: Factory-applied, flame-retardant, 105°C minimum tape wrapping of individual bus bars or flame-retardant, spray-applied insulation of same temperature rating.

2.04 TVSS DEVICES

- A. IEEE C62.41, integrally mounted, plug-in style, solid-state, parallel-connected, sine-wave tracking suppression and filtering modules. UL 1449, second edition, short-circuit current rating matching or exceeding the switchboard short-circuit rating.
1. Fabrication using bolted compression lugs for internal wiring.
 2. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
 3. LED indicator lights for power and protection status.
 4. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
- B. Peak Single-Impulse Surge Current Rating: 160 kA per phase.
- C. Protection modes and UL 1449 SVR for grounded wye circuits with 480Y/277-V, three-phase, four-wire circuits shall be as follows:
1. Line to Neutral: 800 V for 480Y/277, 400 V for 208Y/120.
 2. Line to Ground: 800 V for 480Y/277, 400 V for 208Y/120.
 3. Neutral to Ground: 800 V for 480Y/277, 400 V for 208Y/120.
- D. Protection modes and UL 1449 SVR for 208V or 480V, three-phase, three-wire, delta circuits shall be as follows:
1. Line to Line: 2000 V for 480 V, 1000 V for 240 V.
 2. Line to Ground: 1500 V for 480 V, 800 V for 240 V.
- E. Minimum single-impulse current rating shall be as follows:
1. Line to Neutral: 100,000 amps.

2. Line to Ground: 100,000 amps.
 3. Neutral to Ground: 50,000 amps.
- F. Protection modes shall be as follows:
1. Line to neutral.
 2. Line to ground.
 3. Neutral to ground.
- G. UL 1449 clamping levels shall not exceed 400V, line to neutral and line to ground on 208Y/120V systems and 800V, line to neutral and line to ground on 480Y/277V systems.
- H. Accessories shall include the following:
1. Form-C contacts, one normally open and one normally closed, for remote monitoring of system operation. Contacts to reverse position on failure of any surge diversion module.
 2. Audible alarm activated on failure of any surge diversion module.
 3. Six-digit transient-counter set to totalize transient surges that deviate from the sine-wave envelope by more than 125V.

2.05 OVERCURRENT PROTECTIVE DEVICES

- A. Coordinate trip curves so that faults and shorts will clear at the nearest overcurrent device without tripping upstream devices.
- B. Feeder breakers rated 800A and less shall be group mounted. Feeder breakers rated for greater than 800 amps shall be mounted in individual compartments.
- C. Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents.
1. Ampacity of Molded Case Circuit Breakers may be up to but not including 1200 amps. Comply with UL 489, with interrupting capacity to meet available fault currents.
 2. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for branch circuit-breaker frame sizes 250 A and larger.
 3. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 4. Electronic Trip Unit Circuit Breakers: RMS sensing; field-replaceable rating plug; with the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t response.
 5. Current-Limiting Circuit Breakers: Frame sizes 400A and larger; let-through ratings less than NEMA FU 1, RK-5.

6. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
 7. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection 6 mA trip sensitivity.
 8. Ground-Fault Equipment Protection (GFEP) Circuit Breakers, where required: Class B ground-fault protection (30-mA trip).
- D. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.
1. Lugs: Mechanical style, suitable for number, size, trip ratings, and material of conductors.
 2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
 3. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator. Settings shall be provided by Engineer of Record.
 4. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system.
 5. Shunt Trip: 120V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
 6. Auxiliary Switch: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
 7. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
 8. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
- E. Enclosed, Insulated-Case Circuit Breaker: Fully rated, encased-power circuit breaker with interrupting capacity rating to meet available fault current.
1. Rating range, 1200 amp to 2000 amp.
 2. Fixed circuit-breaker mounting.
 3. Two-step, stored-energy closing.
 4. Microprocessor-based trip units with interchangeable rating plug, LED trip indicators, and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments with I^2t response.
 - d. Ground-fault pickup level, time delay, and I^2t response.
 5. Remote trip indication and control.

6. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system.
 7. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
- F. Bolted-Pressure Contact Switch: For 1200A frame sizes and above. Operating mechanism uses rotary-mechanical-bolting action to produce and maintain high clamping pressure on the switch blade after it engages the stationary contacts.
1. Main-Contact Interrupting Capability: Minimum of 12 times the switch current rating.
 2. Operating Mechanism: Manual handle operation to close switch; stores energy in mechanism for opening and closing.
 - a. Electrical Trip: Operation of lever or push-button trip switch, or trip signal from ground-fault relay or remote-control device, causes switch to open.
 - b. Mechanical Trip: Operation of mechanical lever, push button, or other device causes switch to open.
 3. Auxiliary Switches: Factory installed, single pole, double throw, with leads connected to terminal block, and including one set more than quantity required for functional performance indicated.
 4. Service-Rated Switches: Labeled for use as service equipment.
 5. Ground-Fault Relay: Comply with UL 1053; self-powered type with mechanical ground-fault indicator, test function, tripping relay with internal memory, and three-phase current transformer/sensor.
 - a. Configuration: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - b. Internal Memory: Integrates the cumulative value of intermittent arcing ground-fault currents and uses the effect to initiate tripping.
 - c. No-Trip Relay Test: Permits ground-fault simulation test without tripping switch.
 - d. Test Control: Simulates ground fault to test relay and switch (or relay only if "no-trip" mode is selected).
 6. Open-Fuse Trip Indicating Device: Arranged to trip switch open if a phase fuse opens, mounted on panel.
- G. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle. Fused switches may be applied up to, but not including, 1200-Amp rating where required for interrupting capacity and/or current limiting. Fused bolted pressure switches may be used for mains 1200 Amp and above where required for interrupting capacity current limiting or coordination.
1. Rating: 1200 amp to 2000 amp.

2.06 INSTRUMENTATION

- A. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
 - 1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
 - a. Phase Currents, Each Phase: Plus or minus 1 percent.
 - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
 - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
 - d. Kilowatts: Plus or minus 2 percent.
 - e. Kilovars: Plus or minus 2 percent.
 - f. Power Factor: Plus or minus 2 percent.
 - g. Frequency: Plus or minus 0.5 percent.
 - h. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from 5 to 60 minutes.
 - i. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent. Accumulated values unaffected by power outages up to 72 hours.
 - 2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.
- B. Potential Transformers: IEEE C57.13; 120 V, 60 Hz, single secondary; disconnecting type with integral fuse mountings. Burden and accuracy shall be consistent with connected metering and relay devices.
- C. Current Transformers: IEEE C57.13; 5 A, 60 Hz, secondary; wound type; single secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices. Compatible with EATON PXM 3000 series meters.
- D. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.
- E. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker, ground-fault protection.

2.07 CONTROL POWER

- A. Control Circuits: 120V, supplied through secondary disconnecting devices from control-power transformer.
- B. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.
- C. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for #8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.08 ACCESSORY COMPONENTS AND FEATURES

- A. Spare-Fuse Cabinet: Suitably identified, wall-mounted, lockable, compartmented steel box or cabinet. Arrange for wall mounting.

2.09 Provisions for Expansion:

- A. Make provisions for adding future sections.

PART 3 EXECUTION

3.01 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

3.02 EXAMINATION

- A. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.03 INSTALLATION

- A. Install switchboards and accessories according to NEMA PB 2.1.
- B. Support switchboards on concrete bases, 3-1/2" nominal thickness. Comply with mounting and anchoring requirements specified in Section 26 05 48 - Seismic Controls for Electrical and Communication Work.
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to switchboards.
- C. Provide yellow striping in front of all switchboards outlining required code working space.
- D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.
- E. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

3.04 CONNECTIONS

- A. Install equipment grounding connections for switchboards with ground continuity to main electrical ground bus.
- B. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

1. Mark lugs after torquing with red paint such that paint will be visibly disturbed if lugs are disturbed.

3.05 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

3.06 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components as specified in Section 26 05 53 - Electrical Identification.
- B. Identify switchboard name, designation, power source, source location and voltage.
- C. Label each switchboard fused switch or circuit breaker with engraved laminated-plastic nameplate indicating current rating, load served and load location.
- D. Provide warning and caution signs where indicated or required by the Authority Having Jurisdiction.
- E. Equipment used in emergency systems shall be labeled "Suitable for use on emergency systems" per NEC 700-3.
- F. For fused switches, apply label inside door cover identifying NEMA fuse class and size of fuses installed. Arrange fuses so rating information is readable without removing fuse.

3.07 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
 2. Test continuity of each circuit.
- B. Testing: After installing switchboards demonstrate product capability and compliance with requirements.
 1. Inspect accessible components for cleanliness, mechanical and electrical integrity, and damage or deterioration. Verify that temporary shipping bracing has been removed. Verify that no tools or loose parts are left in the equipment
 2. Inspect bolted electrical connections for completion and tightness.
 3. Perform a ground resistance test
 4. Check the operation at interlocks and switch mechanism.
 5. Procedures: Perform each visual and mechanical inspection and electrical test indicated in NETA ATS, Sections 7.1, 7.5, 7.6, 7.9, 7.10, 7.11, and 7.14 as appropriate. Certify compliance with test parameters.
 6. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 7. Megger test switchboard and feeders with all breakers open before energizing. Use 1000V Megger for 480V equipment and 500V megger for 208V equipment.

8. Verify proper phase rotation
 9. Ensure viability of bonding jumper when switchboards are used as service entrances.
 10. Check load balance. If load unbalance exceeds 10% notify the Engineer for remedial action required.
 11. Verify continuity of equipment grounds and bonding jumper.
 - C. Infrared Scanning: Perform an infrared scan of switchgear two weeks after Substantial Completion and before final acceptance. Make bus joints and connections accessible to a portable scanner and perform scanning during a period of normal working load as advised by Port.
 1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- 3.08 ADJUSTING
- A. Set field-adjustable switches and circuit-breaker trip ranges.
- 3.09 CLEANING
- A. On completion of installation, inspect interior and exterior of switchboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.
- 3.10 STARTUP SERVICES
- A. Engage a factory-authorized service representative to perform startup service.
 - B. Verify that switchboard is installed and connected according to the Contract Documents.
 - C. Verify that electrical control wiring installation complies with manufacturer's submittal by means of point-to-point continuity testing. Verify that wiring installation complies with requirements in Division 26 Electrical Sections.
 - D. Complete installation and startup checks according to manufacturer's written instructions.
- 3.11 DEMONSTRATION AND TRAINING
- A. Engage a factory-authorized service representative to train Port maintenance personnel to adjust, operate, and maintain switchboard.
 1. Train Port maintenance personnel a minimum of four hours on procedures and schedules for energizing and de-energizing, troubleshooting, servicing, and maintaining equipment and schedules.
 2. Review data in maintenance manuals. Refer to Section 01 78 23.13 - Operations and Maintenance Data.
 3. Schedule training with the Port with at least seven days' advance notice.
- 3.12 OPERATION AND MAINTENANCE MANUALS
- A. Comply with Section 01 78 23.13 - Operations and Maintenance Data and Part 1 of this specification.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.

B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of "Panelboards" Work is shown in the Contract Documents. This section includes Load centers, Lighting and Appliance Panelboards 100 amperes through 600 amperes, and Distribution Panelboards 800 amperes through 1200 amperes, rated 600 volts and less.

1.02 GOVERNING CODES, STANDARDS AND REFERENCES

- A. NEMA AB 1 (National Electrical Manufacturers Association) - Molded Case Circuit Breakers,
- B. NEMA FU 1 (National Electrical Manufacturers Association) - Fuses,
- C. NEMA KS 1 (National Electrical Manufacturers Association) - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum),
- D. NEMA PB 1 (National Electrical Manufacturers Association) - Panelboards,
- E. NEMA 250 (National Electrical Manufacturers Association) - Enclosures for Electrical Equipment (1000 Volts Maximum).
- F. NETA ATS (International Electrical Testing Association) - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems,
- G. NFPA 70 (National Fire Protection Association) - National Electrical Code,
- H. UL 50 (Underwriters Laboratory) - Enclosures for Electrical Equipment,
- I. UL 67 (Underwriters Laboratory) - Panelboards,

1.03 SUBMITTALS

- A. Submit materials data in accordance with of Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.
- B. Submittals shall include the following:
 - 1. Product Data: For each type of panelboard, switching and overcurrent protective device, TVSS device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
 - 2. Shop Drawings: For each panelboard and related equipment.
 - a. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - (1) Enclosure types and details for types other than NEMA 250, Type 1.
 - (2) Bus configuration, current, and voltage ratings.
 - (3) Short-circuit current rating of panelboards and overcurrent protective devices.

- (4) Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - (5) Wiring diagrams for power, signal and control wiring.
 - (6) Time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Include selectable ranges for each type of overcurrent protective device.
- 3. Manufacturer Seismic Qualification Certification: Submit certification that panelboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Section 26 05 48 - Seismic Controls for Electrical and Communication Work. Include the following:
 - a. Basis of Certification: Verify whether withstand certification is based on actual test of assembled components.
 - b. The term “withstand” means “the unit will remain in place without separation of internal and external parts during a seismic event and the unit will be fully operational after the event.”
 - c. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - d. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- 4. Field Test Reports: Written reports specified in Part 3.
- 5. Maintenance Data: Include maintenance data for panelboards and components in maintenance manuals specified in Division 1 General Requirements. In addition to requirements specified in Section 01 78 23.13 - Operations and Maintenance Data include the following:
 - a. Manufacturer’s written instructions for testing and adjusting overcurrent protective devices.
 - b. Time-current curves, including selectable ranges for adjustable overcurrent protective devices.
- 6. Panelboard Schedules:
 - a. Panelboard schedules shall utilize the POS standard panel schedule in Microsoft Excel format which has provision for totaling all loads and performing demand calculations by load category.
 - b. Electronic copies of schedules are available from the Facilities and Infrastructure department. The STIA standard template is available on the Port of Seattle internet site, included with the STIA Electrical Standards. <http://www.portseattle.org/Business/Construction-Projects/Airport-Tenants/Pages/Reference-Documents.aspx>.
 - c. This schedule shall be updated with as-built information upon the completion of the project. The contractor shall post a hard copy of the revised panel schedule in any panel modified and submit an

electronic copy of the panel schedule in Port standard excel format showing accurate as-built information.

1.04 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- C. Product Selection for Restricted Space: Verify that product submitted will fit in space shown on drawings and meet NEC working clearance requirements.
- D. Listing and Labeling: Provide components, devices and accessories that are Listed and Labeled as defined in NFPA 70, Article 100 and marked for intended use for the location and environment in which they are installed.
- E. Comply with UL 67, UL50 and NEMA PB 1.
- F. Comply with NFPA 70, as adopted and administered by the Authority Having Jurisdiction.

1.05 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, and encumbrances to workspace clearance requirements.
- B. Pipes and ducts shall not pass over panelboards.

1.06 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

1.07 EXTRA MATERIALS

- A. Spare and extra parts shall be identified for all products, but not provided. Include spare parts information in Operation and Maintenance Manuals.
 - 1. Spare Circuit Breakers: 30 percent spare single phase 20A breakers
 - 2. Keys: Two spares of each type of panelboard cabinet lock
 - 3. Touch-up Paint: One pint container of paint matching enclosure finish packaged with protective covering for storage and identified with labels.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Panelboards, Overcurrent Protective Devices and Accessories:

- a. Eaton.
- b. General Electric.
- c. Square D; Division of Schneider Electric.
- d. Or Approved Equal.

2.02 SERVICE CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
 - 1. Ambient Temperature: Not exceeding 40°C.
 - 2. Altitude: Not exceeding 1000 feet Main
 - 3. Breakers: Main breakers are required for all panelboards.

2.03 FABRICATION AND FEATURES

- A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Section 26 05 48 "Seismic Controls for Electrical and Communication Work."
- B. Enclosures: Flush- or Surface- mounted cabinets.
 - 1. NEMA PB 1, Type to meet environmental conditions at installed location:
 - a. Indoor Dry, and Clean Locations: NEMA 250, Type 1.
 - b. Indoor Locations Subject to dust, falling dirt, and dripping noncorrosive liquids: NEMA 250, Type 12.
 - c. Outdoor or Damp Locations: NEMA 250, Type 3R.
 - d. Corrosive Locations: NEMA 250, Type 4X, stainless steel.
- C. Hinged Front Cover: Entire front trim cover piano-hinged to box for 110-degree opening minimum. Standard door hinged within trim cover. Hinged Door-in-Door panel fronts for all panelboards, except NEMA 3R. Two locks required
 - 1. Full size front cover shall have maintenance master keyed lock.
 - 2. Standard door within front trim cover shall allow access to circuit breakers and shall also have maintenance master keyed lock. Depending on the user group and area, this door may remain unlocked for user group access to the circuit breakers or maintenance may optionally keep this door locked. Special locks from Maintenance shall be added to the panel.
- D. Panel doors shall have a continuous piano hinge for 110 degree opening minimum.
- E. Skirt for surface mounted panelboards shall be same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
- F. Flush-mounted panelboard front cover oversized by 3/4-inch to cover rough opening.
- G. Surface-mounted panelboard front cover with same dimensions as enclosure.
- H. Finish:

1. Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 2. Back Boxes: Same finish as panels and trim.
 - I. Directory Card: With transparent protective cover, mounted inside metal frame, inside panelboard standard door.
 - J. Phase, Neutral, and Ground Buses:
 1. Material: Hard-drawn copper, 98 percent conductivity, silver plated copper.
 2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.
 3. Neutral Bus: 100% rated.
 4. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.
 - K. Conductor Connectors: Suitable for use with conductor material and sizes.
 1. Material: Hard-drawn copper, 98 percent conductivity.
 2. Main and Neutral Lugs: Mechanical type.
 3. Ground Lugs and Bus-Configured Terminators: Mechanical type.
 4. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.
 - L. Service Equipment Label: UL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.
 1. Main circuit breaker is required for panelboards serving a metered tenant or user group.
 - M. 200% neutral bus is required for panels serving predominantly computer loads, sensitive electronic loads, lighting with electronic ballasts variable frequency drives and other non-linear loads.
 - N. Surge Protective Devices is required for panels serving predominantly computer loads and sensitive electronic loads.
 - O. Panelboard shall have a minimum of 30% spare breaker capacity and 30% spare load capacity. 50% spare breaker and load capacity is preferred.
- 2.04 PANELBOARD SHORT-CIRCUIT RATING
- A. Fully rated to interrupt symmetrical short-circuit current available at terminals.
- 2.05 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS
- A. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
 - B. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

- C. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.
- D. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.06 DISTRIBUTION PANELBOARDS

- A. Doors: Front mounted, except omit in fused-switch panelboards; secured with vault-type latch with tumbler lock; maintenance master keyed.
 - 1. For doors more than 36 inches high, provide two latches, keyed alike.
- B. Main Overcurrent Protective Devices: Circuit breaker.
- C. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
- D. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
- E. Fused switches: As required for interrupting high fault currents.

2.07 TVSS PANELBOARDS

- A. Rating: UL 67 listed with TVSS device UL 1449 component recognized.
- B. Hinged Front Cover: Entire front trim cover piano-hinged to box for 110-degree opening minimum. Standard door hinged within trim cover. Hinged Door-in-Door panel fronts for all panelboards, except NEMA 3R.
 - 1. Full size front cover shall have maintenance master keyed lock.
 - 2. Standard door within front trim cover shall allow access to circuit breakers and shall also have maintenance master keyed lock.
- C. Main Overcurrent Devices: Electronic trip circuit breaker.
- D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers.
- E. Bus: Copper phase and neutral buses; 200 percent capacity neutral bus.
- F. TVSS Device: IEEE C62.41, integrally mounted, plug-in-style, solid-state, parallel-connected, sine-wave tracking suppression and filtering modules.
 - 1. Minimum single-impulse current rating shall be as follows:
 - a. Line to Neutral: 100,000A.
 - b. Line to Ground: 100,000A.
 - c. Neutral to Ground: 50,000A.
 - 2. Protection modes shall be as follows:
 - a. Line to neutral.
 - b. Line to ground.
 - c. Neutral to ground.
 - 3. EMI/RFI Noise Attenuation Using 50-ohm Insertion Loss Test: 55 dB at 100 kHz.

4. UL 1449 clamping levels shall not exceed 400V, line to neutral and line to ground on 208Y/120V systems or 800V, line to neutral and line to ground on 480Y/277V systems.
5. Withstand Capabilities: 3000 Category C surges with less than 5 percent change in clamping voltage.
6. Accessories shall include the following:
 - a. Form-C contacts, one normally open and one normally closed, for remote monitoring of system operation. Contacts to reverse position on failure of any surge diversion module.
 - b. Audible alarm activated on failure of any surge diversion module.
 - c. Six-digit transient-counter set to total transient surges that deviate from the sine-wave envelope by more than 125V.

2.08 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents.
 1. Electronic Trip Unit Circuit Breakers: For all main circuit breakers and breakers with frame sizes 250A and larger. RMS sensing, field replaceable rating plug, with the following field adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t response.
 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 3. Current-Limiting Circuit Breakers: Frame sizes 400A and smaller; let-through ratings less than NEMA FU 1, RK-5.
 4. GFCI Circuit Breakers: Single- and two-pole configurations with Class A 6 mA trip sensitivity.
 5. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection, 30mA trip where required.
- B. Molded-Case Circuit-Breaker Features and Accessories. Standard frame sizes, trip ratings, and number of poles.
 1. Lugs: Mechanical style, suitable for number, size, trip ratings, and material of conductors.
 2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
 3. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

4. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system.
5. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.

2.09 ACCEPTABLE OPTIONS

- A. Shunt trip breakers for load management purposes. 120-V trip coil energized from separate circuit
- B. Adjustable trips where engineered coordination settings are provided.

2.10 CURRENT TRANSFORMERS

- A. Round, 2.5" diameter, rated for 600VAC, 50-400 Hz, flexible leads.
- B. Must be compatible with Eaton PXM 3000 series meters. Instrument class meters with 5 amp secondaries.
- C. 125:5 CURRENT TRANSFORMERS ARE NOT COMPATIBLE WITH IQ 220 METERS AND WILL NOT BE ALLOWED.

2.11 LABEL

- A. Add, "Arc Flash Hazard warning sign label" on panel as per NEC Code 110.16
- B. Arc-Flash Study to be performed by Engineer of Record.

PART 3 EXECUTION

3.01 EXISTING WORK

- A. Disconnect abandoned panelboards and provide blank covers.
- B. Where existing panelboard is to remain active, clean and repair panelboard, seal old knock outs and ensure access is maintained.

3.02 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1.
- B. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.
- C. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
- D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.
- F. Surface mounted panelboard fronts shall have same dimensions as enclosure.
- G. Comply with mounting and anchoring requirements specified in Section 26 05 48 - Seismic Controls for Electrical and Communication Work.
- H. Standard Mounting Heights: Top of trim 72-inches above finished floor, unless otherwise indicated.

1. Maximum height of highest operating handle on distribution panelboards shall be 78".
- I. Mounting: Plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.
- J. Floor Mounted Panels: Install panelboards on concrete bases, 3-1/2 inch nominal thickness. Concrete shall be rated for minimum 3000 psi.
 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
 2. For panelboards, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 4. Install anchor bolts to elevations required for proper attachment to panelboards.
 5. Attach panelboard to the vertical finished or structural surface behind the panelboard.
- K. Install filler plates in unused spaces.
- L. Provision for Future Circuits at Flush Panelboards: Stub six 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Identify each as SPARE.
- M. Wiring in Panelboard Gutters: Arrange conductors into groups and bundle and wrap with wire ties after completing load balancing.
- N. Current Transformers: Securely support CTs so that transformer leads are not bearing weight and are not under pressure.
- O. Comply with NECA 1.

3.03 CONNECTIONS

- A. Install equipment grounding connections for panelboards with ground continuity to main electrical ground bus.
- B. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
 1. Mark lugs after torquing with black, red or yellow paint such that paint will be visibly disturbed if lugs are disturbed.

3.04 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components as specified in Section 26 05 53 - Electrical Identification.
- B. Panelboard Nameplates: Label each panelboard with engraved laminated-plastic nameplate with panel designation, power source, source location and voltage.

1. Provide placard at each panelboard reading: "NOTIFY AV/MAINTENANCE IMMEDIATELY AT PHONE NO. (206) 787-5311 IF ANY CIRCUIT BREAKER TRIPS OR CIRCUIT LOADS NEED TO BE ALTERED."
 - C. Provide framed, typed panelboard circuit directory with accurate descriptions of the connected load. Hand-written directories are not acceptable. Complete directory only after all modifications have been made to correct load imbalance.
 1. Number circuit breakers with odd numbers on the left and even numbers on the right when facing the panel. Number consecutively, with multiple-pole breakers assigned multiple numbers.
 2. Describe branch circuit loads and identify locations using room numbers or column lines.
 3. Include date of last changes made and the name and company of the individual making changes.
 - D. For fused switches, apply label inside door cover identifying NEMA fuse class and size of fuses installed. Arrange fuses so rating information is readable without removing fuse.
 - E. Equipment used in emergency systems shall be labeled "Suitable for use on emergency systems" per NEC 700-3.
 - F. For isolated ground panels, label isolated ground bus.
 - G. Provide Arc Flash Hazard label on panelboard. Label shall include the following information: Date of study, Engineer of Record, Arc Flash Level and Port of Seattle Engineer initial.
 - H. Contractors shall utilize the POS standard panel schedule in Microsoft Excel format which has provision for totaling all loads and performing demand calculations by load category. An electronic copy of this schedule is available from the Facilities and Infrastructure department. This schedule shall be "as-built" after completion of the project and an electronic copy returned to the F&I on disk or CD.
 1. Transpose existing load identifications along with new or revised circuitry.
- 3.05 FIELD QUALITY CONTROL**
- A. Prepare for acceptance tests as follows:
 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit. Use 1000-volt megger for 480 volts and 500-volt megger for 208 volts.
 2. Test continuity of each circuit and all ground connections. Megger with all circuit breakers open and then with all circuit breakers closed.
 3. Check for proper phase rotation: Phase A, B, C from left to right and front to back.
 4. After energizing, check load balance under normal operation. If load unbalance exceeds 10 percent, initiate corrective measures.
 - B. Testing: After installing panelboards and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures: Perform each visual and mechanical inspection and electrical test indicated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: The Port shall have the option of performing its own infrared inspection.
 - c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- C. Panelboards will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action. Submit test and inspection reports

3.06 ADJUSTING

- A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable switches and circuit breaker trip ranges.
- C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
 1. Measure as directed during period of normal system loading.
 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
 3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
 4. Tolerance: Difference exceeding 10 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.07 CLEANING

- A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

3.08 OPERATION AND MAINTENANCE MANUALS

- A. Comply with Section 01 78 23.13 - Operations and Maintenance Data and Part 1 of this specification.
 - 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - 2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.
- B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of “Electrical Power Metering” Work is shown in the Contract Documents. This section includes the components for power metering and monitoring. Electrical Power Metering requirements specified in this section may be supplemented by special requirements of systems described in other sections.

1.02 GOVERNING CODES, STANDARDS AND REFERENCES

- A. NFPA 70: National Electrical Code (NEC)
- B. NFPA 70 E: Standard for Electrical Safety in the Workplace
- C. Underwriters Laboratories, Inc.
- D. IEEE 802.3

1.03 SUBMITTALS

- A. Submit materials data in accordance with of Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, calibration reports, and installation instructions for all products.
- B. Submittals shall include the following:
 - 1. Submit product data for the following:
 - a. Attach copies of approved Product Data submittals for products (such as switchboards and switchgear) that describe power monitoring and control features to illustrate coordination among related equipment and power monitoring and control.
 - b. Provide technical data sheets, installation manuals and user documentation manuals that describe the product installation and operation, physical data, electrical characteristics and connection requirements of the power monitoring equipment and cabinet components.
 - 2. Shop Drawings: For power monitoring and control equipment. Include plans, elevations, sections, details, and attachments to other work.
 - a. Enclosure types and details.
 - b. Project specific cabinet layout, including location of all devices, terminal blocks and wireways.
 - c. Project specific wiring and schematic diagrams, clearly identifying internal and field wiring connections and requirements.
 - d. Project specific system diagram, identifying all network interface devices.
 - 3. Seismic Qualification Certificates: Submit certification that meters, accessories, and components will withstand seismic forces

defined in Section 26 05 48 "Seismic Controls for Electrical and Communication Work." Include the following:

- a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
4. Field quality-control reports.
 5. Operation and Maintenance Data: For power monitoring and control units, to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 23.13 "Aviation Operations and Maintenance Documentation," include the following:
 - a. Manufacturer's system installation and setup guides, with data forms to plan and record options and setup decisions.
 - b. Operating and applications software documentation.
 - c. Software licenses.
 - d. Software service agreement.
 6. Software and Firmware Operational Documentation:
 - a. Self-study guide describing the process for setting equipment's network address; setting Owner's options; procedures to ensure data access from any PC on the network, using a standard Web browser; and recommended firewall setup.
 - b. Device address list and the set point of each device and operator option, as set in applications software.

1.04 QUALITY ASSURANCE

- A. Instrument Certifications
 1. Certified to UL 22CZ
 2. CE marked.
 3. Safety: UL 61010-1 3rd edition
 4. Accuracy: ANSI C12.20 Class 0.2 (0.2%), IEC/EN60687 0.2(.2%) for revenue meters.
 5. Electromagnetic Compatibility: FCC Part 15 Subpart B Class A Radiated and Conducted.
 6. IEC Environmental: IEC 60529, 60255-21-1, 60255-21-2, 60255-21-3, 68-2-6

1.05 WARRANTY

- A. The power metering instrument is warranted by the vendor against manufacturing defects for a period of one year.
- B. The power metering software is warranted by the vendor against manufacturing defects for a period of one year.
- C. Warranty service may be performed by the manufacturer or authorized service representative.
- D. The vendor provides technical support service. These services include the following:
 - 1. Technical consultation via telephone for up to three hours per month for the duration of the warranty period.
 - 2. Free upgrades to new firmware for the power metering instruments for the duration of the warranty period.
 - 3. Free upgrades to new software releases for the duration of the warranty period.
- E. The vendor manufactures functionally equivalent replacement units for power metering instruments for a period of not less than ten years following the installation of the original equipment.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Deliver PM system components in shipping splits in sizes that can be moved past obstructions in delivery path.
- B. Deliver PM system components in fully enclosed vehicles after specific environmental conditions have been permanently established in spaces where components are to be placed.
- C. Store PM system components indoors in clean, dry space with uniform temperature controlled within manufacturer's ambient temperature and humidity tolerances for non-operating equipment to prevent condensation. Protect from exposure to dirt, fumes, water, corrosive substances and physical damage.

1.07 COORDINATION

- A. Coordinate features of distribution equipment and power monitoring and control components to form an integrated interconnection of compatible components.
 - 1. Match components and interconnections for optimum performance of specified functions.
 - 2. Coordinate Work of this Section with those in Sections specifying distribution components that are monitored or controlled by power monitoring and control equipment.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Power meters: EATON No Equal. Meters are specified by application as follows:
 - 1. Medium Voltage Unit Substations and Switchgear(5-15kV):
 - a. Main Breakers: PXM 8000.
 - b. Feeder Breakers: PXM 6000.
 - 2. Low Voltage Power Center (600V or less)
 - a. Main Breakers: PXM 6000
 - b. Feeder Breakers: PXE2
 - 3. Low Voltage Switchboards and Distribution Boards larger than 600A:
 - a. Main breaker shall be metered by PXE2 installed at power center feeder breaker.
 - b. Feeders shall be metered via multipoint meters PXMP or PXE2 meters.
 - c. In cases where the switchboard/distribution board is subfed from another switchboard/power center, metering of the feeder (per 2.01.A.3.b) in upstream switchboard shall suffice for main metering of downstream switchboard.
 - 4. Low Voltage Panelboards rated 400A or less
 - a. PXBCM Branch Circuit Monitoring shall be installed on all new panelboards rated 400A or less.
- B. Cabinet: Per section 26 27 16 “Cabinets and Enclosures”
- C. Current Transformers:
 - 1. 250A and smaller: ITI 2DARL
 - 2. Larger than 250A: ITI 5DARL
 - 3. Or Approved Equal.
- D. Shorting Block:
 - 1. Marathon Special Products 1506SC
 - 2. Or Approved Equal.
- E. For PX MPM Series and PX BCM Series Meters
 - 1. Dent Instruments
 - 2. Eaton
 - 3. Or Approved Equal.
- F. Fused Disconnect:

1. Marathon Special Products FDS-30-C-1 (single pole)
 2. FDS-30-C-3 (three poles)
 3. Or Approved Equal.
- G. Meter Cabinet
1. Eaton
 2. Or Approved Equal
- H. Power Gateway
1. Eaton Power Gateway 900 series. No Equal
- I. Network Switch
1. Network switch(es) shall be furnished and installed by Port of Seattle ICT.
- J. Power Supply
1. Eaton ELC-PS02
 2. Eaton PSG60N24RP.
 3. No Equal.

2.02 SYSTEM REQUIREMENTS

- A. Surge Protection: For external wiring of each conductor entry connection to components to protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads.
1. Minimum Protection for Power Lines 120 V and More: Auxiliary panel suppressors complying with requirements in Section 26 43 13 " Surge Protective Devices for Low-Voltage Electrical Power Circuits."
 2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines: Comply with requirements as recommended by manufacturer for type of line being protected.
- B. Addressable Devices: All transmitters and receivers shall communicate unique device identification and status reports to monitoring and control clients.

2.03 POWER METERS

- A. Separately mounted permanently installed instrument for power monitoring.
1. Meter shall support 3-element wye, 2.5 element wye, 2 element delta, 4 wire delta systems.
 2. Surge withstand shall conform to IEEE C37.90.1 and ANSI C62.41 (6 kV).
 3. The meter shall be user programmable for voltage range to any CT or PT ratio.

4. Meter shall have a burden of not more than 0.01 VA per phase maximum at 10 amps.
5. All inputs and outputs shall be galvanically isolated to 2500 VAC.
6. NEMA 12 faceplate rating shall be available for power meter.

B. PXE2 Meters

1. Shall be furnished with dual-port ethernet PXE communication module.

C. Environmental Conditions: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Indoor installation in spaces that have environmental controls to maintain ambient conditions of 0 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing.

2.04 MULTI-POINT METERING

A. Manufacturer shall:

1. Install multi-point metering (MPM) in Switchboard and Panelboards at the factory.
2. Pre-wire current sensors and interface modules to MPM.
3. Pre-wire metering voltages and control power connections.
4. Install optional color HMI where applicable on hinged door.

2.05 BRANCH CIRCUIT MONITORING

A. Power Xpert Branch Circuit Monitor (PXBCM)

1. Where shown on the drawings, supply a UL listed microprocessor-based Branch Circuit Monitoring System (PXBCM). This system shall consist of meter base, and meter module(s) as described below.
2. The Branch Circuit Monitoring shall have the following ratings
 - a. PXBCM as a component shall have a NEMA 1 rating. When installed in an enclosure it shall have the same rating as its enclosure NEMA 1.
3. PXBCM Meter Base
 - a. Each PXBCM-MB Meter Base shall support connection of up to 4 Meter Modules in either a MMS Strip or MME External configuration monitoring a total of up to 100 single-phase two-wire AC loads, 48 single-phase three-wire AC loads or 32 three-phase four-wire AC loads or combinations not to exceed 25 poles per meter module.
 - b. The PXBCM-MB shall be equipped with four meter module ports. Each port shall provide control power and communications to either a PXBCM-MMS Meter Module Strip or a PXBCM-MME Meter Module External with a

- maximum cable length of 28ft between each Meter Base and each Meter Module.
- c. Each PXBCM-MB shall support connection to up to 4 PXBCM-MMS Meter Module Strip or 4 PXBCM-MME Meter Module External, or a combination of up to 4 total PXBCM-MMS and PXBCM-MME each meter module with independent single or three phase voltage metering circuits with inputs up to 277V L-N and 480V L-L.
 - d. PXBCM-MB Power Supply shall be rated for 100-277VAC L:N +/-10% CAT III, 47-63 Hz , 6W.
 - e. The PXBCM-MB shall include a 3 terminal RS-485 serial port for Modbus RTU communications and an RJ-45 port for Ethernet communications. The Ethernet port shall support Modbus TCP communications as well as an Embedded WEB server.
 - f. The PXBCM-MB embedded WEB server shall support device configuration for to up to 4 PXBCM-MMS Meter Module Strip or 4 PXBCM-MME Meter Module External, or a combination of up to 4 total PXBCM-MMS and PXBCM-MME and display of up to 100 points of metering data. It shall be possible to save device configuration information to a file for archiving and for uploading to PXBCM.
 - g. The PXBCM-MB shall support connection to a pre-configured HMI via RS-485 serial port. The HMI shall not require configuration.
 - h. The PXBCM-MB shall be equipped with LED's to indicate communications activity and Device/Alarm Status. An LED shall also indicate if Ethernet is configured for DHCP (automatically assigned IP address) or Fixed IP (manually assigned IP address). The PXBCM-MB shall be equipped with 2 rotary switches to assign Modbus Slave ID 1-99.
 - i. The PXBCM-MB shall be equipped with security mode switches to enable the device to operate in a secure mode to prevent tampering with device configuration and resets over comms.
 - j. The PXBCM Meter Base shall automatically sense the type of PXBCM Meter Module connected to each of its four meter module ports.
 - k. The Configuration Wizard shall support naming and configuration of up 100 virtual meters by assigning 1-3 channels of current to 1, 2 or 3 pole meters. Virtual meters shall aggregate the channel data assigned to each virtual meter and report the aggregated virtual meter values for:
 - (1) Forward and Reverse Energy
 - (2) Watts, VA, Average Amps and Power Factor

- (3) Average and Peak demand for Watts and VA
4. PXBCM-MMS Meter Module Strip
- a. PXBCM-MMS Meter Module Strips shall be available in configurations to mount on either the left or right of a panelboard and contain 9, 15, or 21 CTs. Four additional 333mV connections shall be provided on each PXBCM-MMS for Auxiliary 333mV CT connections which can be used to monitor the panel mains or branch circuits. The MMS shall include both load current and voltage metering circuits providing meter data to the Meter Base.
 - b. The PXBCM Meter Module Strip shall be available with either 9 CT's, 15 CT's or 21 CT's per assembly for factory assembly into Panelboards with 18, 30 or 42 poles. PXBCM MMS CT's shall have be rated for up to 100A continuous current monitoring and designed to mount in an Eaton PRL-1a, PRS-2a or PRL-3e Panelboard with one inch breaker pole spacing.
 - c. PXBCM Meter Module Strip one inch center CTs shall have a window opening sufficient for insulated Aluminum conductor rated for 100A capacity.
 - d. The PXBCM Meter Module Strip shall support direct connection of one set of 3 phase nominal metering voltage inputs up to 277V L-N and 480V L-L voltages and shall be rated as Cat III.
 - e. The PXBCM MMS shall be UL approved for mounting to the panelboard interior with no interference. Strip placement shall line up 1 inch center CT's with breaker poles and not impede the normal routing of branch circuit conductors in the panel enclosure.
 - f. The PXBCM MMS shall connect to the PXBCM MB using factory supplied cables.
5. PXBCM-MME Meter Module External
- a. The PXBCM Meter Module external shall support 25 channels of current using external 333mV current sensors connected to terminal strips on the PXBCM-MME.
 - b. The PXBCM Meter Module External shall support direct connection of one set of 3 phase nominal metering voltage inputs up to 277V L-N and 480V L-L voltages and shall be rated as Cat III.
6. HMI Display shall display data for all configured sub-meters.
- a. HMI configuration shall not be required for each sub-meter. The HMI shall discover the configuration information automatically.
 - b. Displayed information for up to 100 circuits shall include:

- (1) Sub-meter name
- (2) Current
- (3) Voltage
- (4) Energy consumption
- (5) Demand
- (6) Power factor
- (7) Aggregated power and energy readings for any 1, 2, or 3 pole meters

2.06 CURRENT TRANSFORMERS

- A. Ratios as indicated; burdened and C-200 minimum accuracy class suitable for connected relays, revenue grade meters, and instruments unless otherwise identified.
 1. Solid core type.
 2. CT shall be minimum 1% accurate from 1% to 100% of the maximum full scale rating from -15°C to 60°C.
 3. CT shall have #12 AWG UL 1015 rated twisted pair leads which shall be limited to the minimum length necessary to complete the circuit to the power meter.
 4. Aperture of CT shall be adequate to accommodate the outside diameter of the conductors.
- B. All secondary wiring connected to the CTs shall be a minimum of #12 AWG copper and should be limited to the minimum length necessary to complete the circuit to the power meter. Short length of smaller conductors in switch boards may be utilized provided the additional burden imposed by these conductors is negligible when compared to the overall circuit burden.
- C. For PXE2 Series and 6000/8000 Series Meters
 1. All CTs shall be provided with 5A secondaries at the primary rated current.
 - a. For panelboard (up to 400A bus) with multi-point metering application, CTs shall be small, compact, and mountable to the support frame of the panelboard.
 2. CT output shall be 0-5A proportional to the maximum full scale amperage rating.
 3. Current transformer shorting blocks (CTSB) shall be provided on the secondary of the current transformers to ensure that the secondary is automatically short circuited when the load is removed.
- D. For PX MPM Series and PX BCM Series Meters
 1. Provide 100mA output CTs for circuits rated up to 400A

2. Provide split core 333mV output CTs for circuits rated 400A-2000A.

2.07 FUSED DISCONNECT

- A. Disconnect switch that de-energizes fuses without shutting down. Safety type fuse holders for fusing.

METER CABINET

- B. Meter enclosure including control power transformers, fusible disconnect, terminal blocks, CT shorting blocks and lock for enclosure. Factory assembled and UL listed as an assembly.
 1. Enclosure:
 - a. NEMA 12 for indoor applications; NEMA 3R or 4X in indoor or outdoor applications where dust, water or corrosive chemicals are present.
 - b. Provide hinged door with lock.
 - c. Operating temperature: -20°C - +40°C.
 - d. Size per project requirements.
 2. Meter fusing.
 3. Fused control power transformer (where required) – minimum 100VA.
 4. Fusible disconnect for primary voltage.
 5. CT shorting block assembly. Schneider VTFB-6 or approved equal.
 6. PX Gateway (for multiple meter enclosure only).
 7. Gateway power supply.
 8. Network switch..
 9. Sized for future control power UPS.

2.08 POWER GATEWAY

- A. Power gateway for tie-in of multiple existing meters to power monitoring system.

2.09 NETWORK SWITCH

- A. Network switch takes inputs from meters and power gateway. Switch output to nearest Port telecom room.
- B. Network switch shall be furnished and installed by POS ICT.

2.10 POWER SUPPLY

- A. 95 to 240 VAC ($\pm 10\%$) at 47 to 440 Hz, 120 to 310 VDC, 0.2A worst case loading (12W) at 100 VAC, 25°C.

2.11 LAN CABLES

- A. Unshielded Twisted Pair Cables: Category 6 as specified for horizontal cable for data service in Section 27 15 00 "Communications Horizontal Cabling."

2.12 CONTROL-VOLTAGE WIRING

- A. Comply with Section 26 05 23 "Control Signal Transmission Media."
- B. Low-Voltage Control Cable: Multiple conductor, color-coded, No. 20 AWG copper, minimum.
 - 1. Sheath: PVC; except in plenum-type spaces, use sheath listed for plenums.
 - 2. Ordinary Switching Circuits: Three conductors unless otherwise indicated.
 - 3. Switching Circuits with Pilot Lights or Locator Feature: Five conductors unless otherwise indicated.
 - 4. Provide flexible SIS conductors for #8 AWG and smaller for conductors across enclosure hinges.

PART 3 INSTALLATION

3.01 EXAMINATION

- A. Prior to installation, contractor shall perform a plan-in-hand site visit with an F&I Electrical Engineer and a representative from the Port AVM Electric Meter shop.
 - 1. Site visit will include verification of the following:
 - a. Meter type and CTs to be installed
 - b. Meter location.
 - c. Meter wiring requirements, including CT locations, meter source power, meter reference voltage, fused disconnect location and wiring method, control power transformer (if needed) location and wiring method.
 - 2. Electrical shut-down required for project connection will not be approved until site walk has been completed to the satisfaction of the electric shop.
- B. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 EQUIPMENT INSTALLATION

- A. Install power metering cabinets and accessories according to contract drawings.
- B. Comply with mounting and anchoring requirements in Section 26 05 48 "Seismic Controls for Electrical and Communication Work".

- C. Standard Mounting Height: Top of trim is 72 inches above top of floor or housekeeping pad, unless otherwise indicated.
- D. Mounting: Plumb and rigid without distortion of box.
- E. Provide terminal blocks in cabinet. Comply with terminal block requirements in Section 26 05 33 "Raceways and Boxes".
- F. Install fusible disconnect that de-energizes fuse holder without de-energizing meter control power and reference voltage input.
- G. Install safety-type fuse holders for fusing.
- H. CT securing and supporting: Securely support CTs so that transformer leads are not bearing weight and are not under pressure.
- I. Where identified on Contract documents, install metered circuits for branch load revenue metering purposes in accordance with power monitoring and data gathering system requirements. Provide power wiring between CT terminal in panelboards and switchboards and external metering cabinets.

3.03 CONNECTIONS

- A. Connect all wiring as identified on contract drawings. All power supply and communications wiring connections must be performed in accordance with guidelines set out in the product documentation.
- B. Where meter is mounted into an opening cover or door of enclosure, wiring is to be routed and secured neatly and in a workmanlike manner to accommodate opening and closing of door.
- C. Tighten electrical connections and terminals according to manufacturer's published torque tightening values. If manufacturer's torque values are not available, use those specified in UL 486A and UL 486B.
- D. All current and voltage sensing connections to PM instruments must be made using appropriately rated CT shorting blocks.

3.04 CABLING

- A. Comply with NECA 1.
- B. Install cables and wiring according to requirements in Section 27 15 00 "Communications Horizontal Cabling."
- C. Wiring Method: Install wiring in raceway and cable tray. Conceal raceway and wiring except in unfinished spaces.
- D. Install cables without damaging conductors, shield, or jacket.

3.05 IDENTIFICATION

- A. Identify components and power and control wiring according to Section 26 05 53 "Electrical Identification."
- B. Label each power monitoring and control module with a unique designation.
- C. Label each cabinet with engraved laminated plastic nameplate with panel designation, power source, source location and voltage.

- D. Label each meter with engraved laminated plastic nameplate with source panel and circuit designation), Maximo equipment identification number (EQ ID), and tenant space number, if applicable.
 - 1. Maximo equipment identification number shall be provided by POS Aviation Maintenance. Serial number of meter is required to be submitted prior to issuance of EQ ID number.

3.06 GROUNDING

- A. Comply with requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems".
- B. Comply with IEEE 1100, "Recommended Practice for Powering and Grounding Electronic Equipment."
- C. Install equipment grounding connections to cabinets.

3.07 FIELD QUALITY CONTROL

- A. Meters shall not be energized prior to inspection. Schedule inspection through the Port Resident Engineer. Meter inspection shall take place at least three weeks prior to punch walk.
- B. Contractor shall prepare for acceptance tests as follows:
 - 1. Test insulation resistance for each component, connecting supply, feeder and control circuit.
 - 2. Test continuity of each circuit and all ground connections. Megger with all circuit breakers open and then with all circuit breakers closed.
 - 3. Verify continuity of equipment grounds and bonding jumper.
 - 4. Verify correct phasing and orientation of CTs.
- C. For large meter cabinet installations (more than four meters) provide the following:
 - 1. Manufacturer's Field Service: Engage a factory-authorized service engineer to inspect components, assemblies, and equipment installations, including connections, pre-testing, testing, programming and commissioning.
 - a. Meters shall be configured, programmed, tested and commissioned by a certified integrator with 5 years' experience on Port approved meters.
 - b. Perform inspections and tests listed in NETA ATS and certify compliance with test parameters.
 - c. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 26 sections.
 - d. Complete installation and startup checks according to manufacturer's written instructions.
 - e. Manufacturer's certification of proper installation is required.

- D. For meter installations of single meters or cabinets containing four meters or fewer, provide the following:
1. Tests and Inspections:
 - a. Electrical Tests: Use caution when testing devices containing solid-state components.
 - b. Continuity tests of circuits.
 - c. Operational Tests: Set and operate controls at workstation and at monitored and controlled devices to demonstrate their functions and capabilities. Use a methodical sequence that cues and reproduces actual operating functions as recommended by manufacturer. Submit sequences for approval. Note response to each test command and operation. Note time intervals between initiation of alarm conditions and registration of alarms at central-processing workstation.
 - (1) Coordinate testing required by this Section with that required by Sections specifying equipment being monitored and controlled.
 - (2) Test LANs according to requirements in Section 27 15 00 "Communications Horizontal Cabling."
 - (3) System components with battery backup shall be operated on battery power for a period of not less than 10 percent of calculated battery operating time.
 - (4) Verify accuracy of graphic screens and icons.
 - (5) Metering Test: Load feeders, measure loads on feeder conductor with a rms reading clamp-on ammeter, and simultaneously read indicated current on the same phase at central-processing workstation. Record and compare values measured at the two locations. Resolve discrepancies greater than 5 percent and record resolution method and results.
 - (6) Record metered values, control settings, operations, cues, time intervals, and functional observations and submit test reports printed by workstation printer.
 - d. Power monitoring and control equipment will be considered defective if it does not pass tests and inspections.
- E. Field Test Reports (Contractor and Field Service Engineer): Prepare a written report to record the following:
1. Test procedures used.
 2. Test results that comply with requirements.

3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- F. Correct deficiencies and make necessary adjustments. Retest. Verify that specified requirements are met.
- G. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.
- H. Reports: Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.
- I. Remove and replace malfunctioning devices and circuits and retest as specified above.

3.08 CLEANING

- A. On completion of installation, inspect interior and exterior of cabinets. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

3.09 TRAINING

- A. Train Port maintenance personnel to adjust, operate, and maintain systems. See Section 01 79 00 "Training."
 1. Train Port's metering and maintenance personnel in interpreting and using monitoring displays and in configuring and using software and reports. Include troubleshooting, servicing, adjusting, and maintaining equipment. Provide training for a minimum of three shifts, with ten persons per shift. Course materials are to be submitted 30 days prior to the training date for review with copies provided to all participants on the day of training.
 2. Training Aid: Use approved final versions of software and maintenance manuals as training aids.

3.10 ON-SITE ASSISTANCE

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other-than-normal occupancy hours for this purpose.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

- A. For incidental work:

No separate measurement or payment will be made for the work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and

performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by any Subcontractor (of any tier) or Supplier.

B. For work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this Work.

End of Section

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of "Cabinets and Enclosures" Work is shown in the Contract Documents. This section includes hinged cover enclosures, cabinets, terminal blocks, and accessories.

1.02 GOVERNING CODES, STANDARDS AND REFERENCES

- A. NECA (National Electrical Contractors Association) - National Electrical Installation Standards
- B. NEMA 250 (National Electrical Manufacturers Association) - Enclosures for Electrical Equipment (1000 Volts Maximum)
- C. NEMA ICS 4 (National Electrical Manufacturers Association) – Application Guideline for Terminal Blocks.
- D. NFPA 70 (National Fire Protection Association) - National Electrical Code

1.03 SUBMITTALS

- A. Submit materials data in accordance with of Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.
- B. Submittals shall include the following:
 - 1. Product Data: For enclosures, cabinets, and terminal blocks.
 - 2. Manufacturer's Installation Instructions, including storage, handling, protection, examination, preparation, and installation of product.

1.04 QUALITY ASSURANCE

- A. Listing and Labeling: Provide products that are 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 for the location and environment in which they are installed.
- B. Comply with NECA's "National Electrical Installation Standards."
- C. Comply with NFPA 70, as adopted and administered by the Authority Having Jurisdiction.

1.05 EXTRA MATERIALS

- A. Spare and extra parts shall be identified for all products, but not provided. Include spare parts information in Operation and Maintenance Manual

PART 2 PRODUCTS

2.01 HINGED COVER ENCLOSURES

- A. Construction: NEMA 250, Type 1, except as noted below, with continuous hinge cover and flush latch. Key latch to match panelboards.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Application in other than NEMA 250, Type 1 environments:

- a. Indoor Dusty Locations: NEMA 12.
- b. Damp or Wet Locations: NEMA 3R.
- c. Outdoor dirty/oily and washdown locations such as Aircraft Operations Areas: NEMA 4, stainless steel.
- d. Damp or Wet and Corrosive Locations: NEMA 250, Type 4X, stainless steel.
- e. Hazardous Locations: NEMA 250, Type 7, 8, or 9 depending on hazardous area classification and location (unhinged).

2.02 CABINETS

- A. Cabinets: NEMA 250, Type 1, except as noted below, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 - 1. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards.
 - 2. Include metal barriers to separate wiring of different systems and voltage.
 - 3. Include accessory feet where required for freestanding equipment.
 - 4. Application in other than NEMA 250, Type 1 environments:
 - a. Indoor Dusty Locations: NEMA 12.
 - b. Damp or Wet Locations: NEMA 3R.
 - c. Outdoor dirty/oily and washdown locations such as Aircraft Operations Areas: NEMA 4, stainless steel.
 - d. Damp or Wet and Corrosive Locations: NEMA 250, Type 4X, stainless steel.
 - e. Hazardous Locations: NEMA 250, Type 7, 8, or 9 depending on hazardous area classification and location (unhinged).

2.03 TERMINAL BLOCKS

- A. Minimum 600-volt rating for 480-volt circuits.
- B. Clamp or screw terminals sized for maximum conductor size.
- C. Separate connection point for each conductor.
- D. Ten percent spare terminal points.
- E. Individual identification for each terminal block.
- F. Phenolic block separators or barriers to isolate low-voltage and control terminations from analog and DC circuits.
- G. Terminal Blocks: NEMA ICS 4.
- H. Power Terminals: Unit construction type with closed back and tubular pressure screw connectors, rated 600 volts.
- I. Signal and Control Terminals: Modular construction type, suitable for channel mounting, with tubular pressure screw connectors, rated 300 volts.

- J. Provide ground bus terminal block, with each connector bonded to enclosure.

2.04 PLASTIC RACEWAY

- A. Plastic channel with hinged or snap-on cover.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine surfaces to receive enclosures, and cabinets for compliance with installation tolerances, access and working clearances. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 EXISTING WORK

- A. Remove abandoned cabinets and enclosures. Patch surfaces.
- B. Maintain access to existing cabinets and enclosures and other installations which remain active and which require access. Modify installation to provide access as appropriate.
- C. Extend existing cabinets and enclosures using materials and methods as specified.
- D. Clean and repair existing cabinets and enclosures which remain or are to be reinstalled.

3.03 INSTALLATION

- A. Install enclosures and cabinets as indicated, according to manufacturer's written instructions and in accordance with NECA "National Electrical Installation Standards."
- B. Install enclosures and cabinets plumb and level. Anchor securely under the provisions of Section 26 05 48 - Seismic Controls for Electrical and Communication Work.

3.04 IDENTIFICATION

- A. Provide labels for enclosures and components as specified in Section 26 05 53 - Electrical Identification.
- B. Control Panels: Include panel designation, power source location, panel designation and circuit number.
- C. Equipment used in emergency systems shall be labeled "Suitable for use on emergency systems" per NEC 700-3.
- D. Instructional signs: Install approved legend where instructions or explanations are required for system or equipment operation.

3.05 PROTECTION

- A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer that ensure coatings, finishes, and cabinets are without damage or deterioration at the time of Substantial Completion.
 - 1. Repair damage to finishes with matching touchup coating recommended by manufacturer.

3.06 CLEANING

- A. On completion of installation, clean electrical parts and remove conductive and harmful materials
- B. Remove dirt and debris from enclosure.
- C. Clean finishes and touch up damage.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.

- B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of "Wiring Devices" Work is shown in the Contract Documents. This section includes requirements for receptacles, plugs, switches, cover plates, poke-through assemblies, and telephone/power service poles.
- B. Definitions
 - 1. GFCI: Ground-fault circuit interrupter.
 - 2. TVSS: Transient voltage surge suppressor.

1.02 GOVERNING CODES, STANDARDS AND REFERENCES

- A. NEMA WD 1 (National Electrical Manufacturers Association) – General Color Requirements for Wiring Devices.
- B. NFPA 70 (National Fire Protection Association) - National Electrical Code
- C. UL (Underwriter Laboratories) listed.

1.03 SUBMITTALS

- A. Submit materials data in accordance with of Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.
- B. Submittals shall include the following:
 - 1. Product Data: For each type of product.
 - 2. Shop Drawings: Legends for receptacles and switch plates.
 - 3. Samples: For devices and device plates for color selection and evaluation of technical features.
 - 4. Maintenance Data: For materials and products to include in maintenance manuals specified in Division 1 General Requirements.

1.04 QUALITY ASSURANCE

- A. Listing and Labeling: Provide electrical components, devices, and accessories that are 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 for the location and environment in which they are installed.
- B. Comply with NEMA WD 1.
- C. Comply with NFPA 70, as adopted and administered by the Authority Having Jurisdiction.

1.05 COORDINATION

- A. Cord and Plug Sets: Match equipment requirements.
- B. TVSS Receptacles: One for each eight installed, but not less than two.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Specification Grade Receptacles/Special Purpose Receptacles
 - a. Cooper Crouse Hinds.
 - b. Appleton Electrical Products.
 - c. Killark; Division of Hubbell.
 - d. Or Approved Equal.
 2. Wiring Devices:
 - a. Bryant.
 - b. Hubbell Inc.
 - c. Leviton Manufacturing Co.
 - d. Or Approved Equal.
 3. Ground Fault Circuit Interrupters:
 - a. Arrow Hart; Division of Cooper Industries.
 - b. Hubbell Inc.
 - c. Pass & Seymour; Division of Legrand.
 - d. Leviton Manufacturing Co.
 - e. Bryant.
 - f. Or Approved Equal.
 4. Wiring Devices for Hazardous (Classified) Locations:
 - a. Appleton Electrical Products.
 - b. Cooper Crouse-Hinds.
 - c. Hubbell Inc.
 - d. Or Approved Equal.
 5. Multioutlet Assemblies:
 - a. Bryant.
 - b. Hubbell Inc.
 - c. Wiremold; Division of Legrand.
 - d. Or Approved Equal.
 6. Poke-through, Floor Service Outlets and Telephone/Power Poles:
 - a. Hubbell Inc.
 - b. Pass & Seymour; Division of Legrand.
 - c. Wiremold; Division of Legrand.
 - d. Or Approved Equal.

2.02 RECEPTACLES

- A. Provide receptacles with UL, CSA, or ETL label required.
- B. Straight-Blade Receptacles: Single-piece, rivetless, nickel-plated, all-brass grounding system. Nickel-plated, brass mounting strap.
 - 1. Rating: 20-ampere (15-ampere receptacles are not acceptable).
 - 2. Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
 - 3. Duplex, industrial specification grade.
 - 4. Colors and materials are subject to Architects' special requirements, but in general:
 - a. Public Areas: Gray with brushed stainless steel plate.
 - b. Office Areas: Ivory with plastic matching plate.
 - c. Receptacles on Emergency Power: Red color, no exceptions.
 - 5. Label duplex receptacles on UPS "UPS."
- C. Locking Receptacles:
 - 1. Heavy-Duty grade.
 - 2. NEMA configuration.
 - 3. Rating equal to source circuit.
- D. GFCI Receptacles: Straight blade, feed-through or non-feed-through type. All receptacles downstream from a feed-through type GFCI receptacle shall be labeled "GFCI Protected".
 - 1. Trip Rating: 5 mA.
 - 2. Feed-through type, with integral NEMA WD 6, Configuration 5-20R duplex receptacle arranged to protect connected downstream receptacles on the same circuit. Comply with NEMA WD 1, UL 498, UL 943 Class A, and FS W-C-596.
 - 3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.
 - 4. Designed for installation in a 2-3/4 inch deep outlet box without an adapter.
- E. TVSS Receptacles: Duplex type, Straight blade, 125 V, 20 A, NEMA WD 1, NEMA WD 6, UL 498, UL 1449, and FS W-C-596, Configuration 5-20R, with integral TVSS in line to ground, line to neutral, and neutral to ground.
 - 1. TVSS Components: Multiple metal-oxide varistors; rated a nominal clamp level of 400 transient-suppression voltage and minimum single transient pulse energy dissipation of 240 J line to neutral, and 70 J line to ground and neutral to ground, according to IEEE C62.41.2 and IEEE C62.45.
 - 2. Active TVSS Indication: Light visible in face of device to indicate device as "active" or "no longer active."
 - 3. Identification: Distinctive marking on face of device denotes TVSS-type unit.

- F. Industrial Heavy-Duty Receptacle: Comply with IEC 309-1.
 - 1. Welding Receptacles: 60-ampere, 3-phase, 3-wire grounding type (4-pole) with companion plug.
- G. Hazardous (Classified) Location Receptacles: Comply with NEMA FB 11 and UL 1010.
- H. Temporary Generator connection receptacles: Hubbell series 16 single pole devices, Crouse Hinds Posi-lok power distribution system, Or Approved Equal 400A female receptacle assembly.

2.03 CORD AND PLUG SETS

- A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.
 - 1. Cord: Rubber-insulated, stranded-copper conductors, with type SOW-A jacket. Green-insulated grounding conductor, and rated ampacity of equipment plus a minimum of 30 percent.
 - 2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.
 - a. Provide according to NEMA designations to match companion receptacles
 - b. UL, CSA or ETL label required.
 - c. Strain relief suitable for application.

2.04 SWITCHES

- A. Snap Switches:
 - 1. Rating: 20-ampere at 120/277 volts. UL label required
 - 2. Industrial specification grade, quiet operation type.
 - 3. Color: White (subject to Architect's special requirements).

2.05 COVER PLATES

- A. Single and combination types match corresponding wiring device colors (subject to Architect's special requirements).
- B. Plate-Securing Screws: Metal with head color to match plate finish.
- C. Public Areas (Such as Restrooms): Type 302, satin-finished stainless steel. brushed
- D. Unfinished Spaces (Such as Utility Tunnels, Bagwells, Warehouse Spaces, etc.): Galvanized Steel.
- E. Exterior Areas or Damp Locations: Weatherproof with while-in-use cover.
- F. Special Applications: As required by Architect.
- G. Provide gang plates for two or more devices mounted together.

2.06 TELEPHONE/POWER SERVICE POLES

- A. Description: Factory-assembled and wired units to extend power, telephone, and data service from distribution wiring concealed in ceiling to devices or outlets in pole near floor.
- B. Poles: Nominal 2.5-inch square cross section with height adequate to extend from floor to at least 6 inches above ceiling, and separate channels for power and signal wiring.
- C. Mounting: Ceiling trim flange with concealed bracing arranged for positive connection to ceiling supports, and pole foot with carpet pad attachment.
- D. Finishes: One of manufacturer's standard finish and trim combinations to match Architectural requirements.
- E. Wiring:
 - 1. Power: #12 AWG power and ground conductors.
 - 2. Telephone/data cable: Refer to Division 27 Communications.
- F. Power Receptacles: Two single 20A, heavy-duty, NEMA WD 6, Configuration 5-20R units.
- G. UL label required.
- H. Standard only in remodel and retrofit areas where underfloor wiring is impractical.
- I. Telephone and data receptacles per communications standards.
- J. Communications Outlets: Blank insert with bushed cable opening.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Standard Mounting Heights: Comply with NECA 1, unless noted otherwise on drawings:
 - 1. Wall Switches: 48" above finished floor.
 - 2. Convenience Outlets: 18" above finished floor, 6" above counters.
 - 3. Telephone Outlets: 18" above finished floor.
 - 4. Wall Phone Outlets: 54"
 - 5. Thermostats: 60"
- B. Install devices and assemblies plumb and secure.
- C. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
- D. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
- E. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
- F. Install wall plates when painting is complete.

- G. Conductors:
 - 1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
 - 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
 - 3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
 - 4. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtailing existing conductors is permitted, provided the outlet box is large enough
- H. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
- I. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
- J. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
- K. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
- L. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
- M. Use a torque screwdriver when a torque is recommended or required by manufacturer.
- N. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
- O. Tighten unused terminal screws on the device.
- P. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.
- Q. Install wall dimmers to achieve indicated rating after derating for ganging as instructed by manufacturer. Verify dimmers used for fan speed control are listed for that application.
- R. Do not share the neutral conductor on the load side of dimmers.
- S. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical, and grounding terminal of receptacles on the bottom. Group adjacent switches under single, multi-gang wall plates. Located telecom devices within 6" of power receptacles.
- T. Protect devices and assemblies during painting.

- U. Adjust locations at which floor service outlets and telephone/power service poles are installed to suit arrangement of partitions and furnishings

3.02 IDENTIFICATION

- A. Comply with Section 26 05 53 - Electrical Identification.
- B. Receptacles: Identify panelboard and circuit number from which receptacle is served.
 - 1. Label receptacles downstream from a feed-through type GFCI receptacle "GFCI PROTECTED."
 - 2. For duplex receptacles on UPS power, provide label that reads "UPS".

3.03 CONNECTIONS

- A. Connect wiring device grounding terminal to outlet box with bonding jumper.
- B. Connect wiring device grounding terminal to branch-circuit equipment grounding conductor.
- C. Isolated-Ground Receptacles: Connect to isolated-ground conductor routed to designated isolated equipment ground terminal of electrical system. Shall be grounded via a separate green ground conductor with yellow or orange stripe to the panelboard isolated ground bus.
- D. All standard, TVSS, and GFCI receptacles shall be grounded via a separate green equipment ground wire connected to the panelboard ground bus. Metallic raceway shall not be the sole equipment ground current path.
- E. Maintain consistent polarity for power and common terminals on all receptacles.
- F. Test GFCI receptacles per manufacturer's recommendations.

3.04 FIELD QUALITY CONTROL

- A. Test wiring devices for proper polarity and ground continuity. Operate each device.
- B. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
- C. Line Voltage: Acceptable range is 105 to 132 V.
- D. Ground Impedance: Values of up to 2 ohms are acceptable.
- E. Check TVSS receptacle indicating lights for normal indication.
- F. Test GFCI operation with both local and remote fault simulations according to manufacturer's written instructions. Test for tripping values specified in UL 1436 and UL 943.
- G. Wiring device will be considered defective if it does not pass tests and inspections.
- H. Replace damaged or defective components.

3.05 CLEANING

- A. Internally clean devices, device outlet boxes, and enclosures. Replace stained or improperly painted wall plates or devices.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.

B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of "Fuses" Work is shown in the Contract Documents. This section includes cartridge fuses, rated 600V and less, for use in switches, panelboards, switchboards, controllers, and motor-control centers; and spare fuse cabinets.

1.02 GOVERNING CODES, STANDARDS AND REFERENCES

- A. NEMA FU 1 (National Electrical Manufacturers Association) - Low Voltage Cartridge Fuses,
- B. NFPA 70 (National Fire Protection Association) - National Electrical Code,

1.03 SUBMITTALS

- A. Submit materials data in accordance with of Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.
- B. Submittals shall include the following:
 - 1. Product Data: Include the following for each fuse type indicated:
 - a. Ambient Temperature Adjustment Information: If rating of fuses has been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
 - (1) For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature and adjusted fuse rating.
 - (2) Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
 - b. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
 - c. Let-through current curves for fuses with current-limiting characteristics.
 - d. Time-current coordination curves and current-limitation curves for each type and rating of fuse. Coordination charts and tables, and related data.
 - e. Fuse size for elevator feeders and elevator disconnect switches.

1.04 QUALITY ASSURANCE

- A. Source Limitations: Provide fuses from a single manufacturer.
- B. On low-voltage systems, provide nonrenewable cartridge fuses, class and current rating required, voltage rating consistent with circuit voltage.
- C. Listing and Labeling: Provide components, devices and accessories that are Listed and Labeled as defined in NFPA 70, Article 100 and marked for intended use for the location and environment in which they are installed.
- D. Comply with NEMA FU 1.

- E. Comply with NFPA 70, as adopted and administered by the Authority Having Jurisdiction.

1.05 COORDINATION

- A. Coordinate fuse ratings with HVAC and refrigeration equipment nameplate limitations of maximum fuse size.
- B. Select fuses to provide appropriate levels of short circuit and overcurrent protection for components such as wire and cable, bus structures, and other overcurrent equipment.
- C. Select fuses to coordinate with time-current characteristics of other overcurrent protective elements, such as other fuses, circuit breakers, and protective relays. Design system to ensure that device closest to fault operates first.
- D. The Engineer shall verify that the let-through current of the selected fuse does not exceed the rating of downstream devices or conductors. The Engineer shall calculate the short-circuit capability of downstream cable to verify that it is protected by the fuse time-current characteristic curve.
- E. The Engineer shall selectively coordinate all protective devices so faults are isolated to the most localized level.
 - 1. On low voltage systems this may occasionally indicate the use of a fuse in series with a circuit breaker.
 - 2. On medium voltage systems, particular care should be given to coordination of padmount vacuum fault interrupters with upstream feeder fuses and coordination of fuses in series through a transformer (i.e. a 12.47-4.12kV transformer with primary and secondary fuses).

1.06 EXTRA MATERIALS

- A. Spare and extra parts shall be identified for all products, but not provided. Include spare parts information in Operation and Maintenance Manuals.
 - 1. Fuses: 3 of each fuse type and size

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Bussmann; Division of Cooper Industries.
 - 2. Ferraz Shawmut.
 - 3. Littelfuse.
 - 4. Or Approved Equal.

2.02 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, non-renewable cartridge fuse; class and current rating indicated; voltage rating consistent with circuit voltage.

2.03 LOW-VOLTAGE FUSES

- A. Fuses for circuits under 600V shall be UL listed, Class J, Class L, Class R or RK.

- B. Fuses for safety switches shall be class R, intended for use with rejection clips.
 - 1. Use Class L and Class T fuses to protect loads over 600 Amps such as transformer secondaries, switchboard mains or large feeders
 - 2. Use Class J, Class K and Class R fuses to protect most feeder and branch-circuit applications.
- C. Fuse Applications:
 - 1. Main Services and Main Feeders
 - a. 601 to 6000A circuits: Provide Class L with 4-second minimum time delay at 500% rated current, with an interrupting rating of 200,000 amperes RMS symmetrical.
 - b. 600 amperes and less circuits: Provide Class RK1 dual-element, time-delay, non-interchangeable fuses with an interrupting rating of 200,000 amperes, for 600 volt and 250-volt applications, respectively.
 - c. 600-volt RK1 fuses shall have an indicating feature, which clearly indicates when fuse is opened (blown).
 - 2. Motor Circuit Fuses: Provide Class RK1 and Class J dual-element time-delay fuses with 10-second minimum time delay at 500% rated current, sized at 125% of full-load current of motor.
 - 3. Current limiting fuses Protecting Molded-Case Circuit Breaker Panelboards
 - a. Molded case circuit breaker panelboards, having short-circuit ratings less than the available short-circuit current at the point where the panelboard is applied, shall be protected by Class and maximum fuse ratings listed by the panelboard manufacturer.
 - b. Class G (300V) and Class CC (600V) current limiting, noninterchangeable, time delay or non-time delay fuses are used in branch-circuit panelboards.
 - 4. Lighting Fixture Protection
 - a. Lighting fixture ballasts shall be individually protected on their line.
 - b. In each instance, fuse size and type shall be as recommended by the fixture or ballast manufacturer.

2.04 MEDIUM-VOLTAGE FUSES

- A. Fuses for medium-voltage motors shall be R-rated for use with an overload relay and contactor as part of a medium-voltage motor starter package. Typically, the starter manufacturer will select the fuse.
- B. Fuses for other medium-voltage loads including transformers, feeders, and capacitors shall be E-rated general-purpose current limiting fuses.

2.05 POTENTIAL TRANSFORMER FUSES

- A. Medium-voltage fuses shall be E-Rated, intended for the purpose. Low-voltage fuses shall be as selected by the original equipment manufacturer.

2.06 SPARE FUSE CABINET

- A. Cabinet: Wall-mounted, 0.05-inch- thick steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.
 - 1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
 - 2. Finish: Gray, baked enamel.
 - 3. Identification: "SPARE FUSES" in 1-1/2-inch high letters on exterior of door.
 - 4. Fuse Pullers: For each size fuse.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 FUSE APPLICATIONS

- A. Main Services and Main Feeders:
 - 1. 601A to 6000A circuits: Class L, minimum 4 second time delay at 500% rated current, with an interrupting rating of 200,000 amperes RMS symmetrical.
 - 2. 600A and less circuits: Class RK1 dual-element, time delay, non-interchangeable fuses with an interrupting rating of 200,000 amperes, for 600V and 250V applications.
 - a. 600V RK1 fuses shall have an indicating feature which clearly indicates when fuse is opened (blown).
- B. Motor Branch Circuits: Class RK1 and Class J dual element time-delay fuses with 10-second minimum time delay at 500% rated current, sized at 125% of full load current of motor.
- C. Current Limiting Fuses Protecting Molded Case Circuit Breaker Panelboards:
 - 1. Molded case circuit breaker panelboards having short circuit ratings less than the available short circuit current at the point where the panelboard is applied shall be protected by Class and maximum fuse ratings listed by the panelboard manufacturer.
 - 2. Class G (300V) and Class CC (600V) current limiting, non-interchangeable time delay or non-time delay fuses are used in branch circuit panelboards.

- D. Light Fixture Protection:
 - 1. Luminaire ballasts shall be individually protected on their line.
 - 2. In each instance, fuse size and type shall be as recommended by the fixture or ballast manufacturer.

3.03 FUSE INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so that manufacturer, type and rating information is readable without removing fuse. Do not mix brands of types of fuses in device.
- B. The Electrical Contractor at the job site shall install all fuses only when equipment is to be energized. Fuses shall not be installed prior to shipment.
- C. Install spare fuse cabinet[s].

3.04 IDENTIFICATION

- A. Install labels indicating fuse replacement information on inside door of each fused switch as specified in Section 26 05 53 - Electrical Identification.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.
- B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of "Enclosed Switches and Circuit Breakers" Work is shown in the Contract Documents. This section includes individually mounted enclosed switches and circuit breakers used for the following:
 - 1. Service disconnecting means.
 - 2. Feeder and branch-circuit protection.
 - 3. Motor and equipment disconnecting means.
- B. Definitions
 - 1. GFCI: Ground-fault circuit interrupter.
 - 2. RMS: Root mean square.
 - 3. SPDT: Single pole, double throw.

1.02 GOVERNING CODES, STANDARDS AND REFERENCES

- A. NEMA AB 1 (National Electrical Manufacturers Association) - Molded Case Circuit Breakers.
- B. NEMA FU1 (National Electrical Contractors Association) - Low Voltage Cartridge Fuses.
- C. NEMA KS 1 (National Electrical Contractors Association) - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
- D. NETA ATS (International Electrical Testing Association) - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems (International Electrical Testing Association).
- E. NFPA 70 (National Fire Protection Association) - National Electrical Code.

1.03 SUBMITTALS

- A. Submit materials data in accordance with of Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.
- B. Submittals shall include the following:
 - 1. Product Data: For each type of switch, circuit breaker, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
 - 2. Shop Drawings: For each switch and circuit breaker.
 - a. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - (1) Enclosure types and details for types other than NEMA 250, Type 1.
 - (2) Current and voltage ratings.

- (3) Short-circuit current rating.
 - (4) Series rating of installed devices is not allowed.
 - (5) Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - (6) Include time-current coordination curves for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.
- 3. Manufacturer Seismic Qualification Certification: Submit certification that enclosed switches and circuit breakers, accessories, and components will withstand seismic forces defined in Section 26 05 48 - Seismic Controls for Electrical and Communication Work. Include the following:
 - a. Basis of Certification: Verify whether withstand certification is based on actual test of assembled components.
 - (1) The term “withstand” means “the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event.”
 - b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- 4. Field Test Reports: Submit written test reports and include the following:
 - a. Test procedures used.
 - b. Test results that comply with requirements.
 - c. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- 5. Manufacturer’s field service report.
- 6. Maintenance Data: For enclosed switches and circuit breakers and for components to include in maintenance manuals specified in Division 1 General Requirements. In addition to requirements specified in Section 01 77 00 - Project Closeout include the following:
 - a. Routine maintenance requirements for components.
 - b. Manufacturer’s written instructions for testing and adjusting switches and circuit breakers.
 - c. Time-current curves, including selectable ranges for each type of circuit breaker.

1.04 QUALITY ASSURANCE

- A. Listing and Labeling: Provide components, devices and accessories that are Listed and Labeled as defined in NFPA 70, Article 100 and marked for intended use for the location and environment in which they are installed.

1. Service Entrance: Switches and circuit breakers identified for use as service equipment shall be labeled for this application.
 - B. Comply with NEMA AB 1 and NEMA KS 1.
 - C. Comply with NFPA 70, as adopted and administered by the Authority Having Jurisdiction.
 - D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- 1.05 PROJECT CONDITIONS
- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
 1. Ambient Temperature: Not less than minus 22°F (minus 30°C) and not exceeding 104°F (40°C).
 2. Altitude: Not exceeding 1000 feet.
- 1.06 COORDINATION
- A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- 1.07 EXTRA MATERIALS
- A. Spare and extra parts shall be identified for all products, but not provided. Include spare parts information in Operation and Maintenance Manuals.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Cutler-Hammer; Division of Eaton.
 2. General Electric.
 3. Square D.; Schneider Electric.
 4. Siemens.
 5. Or Approved Equal.

2.02 COMPLIANCE

- A. Seismic: Refer to Section 26 05 48 – Seismic Controls for Electrical and Communication Work

2.03 ENCLOSED SWITCHES

- A. Enclosed, Nonfusible Switch: NEMA KS 1, Type HD, with lockable handle.

- B. Enclosed, Fusible Switch, 800A and Smaller: NEMA KS 1, Type HD, with clips to accommodate specified fuses, lockable handles with two padlocks, and interlocked with cover in closed position.
- C. Service Entrance: For switches identified for use as service equipment, provide solid neutral assembly and equipment ground bus.

2.04 ENCLOSED CIRCUIT BREAKERS

- A. Enclosed Circuit Breakers
 - 1. Ground Fault protection type:
 - a. Required for solidly grounded wye service entrance switches over 150 Volts to ground, not exceeding 600 Volts and rated 1000 Amps and above.
 - 2. Switch Duty (SWD) rated type for switching lighting fixtures. Note that energy code restricts use of circuit breakers as sole means of switching lighting circuits. (See State of Washington Nonresidential Energy Code 1513.2)
 - 3. Auxiliary contacts: Provide as required by engineering considerations.
- B. Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250A and larger.
 - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 - 3. Electronic Trip Unit Circuit Breakers: RMS sensing; field-replaceable rating plug; with the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t response.
 - 4. Current-Limiting Circuit Breakers: Frame sizes 400A and smaller; let-through ratings less than NEMA FU 1, RK-5.
 - 5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
 - 6. GFCI Circuit Breakers: Single- and two-pole configurations with 30 mA trip sensitivity.
 - 7. Molded-Case Switch: Molded-case circuit breaker without trip units.
- C. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.

1. Lugs: Mechanical style suitable for number, size, trip ratings, and material of conductors.
 2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
 3. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 4. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system.
 5. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
 6. Auxiliary Switch: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
 7. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
 8. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
- D. Service Entrance: For enclosed circuit breakers identified for use as service equipment, provide solid neutral assembly and equipment ground bus.

2.05 ENCLOSURES

- A. NEMA AB 1, NEMA KS 1 and UL 50 to meet environmental conditions of installed location.
1. Indoor Clean Locations: NEMA 250, Type 1.
 2. Indoor Dusty Locations: NEMA 250, Type 12.
 3. Indoor Wet or Damp Locations and Outdoor Dirty/Oily or Washdown Locations: NEMA 250, Type 4.
 4. Outdoor Locations: NEMA 250, Type 3R.
 5. Corrosive Locations: NEMA 250, Type 4X, stainless steel.

2.06 FACTORY FINISHES

- A. Manufacturer's standard prime-coat finish ready for field painting.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance.
1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 EQUIPMENT INSTALLATION

- A. Comply with NFPA 70 working space requirements and NECA 1.
- B. Standard Mounting Height: Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated. Operating handle typically at 5'-0" above grade or finished floor.
- C. Mount on substantial structure and secure to meet seismic zone 3 requirements. Comply with mounting and anchoring requirements specified in Section 26 05 48 - Seismic Controls for Electrical and Communication Work.
- D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- E. Install fuses with rating indications facing outward.
- F. Set adjustable parameters and provide testing and calibration as required by engineering considerations.

3.03 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Section 26 05 53 - Electrical Identification.
- B. Install enclosure nameplate with switch or circuit breaker designation, power source, source location, voltage, load served and load location.
 - 1. Identify special conditions for shutting down load served.
- C. Apply label inside door cover identifying NEMA fuse class and size of fuses installed.
- D. Equipment used in emergency systems shall be labeled "Suitable for use on emergency systems" per NEC 700-3.

3.04 CONNECTIONS

- A. Install equipment grounding connections for switches and circuit breakers with ground continuity to main electrical ground bus.
- B. Install power wiring. Install wiring between switches and circuit breakers, and control and indication devices.
- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
 - 1. Mark lugs after torquing with red paint such that paint will be visibly disturbed if lugs are disturbed.

3.05 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to initially inspect, test, and adjust components, assemblies, and equipment installations, including connections. Verification will be by third party testing agency.
- B. Prepare for acceptance tests as follows:

1. Test insulation resistance for each enclosed switch, circuit breaker, component, and control circuit.
 2. Test continuity of each line- and load-side circuit.
 - C. Testing: After installing enclosed switches and circuit breakers and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
 1. Procedures: Perform each visual and mechanical inspection and electrical test indicated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- 3.06 ADJUSTING
- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
 - B. Set field-adjustable switches and circuit-breaker trip ranges.
- 3.07 CLEANING
- A. On completion of installation, inspect interior and exterior of enclosures. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.
- 3.08 OPERATION AND MAINTENANCE MANUALS
- A. Comply with Section 01 78 23.13 - Operations and Maintenance Data and Part 1 of this specification.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.
- B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of "Surge Protective Devices for Low-Voltage Electrical Power Circuits" Work is shown in the Contract Documents. This section includes transient voltage surge suppressors for low-voltage power, control, and sensitive electronic equipment.

1.02 GOVERNING CODES, STANDARDS AND REFERENCES

- A. IEEE C62.41, "IEEE Guide for Surge Voltages in Low Voltage AC Power Circuits."
- B. IEEE C62.45, "IEEE Guide for Surge Suppressor Testing."
- C. NEMA Compliance: Comply with NEMA LS 1, "Low Voltage Surge Protective Devices."
- D. NETA ATS (International Electrical Testing Association) - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- E. NFPA 70 (National Fire Protection Association) - National Electrical Code.
- F. NFPA 75, "Protection of Electronic Computer/Data Processing Equipment".
- G. UL 1283 "Electromagnetic Interference Filters".
- H. UL 1449 listing requirements for "Transient Voltage Surge Suppressors".

1.03 SUBMITTALS

- A. Submit materials data in accordance with of Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.
- B. Submittals shall include the following:
 - 1. Product Data: For each type of product indicated include rated capacities, shipping, installed, and operating weights; furnished specialties, and accessories.
 - 2. Product Certificates: Signed by manufacturers of Surge Protective devices, certifying that products furnished comply with the following testing and labeling requirements:
 - a. UL 1283 certification.
 - b. UL 1449 listing and classification.
 - 3. Field Test Reports. Written reports of tests specified in Part 3 of this section. Include the following:
 - a. Test procedures used.
 - b. Test results that comply with requirements.
 - c. Failed test results and corrective action taken to achieve requirements.
 - 4. Maintenance Data: For Surge Protective devices to include in maintenance manuals specified in Division 1 General Requirements.
 - 5. Warranties: Special warranties specified in this section.

1.04 QUALITY ASSURANCE

- A. Source Limitations: Obtain suppression devices and accessories through one source from a single manufacturer.
- B. Listing and Labeling: Provide components, devices and accessories that are 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 for the location and environment in which they are installed.
- C. IEEE Compliance: Comply with IEEE C62.41, "IEEE Guide for Surge Voltages in Low Voltage AC Power Circuits," and test devices according to IEEE C62.45, "IEEE Guide for Surge Suppressor Testing."
- D. NEMA Compliance: Comply with NEMA LS 1, "Low Voltage Surge Protective Devices."
- E. UL Compliance: Comply with UL 1283, "Electromagnetic Interference Filters," and UL 1449, "Transient Voltage Surge Suppressors."

1.05 PROJECT CONDITIONS

- A. Placing into Service: Do not energize or connect [service entrance equipment] [panelboards] [control terminals] [data terminals] to their sources until the surge protective devices are installed and connected.
- B. Existing Utilities: Do not interrupt utilities serving facilities occupied by the Port or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify the Engineer not less than two days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Port's written permission.
 - 3. Coordinate with requirements specified in Section 01 50 00 - Temporary Facilities and Controls for temporary utilities
- C. Service Conditions: Rate surge protective devices for continuous operation under the following conditions, unless otherwise indicated:
 - 1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.
 - 2. Operating Temperature: 30 to 120°F (0 to 50°C).
 - 3. Humidity: 0 to 85 percent, non-condensing.
 - 4. Altitude: Less than 20,000 feet above sea level.

1.06 COORDINATION

- A. Coordinate location of field-mounted surge suppressors to allow adequate clearances for maintenance.
- B. Coordinate surge protective devices with aviation requirements.

1.07 SPECIAL WARRANTY

- A. General Warranty: Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract

Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

- B. Special Warranty: Written warranty, executed by manufacturer agreeing to repair or replace components of surge suppressors that fail in materials or workmanship within five years from date of Substantial Completion.
- C. Special Warranty for Plug-in Cord-Connected Surge Suppressors: Written warranty, executed by manufacturer agreeing to repair or replace electronic equipment connected to circuits protected by surge suppressors.

1.08 EXTRA MATERIALS

- A. Spare and extra parts shall be identified for all products, but not provided. Include spare parts information in Operation and Maintenance Manuals

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Manufacturers of a Broad Line of Suppressors:
 - a. Current Technology; subsidiary of Thomas & Betts; Division of ABB.
 - b. Cutler-Hammer; Division of Eaton.
 - c. Innovative Technology; Division of Eaton.
 - d. Square D Co.
 - e. Or Approved Equal.

2.02 GENERAL REQUIREMENTS

- A. Distribution class or better, sized appropriately for MCOV.
- B. Electrochemical heat sink encapsulated.
- C. LED indicators.
- D. Alarm contacts for remote indication.
- E. UL 1449 listed.
- F. Parallel configuration.
- G. For main service and distribution panels, provide threshold suppression network filtering, voltage envelope clamping.
- H. For branch circuit panels and sub panels serving electronic equipment, provide active tracking on ringwave transients.
- I. Steel enclosures.
- J. Copper bus.
- K. Visual annunciators shall continuously indicate normal and abnormal operation of TVSS equipment.

2.03 SERVICE ENTRANCE AND DISTRIBUTION PANEL SUPPRESSORS

- A. Surge Protective Device Description: Non-modular type with the following features and accessories:
 - 1. LED indicator lights for power and protection status.
 - 2. Audible alarm, with silencing switch, to indicate when protection has failed.
 - 3. One set of dry contacts rated at 5A, 250V ac, for remote monitoring of protection status.
- B. Peak Single-Impulse Surge Current Rating: 240KA or 160 kA per phase.
- C. Connection Means: Permanently wired.
- D. Protection modes and UL 1449 clamping voltage for grounded wye circuits with voltages of 480Y/277V and 208Y/120V 3-phase, 4-wire circuits, shall be as follows:
 - 1. Line to Neutral: 800V for 480Y/277V system, 400V for 208Y/120V system.
 - 2. Line to Ground: 800V for 480Y/277V system, 400V for 208Y/120V system.
 - 3. Neutral to Ground: 800V for 480Y/277V system, 400V for 208Y/120V system.
- E. Protection modes and UL 1449 clamping voltage for 240/120V, single-phase, 3-wire circuits, shall be as follows:
 - 1. Line to Neutral: 400V.
 - 2. Line to Ground: 400V.
 - 3. Neutral to Ground: 400V.
- F. Protection modes and UL 1449 clamping voltage for 240/120V, 3-phase, 4-wire circuits, with high leg shall be as follows:
 - 1. Line to Neutral: 400V, 800 V from high leg.
 - 2. Line to Ground: 400V.
 - 3. Neutral to Ground: 400V.
- G. Protection modes and UL 1449 clamping voltage for voltages of 240, 480, or 600; 3-phase, 3-wire, delta circuits shall be as follows:
 - 1. Line to Line: 2000V for 480V system, 1000V for 240V system.
 - 2. Line to Ground: 2000V for 480V system, 1000V for 240V system.

2.04 PANELBOARD SUPPRESSORS

- A. Surge Protective Device Description: Non-modular type with the following features and accessories:
 - 1. LED indicator lights for power and protection status.
 - 2. Audible alarm, with silencing switch, to indicate when protection has failed.
 - 3. One set of dry contacts rated at 5A, 250V ac, for remote monitoring of protection status.
- B. Peak Single-Impulse Surge Current Rating: 120KA or 80kA per phase.

- C. Protection modes and UL 1449 clamping voltage for grounded wye circuits with voltages of 480Y/277V or 208Y/120V, 3-phase, 4-wire circuits, shall be as follows:
 - 1. Line to Neutral: 800V for 480Y/277V system, 400V for 208Y/120V system.
 - 2. Line to Ground: 800V for 480Y/277V system, 400V for 208Y/120V system.
 - 3. Neutral to Ground: 800V for 480Y/277V system, 400V for 208Y/120V system.
- D. Protection modes and UL 1449 clamping voltage for 240/120V, single-phase, 3-wire circuits, shall be as follows:
 - 1. Line to Neutral: 400V.
 - 2. Line to Ground: 400V.
 - 3. Neutral to Ground: 400V.
- E. Protection modes and UL 1449 clamping voltage for 240/120V, 3-phase, 4-wire circuits, with high leg shall be as follows:
 - 1. Line to Neutral: 400V, 800 V from high leg.
 - 2. Line to Ground: 400V.
 - 3. Neutral to Ground: 400V.
- F. Protection modes and UL 1449 clamping voltage for voltages of 240, 480, or 600; 3-phase, 3-wire, delta circuits shall be as follows:
 - 1. Line to Line: 2000V for 480V system, 1000V for 240V system.
 - 2. Line to Ground: 1500V for 480V system, 800V for 240V system.

2.05 AUXILIARY PANEL SUPPRESSORS

- A. Surge Protective Device Description: Unit type, panel-mounted design with the following features and accessories:
 - 1. LED indicator lights for power and protection status.
 - 2. Audible alarm, with silencing switch, to indicate when protection has failed.
 - 3. One set of dry contacts rated at 5A, 250V ac, for remote monitoring of protection status.
 - 4. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
 - 5. Red and green LED indicator lights for power and protection status.
 - 6. Audible alarm, with silencing switch, to indicate when protection has failed.
- B. Peak Single-Impulse Surge Current Rating: 160KA, 120KA, or 80kA per phase.
- C. Protection modes and UL 1449 clamping voltage for grounded wye circuits with voltages of 480Y/277V or 208Y/120V, 3-phase, 4-wire circuits, shall be as follows:
 - 1. Line to Neutral: 800V for 480Y/277V system, 400V for 208Y/120V system.
 - 2. Line to Ground: 800V for 480Y/277V system, 400V for 208Y/120V system.
 - 3. Neutral to Ground: 800V for 480Y/277V system, 400V for 208Y/120V system.

- D. Protection modes and UL 1449 clamping voltage for 240/120V, single-phase, 3-wire circuits, shall be as follows:
 - 1. Line to Neutral: 400V.
 - 2. Line to Ground: 400V.
 - 3. Neutral to Ground: 400V.
- E. Protection modes and UL 1449 clamping voltage for 240/120V, 3-phase, 4-wire circuits, with high leg shall be as follows:
 - 1. Line to Neutral: 400V, 800V from high leg.
 - 2. Line to Ground: 400V.
 - 3. Neutral to Ground: 400V.
- F. Protection modes and UL 1449 clamping voltage for voltages of 240, 480, or 600; 3-phase, 3-wire, delta circuits shall be as follows:
 - 1. Line to Line: 2000V for 480V system, 1000V for 240V system.
 - 2. Line to Ground: 1500V for 480V system, 800V for 240V system.

2.06 PLUG-IN SURGE SUPPRESSORS

- A. Description: Non-modular, plug-in suppressors with at least four 15A, 120V ac, NEMA WD 6, Configuration 15-15R receptacles, suitable to plug into a NEMA WD 6, Configuration 15-15R receptacle; with the following features and accessories:
 - 1. LED indicator lights for power and protection status.
 - 2. LED indicator lights for reverse polarity and open outlet ground.
 - 3. Circuit breaker and thermal fusing. When protection is lost, circuit opens and cannot be reset.
 - 4. Circuit breaker and thermal fusing. Unit continues to supply power if protection is lost.
 - 5. Cord connected with 15-foot line cord.
 - 6. Rocker-type on-off switch, illuminated when in the on position.
 - 7. One RJ11/12C telephone line protector, suitable for modem connection. Maximum clamping voltage 220 peak on pins No.3 and 4.
- B. Peak Single-Impulse Surge Current Rating: 13 kA per phase.
- C. Protection modes and UL 1449 clamping voltage shall be as follows:
 - 1. Line to Neutral: 475V.
 - 2. Line to Ground: 475V.
 - 3. Neutral to Ground: 475V.

2.07 ENCLOSURES

- A. NEMA 250, with type matching the enclosure of panel or device being protected. NEMA 1 or 12.

PART 3 EXECUTION

3.01 INSTALLATION OF SURGE PROTECTIVE DEVICES

- A. Install devices at service entrance on load side, with ground lead bonded to service entrance ground.
- B. Install devices for panelboard and auxiliary panels with conductors between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.
 - 1. Provide multi-pole, 15A circuit breaker as a dedicated disconnect for the suppressor, unless otherwise indicated.

3.02 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.03 IDENTIFICATION

- A. Identify surge suppressors according to Section 26 05 53 - Electrical Identification.

3.04 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.
 - 1. Verify that electrical wiring installation complies with manufacturer's installation requirements.
- B. Testing: Perform the following field quality-control testing:
 - 1. After installing surge protective devices, but before electrical circuitry has been energized, test for compliance with requirements.
 - 2. Complete startup checks according to manufacturer's written instructions.
 - 3. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.19. Certify compliance with test parameters.
- C. Repair or replace malfunctioning units. Retest after repairs or replacements are made.

3.05 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Port maintenance personnel to adjust, operate, and maintain surge protective devices.
 - 1. Train Port's maintenance personnel a minimum of two hours on procedures and schedules for maintaining suppressors.
 - 2. Review data in maintenance manuals. Refer to Section 01 78 23.13 - Aviation Operations and Maintenance Documentation.
 - 3. Schedule training with Port with at least seven days' advance notice.

3.06 OPERATION AND MAINTENANCE MANUALS

- A. Comply with Section 01 78 23.13 - Aviation Operations and Maintenance Documentation and Part 1 of this specification.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.

- B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of "Interior Lighting" Work is shown in the Contract Documents. This section includes interior lighting fixtures, lighting fixtures mounted on exterior building surfaces, lamps, ballasts, emergency lighting units, and accessories.

1.02 GOVERNING CODES, STANDARDS AND REFERENCES

- A. NFPA 70 (National Fire Protection Association) - National Electrical Code.
- B. NFPA 101 (National Fire Protection Association) - Life Safety Code.

1.03 SUBMITTALS

- A. Submit materials data in accordance with of Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.
- B. Submittals shall include the following:
 - 1. Product Data: For each type of lighting fixture indicated, arranged in order of fixture designation. Include data on features, accessories, and the following:
 - a. Physical description and dimensions of fixtures.
 - b. Ballast, including BF.
 - c. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.
 - d. Certified results of laboratory tests for fixtures and lamps for photometric performance.
 - e. Emergency lighting unit battery and charger.
 - f. Fluorescent and high-intensity-discharge ballasts.
 - g. Types of lamps.
 - 2. Wiring Diagrams: For power, signal and control wiring. Detail wiring for fixtures and differentiates between manufacturer-installed and field-installed wiring.
 - 3. Coordination Drawings: Reflected ceiling plans and sections drawn to scale and coordinating fixture installation with ceiling grid, ceiling-mounted items, and other components in the vicinity. Include Work of all trades that is to be installed near lighting equipment.
 - 4. Dimming Ballast Compatibility Certificates: Signed by manufacturer of ballast certifying that ballasts are compatible with dimming systems and equipment with which they are used.
 - 5. Maintenance Data: For lighting fixtures to include in maintenance manuals specified in Division 1 General Requirements.
 - 6. The authorized manufacturer representative for the project area shall prepare submittals for each lighting fixture type. Along with the fixture submittals, a list is to be provided identifying the manufacturer

representative for each fixture type. Provide manufacturers names, addresses, and telephone numbers. Requests for prior approval shall also include this information. Submittals or requests for prior approval without this information will be rejected.

1.04 QUALITY ASSURANCE

- A. Listing and Labeling: Provide fixtures, emergency lighting units, and accessories that are Listed and Labeled as defined in NFPA 70, Article 100 and marked for intended use for the location and environment in which they are installed.
- B. Comply with NFPA 70, as adopted and administered by the Authority Having Jurisdiction.
- C. NFPA 101 Compliance: Comply with visibility and luminance requirements for exit signs.

1.05 SUBSTITUTIONS

- A. Lighting fixtures designated for this project is based on the fixture types and manufacturers specified. If substitution of fixtures other than those specified is desired product information must be submitted, and approved (prior approval) by the Engineer 10-days prior to bid time. No requests for substitution will be accepted after this date.
- B. Substitution requests shall include all information required under 1.04 SUBMITTALS of this section. Requests for approval shall be accompanied by a working fixture sample (including lamps, cord and plug). Provide the name of at least one installation where each proposed substitute has been installed for at least six months. Provide the name and telephone number of the Engineer of Record.

1.06 CUSTOM LIGHT FIXTURES

- A. All custom light fixtures require a prototype to be submitted prior to commencement of fabrication. The purpose of the prototype will be to review construction, lamp placement within the fixture, lamp type, optical assembly, finishes, etc. Modifications may be required as a result of the prototype review. These modifications and others that do not materially affect the cost of the fixture shall be incorporated at no additional cost to the Port.

1.07 COORDINATION

- A. Fixtures, Mounting Hardware, and Trim: Coordinate layout and installation of lighting fixtures with ceiling system and other construction.
- B. Coordination Meetings: Meet at least twice with the ceiling installer. Hold first meeting before submittal of shop drawings to coordinate each light fixture mounting condition with ceiling type. During second meeting, coordinate fixture layout in each area. Meet at least twice with the mechanical systems installer prior to fabrication and installation of ductwork. Coordinate depth and location of all light fixtures and ductwork in all areas.

1.08 SPECIAL WARRANTY

- A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract

Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

1.09 EXTRA MATERIALS

- A. Spare and extra parts shall be identified for all products, but not provided. Include spare parts information in Operation and Maintenance Manuals.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturers:
1. Fluorescent Ballasts – Electronic:
 - a. Advance; Division of Philips.
 - b. Osram Sylvania.
 - c. Triad; Universal Lighting Technologies.
 - d. Or Approved Equal.
 2. HID Ballasts:
 - a. Advance; Division of Philips.
 - b. Universal Lighting Technologies.
 - c. Or Approved Equal.
 3. Lamps – Fluorescent and HID:
 - a. Osram Sylvania.
 - b. Venture Lighting.
 - c. General Electric.
 - d. Or Approved Equal.
 4. Lamps – LED:
 - a. Cree.
 - b. Philips.
 - c. EcoSmart.
 - d. Or Approved Equal.
 5. LED Drivers:
 - a. Cree.
 - b. Philips.
 - c. Lutron.
 - d. Or Approved Equal.
- B. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the products indicated in the Lighting Fixture Schedule located on the Drawings.

2.02 FIXTURES AND FIXTURE COMPONENTS, GENERAL

- A. Provide thermal protection via a replaceable cartridge fuse and fuse holder that encloses the fuse. Comply with disconnect switch requirements integral with the fixture.
- B. Hangers for pendant fixtures shall be rigid type; with not less than five-threaded engagement turns at each end. A safety factor of 4 shall be used in sizing anchors and hangers.
- C. Provide plaster frames for recessed lighting fixtures mounted in other than T-Bar.
- D. Recessed fluorescent downlights shall have cones, which are low brightness, low iridescence, and semi-specular or specular alzak as specified and shall be self flanged type.
- E. Emergency exit lights and egress lights with battery pack shall be Dual Lite Spectron series, Lightguard OmniTest and F100/F85 models, incorporating a self-diagnostic chip, Or Approved Equal. Self diagnostic test feature shall incorporate automatic tests to ensure proper unit operation per code requirements. Automatic test feature shall verify battery voltage and lamp continuity, and shall illuminate lamps and discharge battery for minimum 3 minutes every 30 days. Exit lights with LEDs are acceptable provided they meet code requirements. Exit sign lettering shall be green.
- F. LED fixtures shall be used for artistic lighting and lighting of artwork unless conditions preclude its use. Evaluate use of LED fixtures for architectural, landscaping, and other applications on a life-cycle cost basis.
- G. Metal Parts: Steel or aluminum with 300°F baked enamel finish, brushed aluminum with baked acrylic clear lacquer finish, or stainless steel with a brushed finish. Paint shall be water based with low VOC. Free from burrs, sharp corners, and edges.
- H. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.
- I. Doors, Frames, and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit relamping without use of tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent accidental falling during relamping and when secured in operating position.
- J. Reflective surfaces, which are painted, shall be baked white enamel or manufacturer standard color, two coats minimum with an average reflectance of 90% or better.
- K. Lenses, Diffusers, Covers, and Globes: 100 percent virgin acrylic plastic or annealed crystal glass, unless otherwise indicated.
 - 1. Plastic: High resistance to yellowing and other changes due to aging, exposure to heat, and ultraviolet radiation.
 - 2. Lens Thickness: 0.125 inch (3 mm) minimum, unless greater thickness is indicated.
- L. Electromagnetic Interference Filters: Integral to fixture assembly. Provide one filter for each ballast. Suppress conducted electromagnetic interference filters as required by MIL-STD-461.

2.03 HIGH-INTENSITY-DISCHARGE LAMP BALLASTS

- A. General: Electromagnetic Ballast for Metal-Halide Lamps: Comply with ANSI C82.4 and UL 1029. Include the following features unless otherwise indicated.
 - 1. Multi-tap ballast.
 - 2. Type: Constant wattage autotransformer or regulating high-power-factor type, except for metal-halide lamps below 175-watts without igniters where high resistance auto transformer type is acceptable.
 - 3. Operating Voltage: Match system voltage.
 - 4. Minimum Starting Temperature: Minus 22°F (Minus 30°C) for single lamp ballasts.
 - 5. Normal Ambient Operating Temperature: 104°F (40°C).
 - 6. Open-circuit operation that will not reduce average life.
 - 7. Auxiliary, Instant-on, Quartz System: Automatically switches quartz lamp on when fixture is initially energized and when momentary power outages occur. Automatically turns quartz lamp off when high-intensity-discharge lamp reaches approximately 60 percent light output.
 - 8. Each ballast shall be individually protected by an in-line fuse in a fuseholder Littelfuse, Bussmann Or Approved Equal.
- B. Encapsulation: Manufacturer's standard epoxy-encapsulated model designed to minimize audible fixture noise. Noise rating B or better.
- C. High-Pressure Sodium Ballasts: Equip with a solid-state igniter/starter having an average life in pulsing mode of 10,000 hours at an igniter/starter case temperature of 90°C.

2.04 LED DRIVERS

- A. Class 1, constant current.
- B. Power factor >90% at full load.
- C. THD <20%.
- D. Integral surge protection in accordance with ANSI C62.41.2.
- E. Minimum 5 year warranty.

2.05 EXIT SIGNS

- A. General Requirements: Comply with UL 924 for sign colors, visibility, luminance, and lettering size. Comply with Authorities Having Jurisdiction.
- B. Internally Lighted Signs: As follows:
 - 1. Lamps for AC Operation: Green Light-emitting diodes, 50,000 hours minimum rated lamp life.
- C. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
 - 1. Battery: Sealed, maintenance-free, nickel-cadmium type with special warranty.

2. Charger: Fully automatic, solid-state type with sealed transfer relay.
 3. Operation: Relay automatically energizes lamp from unit when circuit voltage drops to 80 percent of nominal or below. When normal voltage is restored, relay disconnects lamps, and battery is automatically recharged and floated on charger.
 4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 6. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Automatic test feature shall verify battery voltage and lamp continuity, and shall illuminate lamps and discharge battery for minimum 3 minutes every 30 days. Test failure is annunciated by an integral audible alarm and a flashing red LED.
 7. Self-diagnostic type with test switches and indicator lights.
- D. Self-Luminous Signs: Using strontium oxide aluminate compound to store ambient light and release the stored energy when the light is removed. Provide with universal bracket for flush-ceiling, wall, or end mounting.

2.06 EMERGENCY LIGHTING UNITS

- A. General Requirements: Self-contained units. Comply with UL 924. Units include the following features:
1. Battery: Sealed, maintenance-free, lead-acid type with minimum 10-year nominal life and special warranty.
 2. Charger: Fully automatic, solid-state type with sealed transfer relay.
 3. Operation: Relay automatically turns lamp on when supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps, and battery is automatically recharged and floated on charger.
 4. Wire Guard: Where indicated, heavy-chrome-plated wire guard arranged to protect lamp heads or fixtures.
 5. Integral Time-Delay Relay: Arranged to hold unit on for fixed interval after restoring power after an outage. Provides adequate time delay to permit high-intensity-discharge lamps to restrike and develop adequate output.
 6. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 7. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 8. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Automatic test feature shall verify battery voltage and lamp continuity, and shall illuminate lamps and discharge battery for minimum 3 minutes every

30 days. Test failure is annunciated by an integral audible alarm and a flashing red LED.

9. Self-diagnostic type with test switches and indicator lights.

2.07 LAMPS

- A. Provide products manufactured by one of the following:
 1. Osram/Sylvania.
 2. Venture.
 3. General Electric.
 4. Durotest.
 5. Philips.
 6. Or Approved Equal.
- B. Lamp each fixture with the proper quantity of lamps of the type specified in the Lighting Fixture Schedule.
- C. Incandescent lamps shall be rated for 130 volts and approved by Facilities and Infrastructure for each application.
- D. Standard fluorescent fixtures shall use T8 style lamps.
- E. Comply with ANSI C78 series that is applicable to each type of lamp.
- F. Fluorescent lamps shall pass federal TCLP tests.
- G. Color:
 1. Office Areas: 4200K (i.e., cool white)
 2. Public and Tenant Areas: 3500K (i.e., warm white)
- H. Fluorescent Color Temperature and Minimum Color-Rendering Index: 3500 K and 85 CRI, unless otherwise indicated.
- I. Fluorescent Color Temperature and Minimum Color-Rendering Index: 4100 K and 85 CRI, unless otherwise indicated.
- J. Non-compact Fluorescent Lamp Life: Rated average is 20,000 hours at 3 hours per start when used on rapid-start circuits.
- K. Fluorescent Lamps provided are required to have passed Federal TCLP testing.
- L. Metal-halide lamps shall be phosphor coated and compatible with fixture specified.
- M. All fluorescent and HID lamps shall be seasoned after installation by operating the lamps for approximately 100 hours without turning off.
- N. Lighting fixtures that contain lamps which require protective shielding shall be furnished with a tempered glass lens or approved unbreakable lens, which is UL listed for the application.
- O. LED Lamps:
 1. Color temperature range from 3500K-5500K based on specific project parameters.
 2. CRI >80.

3. Lumens per watt >50.
 4. Minimum 40,000 hour life at above 70% rated light output.
- P. HID Lamps:
1. Pulse-Start, Metal-Halide Lamps: Minimum CRI 85, and color temperature 3500 K or 4200 K.
 2. Ceramic, Pulse-Start, Metal-Halide Lamps: Minimum CRI 85, and color temperature 3500 K or 4000 K.

2.08 FIXTURE SUPPORT COMPONENTS

- A. Comply with Section 26 05 48 - Seismic Controls for Electrical and Communication Work for channel- and angle-iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fitting and ceiling canopy. Finish same as fixture.
- C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy arranged to mount a single fixture. Finish same as fixture.
- D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- E. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.
- F. Aircraft Cable Support: Use cable, anchorages, and intermediate supports recommended by fixture manufacturer.

2.09 FINISHES

- A. Fixtures: Manufacturer's standard, unless otherwise indicated.
 1. Paint Finish: Applied over corrosion-resistant treatment or primer, free of defects.
 2. Metallic Finish: Corrosion resistant.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Fixtures: Set level, plumb, and square with ceiling and walls, and secure according to manufacturer's written instructions and approved submittal materials. Install lamps in each fixture.
- B. Fixture installation shall comply with seismic zone 3 requirements.
- C. Provide all accessories required for a complete and operational system.
 1. For recessed fixtures, other than T-Bar, provide plaster frames and flanges suitable for ceiling.
 2. Provide plates, barriers, or rings to cover any exposed ceiling material between fixture canopy or pan and outlet box
- D. Remote Mounting of Ballasts, where necessary: Distance between the ballast and fixture shall not exceed that recommended by ballast manufacturer. Verify, with ballast manufacturers, maximum distance between ballast and luminaire.

- E. Fixtures shall be supported by separate means such as wire or chains from the building structure and not from the ceiling system, ductwork, piping, or other systems, with the exception of fixture types to be installed in suspended ceilings. See NEC Article 314-23.
- F. Support for Fixtures in or on Grid-Type Suspended Ceilings: Use grid for support.
 - 1. Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 6 inches from fixture corners.
 - 2. Support Clips: Fasten to fixtures and to ceiling grid members at or near each fixture corner with seismic clips that are UL listed for the application.
 - 3. Fixtures of Sizes Less Than Ceiling Grid: Arrange as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
- G. Suspended Fixture Support: As follows:
 - 1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
 - 2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
 - 3. Continuous Rows: Suspend from cable installed according to fixture manufacturer's written instructions and details on Drawings.
- H. Connect wiring according to Section 26 05 19 - 600 Volt or Less Wire and Cable.
 - 1. Do not use fixtures as a raceway for circuit conductors except for the single branch circuit supplying the fixtures. Branch circuit wiring shall not pass through an outlet box that is an integral part of an incandescent fixture unless the fixture is identified for the purpose.
 - 2. Wiring within fixtures shall be neatly arranged and protected from damage.
- I. Flush and recessed fixtures without an integral outlet box shall have a tap connection conductor, with insulation rated for 90°C, run from fixture terminal connection to an outlet box at least 1-foot from the fixture.
- J. Fixture whips shall be between 4' and 6' long.
- K. Mount remote LED drivers in accessible ceiling space as close as possible to fixture.
 - 1. Where ceiling is not accessible, mount in nearest electrical closet or service space provided that manufacturer's distance requirements are not exceeded.
- L. Mount LED fixtures to allow adequate air circulation around fixture cooling fins. Do not mount in a location where ambient temperature will exceed 40°C.
- M. Air-Handling Fixtures: Install with dampers closed.

3.02 CONNECTIONS

- A. Ground equipment.
 - 1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.03 IDENTIFICATION

- A. Comply with Section 26 05 53 - Electrical Identification.

3.04 FIELD QUALITY CONTROL

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- B. Advance Notice: Give dates and times for field tests.
- C. Provide instruments to make and record test results.
- D. Test as follows:
 - 1. Verify proper operation, switching and phasing of each fixture after installation according to their listing and the requirements in NFPA 101.
 - 2. Emergency Lighting: Interrupt electrical supply to demonstrate proper operation. Verify normal transfer to battery source and retransfer to normal.
 - 3. Report results in writing.
- E. Malfunctioning Fixtures and Components: Replace or repair, then retest. Repeat procedure until units operate properly.
- F. Corrosive Fixtures: Replace during warranty period.

3.05 CLEANING AND ADJUSTING

- A. Clean fixtures internally and externally after installation. Use methods and materials recommended by manufacturer.
- B. Adjust aimable fixtures to provide required light intensities.

3.06 INTERIOR LIGHTING FIXTURE SCHEDULE

- A. Refer to Lighting Fixture Schedule on the Drawings.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.
- B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any

Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

- A. The extent and location of "Communication Work" is shown in the Contract Documents. This Section includes general requirements for accomplishing Communication Work as specified herein and indicated on the Drawings.
- B. Any item not specifically shown on the drawings or called for in the specifications, but normally required to conform to the intent, are to be considered as part of the Contract.

1.02 GOVERNING CODES, STANDARDS AND REFERENCES

- A. The latest published edition of a reference shall be applicable to this project unless identified by a specification date.
- B. Building Industry Consulting Service International (BICSI) Telecommunications Distribution Methods Manual, current edition.
- C. American National Standards Institute /Telecommunications Industry Association (ANSI/TIA)
- D. Federal Communications Commission Title 47
 - 1. FCC Part 15
 - 2. FCC Part 68
- E. ISO/IEC 11801 International Organization for Standardization
- F. National Electrical Manufacturers Association (NEMA)
- G. National Electrical Safety Code (NESC)
- H. National Fire Protection Association (NFPA)
 - 1. NFPA 70 National Electrical Code (NEC)
 - 2. NFPA 75 Protection of Electronic Computer / Data Processing Equipment
 - 3. NFPA 101 Life Safety Code
- I. Federal Occupational Safety and Health Administration (OSHA)
- J. Underwriters Laboratories, Inc.

1.03 SUBMITTALS

- A. Submit materials data in accordance with of Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.
- B. Submittals shall include the following:
 - 1. Review of Shop Drawings and Brochures shall not relieve the Contractor of responsibility for dimensions and/or errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood that the noting of some errors, but the overlooking of others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings and Brochures, the requirements of the Contract Documents shall govern and are not waived

or superseded in any way by the review of the Shop Drawings and Brochures.

2. Manufacturer Approval Drawings: Equipment that is laid out, configured, or designed by manufacturer based on performance specifications only shall be submitted to the Engineer for approval prior to release of drawings for manufacturing.
- C. Ordering Materials: Order materials within two (2) weeks of receiving reviewed submittals from the Engineer. Provide proof of order placement upon request. Failure to comply will be considered non-performance and progress payments will be suspended until proof of order placement is reviewed and accepted by the Engineer.

1.04 DRAWINGS

- A. The communications drawings are diagrammatic and are not intended to show all raceway, wiring, exact locations of equipment, terminations, or number or types of fittings required by the communication system. Provide all related communication Work which is specified herein, diagrammed or scheduled on the communication drawings, required by code enforcing agencies and as indicated on other details or elevations for complete and operating electrical systems. Since the drawings of floor, wall, and ceiling installation are made at a small scale, outlets, devices, equipment, etc. are indicated only in their approximate location unless dimensioned or otherwise indicated. Locate outlets and apparatus symmetrically on floors, walls and ceilings where not dimensioned and coordinate such locations with the Work of other trades to prevent interferences. Verify all dimensions on the job. Do not scale the electrical drawings. Refer to Architectural and Mechanical shop drawings and project drawings for dimensions as applicable.

1.05 PRODUCTS

- A. General: Products are specified by manufacturer name, description, and/or catalog number to show intended function and quality. Report discrepancies, such as discontinued equipment or catalog numbers, to the Engineer prior to bidding. If the Contractor is unable to interpret any part of the plans and/or specifications, the Contractor shall notify the Engineer, who will issue interpretation and/or additional clarifications to Bidders before the project is bid.
- B. Manufacturers: Provide only equipment specified in the Contract Documents or approved by addendum. Manufacturers' catalog numbers and descriptions establish the quality of product required.
- C. Warranty: Comply with Section 01 78 36 - Warranties and Bonds. Warranty shall be manufacturer's standard or a minimum of one year unless noted otherwise in Division 27 Communication Sections.

1.06 SUBSTITUTIONS

- A. Comply with Section 01 25 00 - Substitutions.

1.07 QUALITY ASSURANCE

- A. All materials shall be new and unused and free from defects. All materials shall meet all applicable codes provided a standard has been established for the material in question. Properly store all materials and equipment for protection from physical damage or damage due to corrosion

- B. Review accessibility of equipment for operation, maintenance and repair prior to installation. Proceed with installation only after unsatisfactory conditions have been corrected
- C. Equipment Manufacturer Qualifications: Equipment manufacturers shall have at least 10 years experience in manufacturing products and accessories similar to those for this Project, with a record of successful in-service performance.
- D. Any given item of equipment or material shall be the product of one manufacturer throughout the facility. Multiple manufacturers of any one item will not be permitted, unless specifically noted otherwise.
- E. All products, services and materials provided and performed under the scope of this Specification shall conform to the manufacturer's requirements.
- F. Contractor is solely responsible for quality control of the Work and must comply with the Quality Control requirements specified herein.
- G. Installation Qualifications:
 - 1. In order to provide proper coordination, uniform quality and system integrity, the equipment and installation specified within this Specification shall be provided and installed by a single contractor with a proven track record in the field of the specified system. Personnel shall be competent and qualified by experience and training for the installation.
 - 2. Contractor shall be trained and certified by the manufacturer of the proposed system as a Certified Installer. A copy of the certificate shall be included with the bid.
 - 3. Upon award of the project and prior to the commencement of work, provide evidence that the General Foreman, Foreman or Crew Leader of the installation crew holds the designation of BICSI Technician, and that thirty-three percent (33%) of the installers have completed the BICSI Installer Level 1 or greater. The certificates of at least one BICSI Technician and one BICSI Installer Level 1 or 2 shall be submitted with the bid documents.

1.08 COORDINATION AND SCHEDULING

- A. Comply with Section 01 32 16 - Bar Chart Schedule.
- B. Coordinate and schedule Communication Work with the Work of other trades. Every reasonable effort shall be made to prevent conflicts as to space requirements, dimensions, locations, code required working spaces, access openings, drawout and removal spaces or other matters tending to obstruct or delay the Work of other trades. All changes caused by failure to coordinate shall be made at the Contractor's expense.

1.09 SAFETY AND PROTECTION

- A. Safety Measures To Be Taken: The Engineer has not been retained or compensated to provide design and construction review services relating to the Contractor's safety precautions or to the means, methods, techniques, sequences or procedures required for the Contractor to perform his Work. The Contractor will be solely and completely responsible for conditions of the job site, including safety of all persons and property during performance of the Work. This requirement will apply continuously and not be limited to normal working hours. The duty of the

Engineer to conduct construction observations of the Contractor's performance is not intended to include review of the adequacy of the Contractor's safety measures, in, on or near the construction site. It shall be the Contractor's responsibility to comply with applicable safety and health regulations for construction. The Contractor shall consult with the state or federal safety inspector for interpretation whenever in doubt as to whether safe conditions do or do not

- B. Comply with Section 01 35 13.13 - Operational Safety on Airports During Construction, Port of Seattle Construction Health & Safety Manuals and with applicable State of Washington safety rules and health standards, including WAC-294-45, and the Port of Seattle "Electrical Safety Rules." Any violation shall result in a warning citation.

1.10 DEMOLITION

- A. Existing material that is not to be reused or is not requested by the Port to be retained shall be removed from the site and shall become the property of the Contractor for salvage. All materials removed from the site shall be disposed of at facilities licensed for the material.
- B. In areas of where alterations are to be done, existing pathways may be reused, with the approval of the Engineer, in their original location, unless noted otherwise.
 - 1. Wiring that is discovered with damaged or deteriorating insulation shall be replaced with new.
 - 2. No existing wiring once removed may be reused, unless noted otherwise.

1.11 CERTIFICATION AND WARRANTY

- A. All work and all items of equipment and materials shall be warranted for a minimum period of one year from the date of acceptance of the work. Where a manufacturer's warranty is longer than one year, the Contractor shall offer the extended warranty. The Contractor shall, upon notification of any defective items, repair or replace such items within 24 hours without cost to the Owner, all to the satisfaction of the Owner/Engineer.
- B. Furnish a warranty in accordance with any General Conditions
- C. Listed Equipment: All applicable material, including accessories to the system and including all wire and cable, shall be listed by an approved agency recognized by Washington State Department of Labor and Industries for the use intended e.g., UL, CSA, ETL, or other NRTL.

1.12 PROJECT FINALIZATION

- A. Fully test and adjust all equipment installed under this specification and demonstrate its proper operation.
 - 1. Testing that involves use of instruments other than meggers and volt-ohm meters shall be performed by an independent testing agency according to the requirements of Section 27 08 00 - Acceptance Testing.
- B. Present the Port with Certificate of Inspection from the Authorities Having Jurisdiction upon completion of the Work stating that all Work complies with all applicable Codes and Ordinances.

- C. Comply with Division 1 General Requirements for cleaning, closeout procedures, commissioning, training, operations and maintenance manuals, and record drawings.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION – NOT USED

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.

- B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of “Grounding and Bonding for Communication Systems” Work is shown in the Contract Documents. This section includes grounding and bonding of communications systems and equipment. Grounding and bonding requirements specified in this section may be supplemented by special requirements of systems described in other Sections.

1.02 GOVERNING CODES, STANDARDS AND REFERENCES

- A. ANSI/BICSI N3-20 (American National Standards Institute/Building Industry Consulting Services International) - Planning and Installation Methods for Bonding and Grounding of Telecommunication and ICT Systems and Infrastructure
- B. ANSI/TIA-607 (American National Standards Institute/Telecommunication Industry Association) - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
- C. ASTM B8 (American Society for Testing and Materials) - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
- D. NFPA 70 (National Fire Protection Association) - National Electrical Code (NEC)
- E. NFPA 780 (National Fire Protection Association) - Standard for the Installation of Lightning Protection Systems
- F. UL (Underwriters Laboratories)
- G. UL 467 (Underwriters Laboratories) - Grounding and Bonding Equipment

1.03 SUBMITTALS

- A. Submit materials data in accordance with of Section 01 33 00 - Submittals. Furnish manufacturers’ technical literature, standard details, product specifications, calibration reports, and installation instructions for all products.
- B. Submittals shall include the following:
 - 1. Product Data: For each type of product indicated.
 - 2. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - a. Grounding: Indicate locations of grounding bus bars.
 - b. Grounding and Bonding System line diagram.
 - 3. Field quality control reports.
 - 4. As-Built Data: Plans showing dimensioned as-built locations of grounding features.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: All installation of the Telecommunication Ground Systems shall be done by a licensed electrician.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.05 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install equipment frames and cable trays until spaces are enclosed and weather tight, wet work in spaces is complete and dry.

1.06 COORDINATION

- A. Coordinate layout and installation of communications pathways with the other trades installing equipment in the ceiling.
- B. Coordinate grounding and bonding of communications systems with the electrical installer.
- C. Coordinate the labeling scheme for the communications systems with the Owner.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Chatsworth Products, Inc. (CPI)
 - 2. Harger Lightning & Grounding
 - 3. Commscope
 - 4. Or Approved Equal

2.02 GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

- A. Grounding Electrode System
 - 1. Comply with requirements of Section 26 05 26 – Grounding and Bonding for Electrical Systems.
- B. Primary Bonding Busbar
 - 1. The PBB (Primary Bonding Busbar) must be a predrilled copper busbar with holes for use with standard- sized lugs, have minimum dimensions of 6.3 mm (0.25 in) thick by 101 mm (4 in) wide, and length per contract drawings. It must be listed by an NRTL.
 - 2. Hole patterns on the busbars shall accommodate two-hole lugs per the of ANSI/BICSI N3-20 and ANSI/TIA-607 standards.
 - 3. Accessories:
 - a. Insulators to electrically isolate busbars from the mounting surfaces.
 - b. Mounting hardware shall be stainless steel hardware to fasten the two-hole ground lugs to the Busbar.
- C. Secondary Bonding Busbar
 - 1. The SBB (Secondary Bonding Busbar) must be a predrilled copper busbar with holes for use with standard- sized lugs, have a minimum dimension of 6.3 mm (0.25 in) thick by 51 mm (2 in) wide, and length per contract drawings. It must be listed by an NRTL.

2. Hole patterns on the busbars shall accommodate two-hole lugs per the ANSI/BICSI N3-20 and ANSI/TIA-607 standards.
3. Accessories:
 - a. Insulators shall electrically isolate Busbars from the wall, or other mounting surfaces, thereby controlling the current path.
 - b. Mounting hardware 316 stainless steel hardware to fasten the two-hole ground lugs to the Busbar.
- D. Grounding Conductors
 1. Comply with requirements of Section 26 05 26 – Grounding and Bonding for Electrical Systems.
- E. Bonding Accessories
 1. Two Mounting Hole Ground Terminal Block for Racks and Cabinets
 - a. Ground terminal block shall be made of electroplated tin aluminum extrusion.
 - b. Ground terminal block shall accept conductors ranging from #14 AWG through 2/0.
 - c. The conductors shall be held in place by two stainless steel set screws.
 - d. Ground terminal block shall have two 1/4" (6.4 mm) holes spaced on 5/8" (15.8 mm) centers.
 - e. Ground terminal block shall be UL Listed as a wire connector.
 2. Compression Lugs
 - a. Compression lugs shall be manufactured from electroplated tinned copper.
 - b. Compression lugs shall have two holes spaced on 5/8" (15.8 mm) centers.
 - c. Compression lugs shall be sized to fit a specific size conductor, sizes #6 AWG to 4/0, as stated below.
 - d. Compression lugs shall be UL Listed as wire connectors.
 3. Antioxidant Joint Compound
 - a. Oxide inhibiting joint compound for copper-to-copper, aluminum-to-aluminum or aluminum-to-copper connections.
 4. C-Type, Compression Taps
 - a. Compression taps shall be manufactured from copper alloy.
 5. Pipe Clamp With Grounding Connector
 - a. Pipe clamp shall be made from electroplated tinned bronze. Installation hardware will be stainless steel.
 - b. Pipe clamp shall be sized to fit up to two conductors ranging in size from #6 AWG to 250KCMIL; conductors must be the same size.

- c. Pipe clamp installation hardware shall be sized to attach to pipes, sizes 1" to 6" (0.75" to 6.63" in diameter).
- 6. Equipment Ground Jumper Kit
 - a. Kit includes one 24"L insulated ground jumper with a straight two hole compression lug on one end and an L-shaped two hole compression lug on the other end, two plated installation screws, an abrasive pad and a 0.5oz tube of antioxidant joint compound.
 - b. Ground conductor is an insulated green/yellow stripe #6 AWG wire
 - c. Lugs are made from electroplated tinned copper and have two mounting holes spaces 0.5" to 0.625" apart that accept 1/4" screws.
 - d. Jumper will be made with UL Listed components.

PART 3 EXECUTION

3.01 GENERAL

- A. All installation of the Communication Ground Systems shall be done by a licensed electrician. This includes but not limited to:
 - 1. PBB (Primary Bus Bar) and SBB (Secondary Bus Bar)
 - 2. All communications grounding and bonding conductors.
 - 3. Bonding to all non-active (non-current carrying) communications metal support structures, rack, runway, etc. within each Communication Room or Space.
- B. The PBB/SBB is not to be used as an ac equipment ground.
- C. The TBB should not be placed in ferrous metallic conduit. If it is necessary to place grounding and bonding conductors in conduit that exceeds 1m (3') in length, the conductors shall be bonded to each end of the conduit using a grounding bushing or a # 6 AWG conductor, minimum.
- D. Provide grounding connections as specified in Section 26 05 26 – Grounding and Bonding for Electrical Systems.

3.02 INSTALLATION

- A. Outdoor grounding and bonding connections.
 - 1. Provide outdoor grounding and bonding connections as specified in Section 26 05 26 – Grounding and Bonding for Electrical Systems.
- B. Wall-Mount Bus Bars
 - 1. Attach bus bars to the wall with appropriate hardware according to the manufacturer's installation instructions.
 - 2. Conductor connections to the PBB or SBB shall be made with two-hole bolt-on compression lugs sized to fit the busbar and the conductors.
 - 3. Each lug shall be attached with stainless steel hardware after preparing the bond according to manufacturer recommendations and treating the

bonding surface on the busbar with antioxidant to help prevent corrosion at the bond.

4. The wall-mount busbar shall be bonded to ground as part of the overall Telecommunications Bonding and Grounding System.

C. Grounding Conductors

1. Telecommunications grounding connectors shall have a minimum size of #6 AWG.
2. All Telecommunication grounding conductors shall be sized so that no more than 40V can be present along its entire length.

D. Rack and Cabinet Mount Bus Bars and Ground Bars

1. Provide bus bar as shown in the Contract Documents.
2. Bond the rack-mount bus bar or ground bar to the room's PBB or SBB.

E. Ground Terminal Block

1. Provide as needed to bond rack and cabinet to the PBB or SBB.

F. Bonding Conductor

1. Where building steel is available within the room, the PBB/SBB shall be bonded to the nearest structural steel column.
2. Where building steel is not available within the room, a bonding conductor can be routed between PBB and the nearest effectively grounded AC electrical branch circuit panel board, provided a low ground impedance of the panel board has been verified with a ground impedance tester.
3. The size of any bonding conductors shall follow the recommended sizes shown on the drawings.
4. Comply with requirements in Section 26 05 26 – Grounding and Bonding for Electrical Systems.

3.03 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with ANSI/TIA-606-A. Comply with requirements in Section 27 05 53 – Identification and Labeling.
- B. Provide nonmetallic pre-printed labels, white background with black printing that can be permanently mounted to the busbar.
- C. The bonding conductors for telecommunications, TBB conductor, and each grounding equalizer shall be green or marked with a distinctive green color.
 1. All cabling used to bond grounds are to be tagged with labels with the point of origin and destination i.e. going to/coming from, with printed labels.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and

included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.

B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

- A. The extent and location of "Pathways for Communications Systems" Work is shown in the Contract Documents. The Contractor shall furnish and install cable pathways as shown in the Drawings and specified herein. Pathways shall include, but not be limited to, solid-trough cable trays with solid covers, metallic conduit, plastic innerduct, pull boxes, structural supports, and seismic bracing.
- B. The Contractor shall provide and install all hardware, fasteners, or other materials required to install and support cable trays as shown on the drawings.
- C. All conduit and cable tray assemblies shall be accordance with Section 26 05 48 – Seismic Controls for Electrical and Communication Work.
- D. Cable pathways should also include open form cable trays for horizontal cable, in addition to other types of flexible cable trays.
- E. The use of aluminum cable tray is allowed.
- F. Section Includes:
 - 1. Section 26 05 33 – Raceways and Boxes.
 - 2. Section 26 05 36 – Cable Trays.

1.02 GOVERNING CODES, STANDARDS AND REFERENCES

- A. ANSI/TIA-569 – Telecommunications Pathways and Spaces
- B. ANSI/TIA-606 – Administration Standard for Telecommunications Infrastructure
- C. ANSI/TIA-607 – Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
- D. ANSI/UL-1666 Standard for Test For Flame Propagation Height of Electrical And Optical-Fiber Cables Installed Vertically In Shafts
- E. ASTM A123 – Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
- F. ASTM A1011 - Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
- G. ASTM A1008 Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable
- H. ASTM A653 – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot Dip Process
- I. ASTM B633 – Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
- J. ASTM C1107 – Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
- K. NEMA VE 1 – Metal Cable Tray Systems
- L. BICSI – Telecommunications Distribution Methods Manual

- M. NEMA VE2 - Cable Tray Installation Guidelines
- N. NFPA 70, National Electrical Code (NEC)
- O. NFPA 70B - Recommended Practice for Electrical Equipment Maintenance
- P. Underwriters Laboratory (UL)
- Q. NFPA 262 - Test for Fire and Smoke Characteristics of Wires and Cables
- R. UL 2024 - Standard for Cable Routing Assemblies and Communications Raceways
- S. Washington State Department of Labor and Industries.

1.03 SUBMITTALS

- A. Submit materials data in accordance with of Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.
- B. Submit manufacturer's instructions for storage, handling, protection, examination, preparation, operation, and installation of products. Include application conditions or limitations of use stipulated by any product testing agency.
- C. Submittals shall include the following:
 - 1. Layout Drawings: Submit layout drawings of cable tray and conduits where field conditions require deviation from routes indicated on the drawings and where additional bends or vertical transitions are needed.
 - 2. Submittal Drawings: Submit drawings of typical cable tray and accessories including clamps, brackets, hanger rods, splice plate connectors, expansion joint assemblies, and fittings, showing accurately scaled components.
 - 3. Product Data: Submit manufacturer's data on cable tray including, but not limited to, types, materials, finishes, inside depths, and fitting radii. For side rails, submit cross sectional properties including Section Modulus (Sx) and Moment of Inertia (Ix).

1.04 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of cable trays and fittings of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Layout Responsibility: Preparation of Shop Drawings shall be under the direct supervision of an RCDD, or BICSI Installer 2 Copper, or BICSI Installer 2 Fiber, or BICSI Technician.
 - 2. Installation Supervision: Installation shall be under the direct supervision of BICSI Technician, BICSI Installer 2 Copper or BICSI Installer 2 Fiber, who shall be present at all times when Work of this Section is performed at Project site.
 - 3. Field Inspector: Currently registered by BICSI as RCDD, or BICSI Installer 2 Copper to perform the on-site inspection.

- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with ANSI/TIA-569-C.
- E. Comply with TIA/EIA-606-A.
- F. Cable tray shall be listed and labeled by Underwriters Laboratories (UL) as required or Washington State Labor and Industry recognized for their intended use.
- G. NEMA Compliance: Comply with NEMA standards publication number VE1, "Cable Tray Systems."
- H. NEC Compliance: Comply with NEC, as applicable to construction and installation of conduit, innerduct, cable tray and cable channel systems (Article 318, NEC).
- I. NFPA Compliance: Comply with NFPA 70B, "Recommended Practice for Electrical Equipment Maintenance" pertaining to installation of cable tray systems.

1.05 DRAWINGS

- A. The Drawings indicate the general route of the cable trays and conduits. Data presented on the Drawings are as accurate as preliminary surveys and planning can determine. Accuracy is not guaranteed and field verification of all dimensions and routing is required.
- B. Specifications and Drawings are for assistance and guidance, but exact routing, locations, distances, and levels will be governed by actual field conditions. The Contractor shall make field surveys as part of his Work. Deviations from indicated routes, additional bends, and vertical transitions shall be submitted to the Construction Manager for approval prior to installing cable trays or conduits.

1.06 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install equipment frames and cable trays until spaces are enclosed and weather tight, wet work in spaces is complete and dry, and work above ceilings is complete.

1.07 COORDINATION

- A. Coordinate layout and installation of communications pathways with the other trades installing equipment in the ceiling.

PART 2 PRODUCTS

2.01 PATHWAYS FOR COMMUNICATIONS SYSTEMS

- A. All pathways for communications systems shall comply with ANSI/TIA-569-C and BICSI Telecommunications Distribution Methods Manual, 12th Ed.
- B. Comply with the requirements of Sections 26 05 36 – Cable Trays, 26 05 29 – Hangers and Supports for Electrical Systems, and 26 05 33 – Raceways and Boxes.

2.02 COMMUNICATION CABLE TRAYS

- A. General: The Contractor shall furnish and install a complete cable tray system to support innerduct and cable as indicated on the drawings or included in the scope of Work.
- B. Manufacturer: Cable tray systems shall be as manufactured by:
 - 1. Cooper B-Line
 - 2. Chatsworth Products, Inc.
 - 3. Or Approved Equal.
- C. Cable Tray Sections and Components:
 - 1. General: Provide metal cable trays of types, classes, and sizes indicated within the scope of Work; with splice plates, bolts, nuts and washers for connecting units. Construct units with rounded edges and smooth surfaces; in compliance with applicable standards; and with the following additional construction features.
 - 2. Cable tray for distribution of backbone and horizontal cabling outside the telecommunications room.
 - 3. Provide metal cable trays of types, classes, and sizes indicated within the scope of Work; with splice plates, bolts, nuts and washers for connecting units. Construct units with rounded edges and smooth surfaces; in compliance with applicable standards; and with the following additional construction features.
 - 4. Special accessories shall be furnished as required to protect, support, and install the cable tray system. Accessories shall consist of, but are not limited to, ground-bonding jumpers, blind-end plates, clamps, hangers, brackets, conduit adapters, installation hardware, and other appurtenances as required for a complete installation. Provide cable drop outs to maintain proper bend radius for cables leaving the tray.
 - 5. Cable Tray Material: Metal, suitable for indoors, and protected against corrosion by use of aluminum material (6063-T6 alloy).
 - 6. Provide enclosed cable tray (NOT solid bottom, bendable or thru cable tray) with cover for distribution of backbone and horizontal cabling. Enclosed cable tray material shall be metal, suitable for indoors and protected against corrosion by electroplated zinc galvanizing, complying with ASTM B 633, Type 1, not less than 0.000472" (0.012 mm) thick. Cable tray size as shown on the floor plans.
 - 7. Supports: Cable tray supports shall be placed so that the support spans do not exceed the maximum span indicated on the Drawings or as recommended by the cable tray manufacturer. Supports shall be as shown on the Structural plan.
 - 8. Where specifically shown on plans, continuous, rigid, welded steel or stainless steel wire mesh construction capable to support min 70 lb/ft for a

12" width and 100 lb/ft at 24" width, for distribution of horizontal cabling, as indicated on drawings.

9. Provide all fittings and accessories required to protect, support and install a cable tray support system.
10. Provide bottom to conceal cables in the color that has been coordinated previously with architect to match the area color theme.
11. Provide cable runaway radius drop at cable transitions from tray to racks.
12. Provide bonding and grounding clamps and #6 AWG ground wire between metallic cable tray and nearest telecommunications grounding bus bar (TGB).
13. Accessories: Special accessories shall be furnished as required to protect, support, and install the cable tray system. Accessories shall consist of, but are not limited to, ground-bonding jumpers, blind-end plates, clamps, hangers, brackets, conduit adapters, installation hardware, and other appurtenances as required for a complete installation.
14. NEC compliance: Cable trays shall be manufactured, to meet requirements of NEC Article 392 – Cable Trays. Bonding and grounding shall meet the requirements specified in Section 26 05 26 – Grounding.

2.03 CONDUIT REQUIREMENTS

- A. Tenant Demarcation conduit; One 2" conduit is placed from Destination Equipment location to the Port of Seattle ER that is within 90m.
- B. Horizontal Data and Voice information outlet locations shall be 1" conduit to a 4x4 box, reducer to 1-gang.
- C. Floor, roof and structural ceiling penetrations: Use rigid steel conduit. Extend through floor, roof and structural ceiling to at least 4 inches above and below penetration. Sleeves for raceways and cables shall meet requirements specified in Section 26 05 33 – Raceways and Boxes.
- D. The Contractor shall provide all metal conduits with threaded plastic bushings and pull cords.
- E. Routing of any metallic media cabling such as voice, data or coaxial in the same conduit as power conductors is not allowed.
- F. Continuous conduit runs shall not exceed 100' or have more than two 90 degree bends without using appropriately sized pull boxes.
- G. Maximum conduit pathway capacity shall not exceed a 40% fill.
- H. The intent of the installation of the raceway is as follows:
 1. Where ceilings are accessible, the raceway and entrance end fitting shall extend above the ceiling and the conduits installed above the ceiling in the room to the nearest hallway distribution system.
 2. Where ceilings are partially accessible, or if the Drawings and/or Specifications indicate installation of access panels, the raceway shall extend above the ceiling and the conduits installed above the ceiling in the room to the nearest hallway distribution system.

3. Where ceilings are inaccessible or no ceilings exist, the raceway shall extend up as close to the ceiling as practical to allow installation of conduits as high as possible to the nearest hallway distribution system.
- I. Station Conduits
 1. Station conduit is defined as conduit that originates at the TO and rises within the walls or is exposed from a raceway and extends up into the drop ceiling or over to the hallway distribution system.
 2. Provide station conduits from TOs to above the drop ceiling or extend over to the hallway distribution systems consisting of 1" EMT minimum or appropriate size as shown on the Drawings or as specified herein for installation of telecommunications cables.
 3. Provide an insulating press fit bushing on all telecommunications conduits including interconnecting nipples and stub to distribution system. To prevent conflicts with other cables or conduits to cable tray, the conduit shall be stubbed not less than 6" above or below conduit/cable tray center line. Where space permits, every effort shall be made to bend station conduits down such that the flow of installed cables promotes the minimum length back to the TR and the least amount of bends in the cables. Bushings must be rated to be used in an environmental air handling space (Plenum).
 4. Manufacturer of insulating bushing on all telecommunication conduits shall be Arlington Or Approved Equal.
 5. Provide measured pull line in 12" increments in each empty conduit to hallway distribution system.
 6. Routing of any metallic media cabling such as voice, data or coaxial in the same conduit as power conductors is not allowed.
 7. Indelibly mark station conduit at hallway distribution end with Room # that conduit serves.
 8. The use of 90 degree electrical pulling elbows is prohibited.
 9. Do not include more than two 90 degree bends between pulling points when installing station conduit runs. If the path of the station conduits requires more than 180 degrees of total bends, installation of an appropriate sized junction box is required. Place an appropriate sized junction box in each individual station conduit run that exceeds 100' in length.
 10. The use of a third bend in a conduit is only acceptable if:
 - a. The total conduit run is reduced by 15%.
 - b. The conduit size is increased to the next trade size.
 - c. One of the bends is located within 12" of the cable feed end.
- J. Pathway Requirements for Entrance Conduits
 1. If the entrance conduits exceeds the 180 degree of total bends limitation, an appropriate sized junction box, manhole, or hand hole is required.

2. As-built drawings of entrance conduit path required to be submitted to Owner's Representative before covered with soil.

K. Riser Conduits

1. Riser conduits shall only be used when noted on the Construction Documents for special applications only. Riser conduits are not required as a general rule for the riser system when rooms are stacked (sleeves and vertical cable trays will be used instead).
2. Conduits entering ER and TR rooms shall be reamed or bushed and terminated not more than 4" from entrance wall and within 12" of room corners.
3. Conduits entering ER and TR rooms from below floor shall be terminated not more than 4" above finished floor.
4. Conduits for riser cables shall be continuous and separate from all other conduit or enclosed raceway systems. Do not include more than two 90 degree bends between pulling points when installing riser conduits. Where junction boxes are required, locate in accessible areas, such as above suspended ceilings in hallways.
5. Conduits shall not be less than 4" trade size and be equipped with a measured pull line at 12" increments rated at a minimum 1200 lb. test.
6. Provide restorable fire stops inside and around conduits as recommended by UL1479 or ASTM E814 for all conduits penetrating fire-rated construction. Fire-rated construction to be verified with authorities having jurisdiction.
7. Provide an insulating press fit bushing on all telecommunications riser conduits. Bushings must be rated to be used in an environmental air handling space (Plenum).
8. Manufacturer of insulating bushing on all telecommunication conduits shall be Arlington Or Approved Equal.
9. Riser conduits shall not be used for the distribution of horizontal cables.

2.04 Telecom Outlets (TO)

- A. Pathway at TO consists of one (1) 4-11/16" square by 2-1/8" deep flush mounted box. Each outlet box shall have a EMT conduit stubbed above the drop ceiling or extended into the hallway cable tray. Conduits size is as follows:
 1. For Outlets with (3) or less cables, use a 1" EMT conduit.
 2. For Outlets with (3) to (6) cables, use a 1-1/4" EMT conduit.
 3. For all other sizes, calculate fill ratio at 40% for proper sized conduit.

2.05 Cable Support:

- A. Provide all manufacturer's approved and supplied fittings and accessories required to protect, support and install a cable tray support system.
- B. NRTL labeled for support of Category 6 and 6A cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.
- C. Support brackets with cable tie slots for fastening cable ties to brackets.

- D. Lacing bars, spools, J-hooks, and D-rings.
 - E. Velcro, straps and other devices.
- 2.06 Ladder Rack
- A. Used for cabling distribution inside the telecommunications rooms.
 - B. Provide all fittings and accessories required to protect, support and install the cable tray system. Provide cable drop outs to maintain proper bend radius for cables leaving the tray.
 - C. Cable Tray Material: Metal, suitable for indoors, and protected against corrosion by use of aluminum material (6063-T6 alloy).
 - D. Cable tray size as shown on the floor plans.
 - E. Rung spacing 9".
 - F. Acceptable manufacturers:
 - 1. CPI
 - 2. Panduit
 - 3. Hubbell
 - 4. Or Approved Equal
 - G. Provide all fittings and accessories required to protect, support and install a ladder rack support system.
 - H. Provide cable runaway radius drop at cable transitions from tray to racks.
 - I. Provide bonding and grounding clamps and #6 AWG ground wire between metallic cable tray and nearest telecommunications grounding bus bar (TGB).
- 2.07 J-Hooks
- A. Hanger/brackets with fasteners.
 - B. Support the cables utilizing J-hooks where cable tray is not shown, but an accessible finished ceiling exists.
 - C. Provide J-hooks at a maximum of every 4'.
 - D. Acceptable manufacturer:
 - 1. Panduit – J-Mod
 - 2. Or Approved Equal
- 2.08 Innerduct
- A. Used to protect the fiber in the cable tray and conduit and to facilitate future cable installation in pathways connecting the various structures on site.
 - B. Specifications: Multi celled textile innerduct.
 - 1. MaxCell
 - 2. Or Approved Equal
 - C. For 4" conduit install (3) 3" 3-cell fabric innerduct. Each cell shall be rated for 1" or larger diameter cables. For 2" conduits, install (1) 3" 3-cell fabric innerduct.

- D. Color: Use three unique colors, use one color per 3-pack (color shall be in stitched spine or on fabric material).
- E. Use product where innerduct will meet Port of Seattle cable infrastructure growth requirements in 2" and above backbone conduit runs.
- F. Fabric innerduct shall not be used in cable trays.
- G. Pull Tape: Provide tape per fabric Innerduct.
- H. Specifications: Non-fabric duct
 - 1. Pyramid
 - 2. Carlon
 - 3. Or Approved Equal
- I. Color: Orange
- J. Construction: Corrugated
- K. Pull Tape: Preinstalled, with footage markings
- L. UL: UL 910 and/or 2024 list with tags or marking and for cables listed under ANSI/UL-1666 (1997) or Washington State Labor and Industries recognized.
- M. National Electrical Code (NEC) Compliance: Comply with NEC as applicable.
- N. Flexible fabric innerduct
 - 1. For 4" conduit install (3) 3" 3-cell fabric innerduct. Each cell shall be rated for 1" or larger diameter cables. For 2" conduits, install (1) 3" 3-cell fabric innerduct.
 - 2. Color: Use three unique colors, use one color per 3-pack (color shall be in stitched spine or on fabric material)
 - 3. Use product where innerduct will meet Port of Seattle cable infrastructure growth requirements in 2" and above backbone conduit runs.
 - 4. Fabric innerduct shall not be used in cable trays
 - 5. Pull Tape: Provide tape per fabric innerduct.
 - 6. UL: UL 910 and/or 2024 list with tags or marking and for cables listed under ANSI/UL-1666 (1997) or Washington State Labor and Industries recognized.
 - 7. National Electrical Code (NEC) Compliance: Comply with NEC as applicable.
- O. Fittings: Non-metallic couplings suitable for the application as recommended by the innerduct manufacturer.

2.09 Sleeves for Pathways and Cables

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends, with plastic bushings.
- B. Sleeves for Rectangular Openings: Galvanized sheet steel. Minimum Metal Thickness:

1. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16" (400 mm), thickness shall be 0.052" (1.3 mm).
 2. For sleeve cross-section rectangle perimeter equal to, or more than, 50" (1270 mm) and (1) or more sides equal to, or more than, 16" (400 mm), thickness shall be 0.138" (3.5 mm).
- C. Refer to Section 27 05 00 – Common Work Results for Communications.
- 2.10 Fire Stopping
- A. In all buildings, floor/ceiling assemblies, stairs, and elevator penetrations must be sealed with a 2-hour fire stop assembly at a minimum, unless otherwise noted.
 - B. Contact Owner's Representative to identify walls which are fire-rated construction. Walls must be sealed with a 2-hour fire stop assembly at a minimum.
 - C. Communication pathways requiring fire stopping shall utilize removable/re-usable fire stopping putties for ease of Moves, Adds, and Changes.
 - D. All fire stopping penetrations shall conform to the recommended practices listed in UL1479 or ASTM.
 - E. Refer to Section 27 05 00 – Common Work Results for Communications for more information.
- 2.11 Pull Cord
- A. The pull cord shall be new polypropylene over polyester rope with a minimum 1700 lb. tensile strength.
 - B. The Contractor shall leave at least 18" of pull cord accessible at both ends of the conduit, cable tray, or innerduct.
 - C. The pull cord shall be continuous with no knots or splices for the length installed.
- 2.12 Grounding
- A. Comply with requirements in Section 27 05 26 – Grounding and Bonding for Communications Systems
 - B. Comply with ANSI-J-STD-607-A.
- 2.13 SUPPORTS, IN ADDITION TO STRUCTURAL SEISMIC SUPPORTS AND BRACING
- A. Structural supports and seismic bracing for cable trays shall be as shown in the design drawings and details. Seismic control shall meet requirements specified in Section 26 05 48 – Seismic Controls for Electrical and Communication Work.
- 2.14 GROUT
- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 EXECUTION

3.01 GENERAL

- A. Comply with NECA 1.

- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- D. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.
- E. All installation shall be in accordance with manufacturer's published recommendations.
- F. Install to facilitate service, maintenance, and repair or replacement of components of both communications equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- G. Right of Way: Give to piping systems installed at a required slope.

3.02 PATHWAYS

- A. Cable Trays: Comply with NEMA VE 2 and ANSI/TIA-569-C.
- B. Cable pathways will follow the corridors of the building whenever possible.
- C. Where cable tray or conduit is not specified, a continuous pathway of independent supports shall be provided. The distance between supports shall not exceed 48" and shall be fastened to building structure.
- D. All metallic pathways will be bonded to complete continuity to building ground.
- E. Cable trays will be installed in accordance to NFPA 70, Article 392.
- F. Cable trays should not extend more than 12" inside of the TR.
- G. Enclosed pathways will be provided with pull string rated at 200 lbs.
- H. Coordinate installation of cable tray with other trades to allow a minimum of 12" above, 18" in front, and 12" below of clearance from piping, conduits, ductwork, etc. Allowance must be provided for access to the tray with reasonable room to work. Obstructions to the tray must be minimized and cannot block more than 6' of the tray at any point in the run.
- I. Cable trays will be installed to allow technician/installer adequate access and working clearances.
- J. Maintain the following distances for EMI sources:
 - 1. Comply with TIAEIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
 - 2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5".

- b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12".
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24".
 - 3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2".
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6".
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12".
 - 4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3".
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6".
 - 5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or higher: A minimum of 48".
 - 6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5".
 - K. Coordinate with the architect the color scheme for the trays and other pathways in the open spaces to be inconspicuous.
 - L. Comply with requirements for demarcation point, pathways, cabinets, and racks specified in Section 27 11 00 – Communications Room Equipment Fittings. Drawings indicate general arrangement of pathways and fittings.
 - M. Comply with ANSI/TIA-569-C for pull-box sizing and length of conduit and number of bends between pull points.
 - N. Comply with requirements in Section 26 05 33 – Raceways and Boxes for installation of conduits and wireways.
 - O. Install manufactured conduit sweeps and long-radius elbows whenever possible.
- 3.03 INSTALLATION OF PULL STRINGS**
- A. The conduit/pathway installing contractor shall be responsible for installing a pull cord and true tape from end to end in every conduit, cable tray, and/or innerduct.
 - B. Pull strings shall be left in place.
 - C. In existing conduits or cable tray with existing pull strings, the Contractor shall replace used pull strings with new pull strings.
 - D. Pull strings are not required where conduit or innerduct fill is greater than 33% after installation of cable.

3.04 PATHWAY INSTALLATION IN COMMUNICATIONS EQUIPMENT ROOMS:

- A. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
- B. Install cable trays to route cables if conduits cannot be located in these positions.
- C. Secure conduits to backboard when entering room from overhead.
- D. Extend conduits 3" (76 mm) above finished floor.
- E. Install metal conduits with bonding and grounding bushings and connect with bonding and grounding conductor to bonding and grounding system in compliance with ANSI/TIA-607-B and ANSI/NECA/BICSI-607.

3.05 SUPPORTS AND BRACING

- A. Install in accordance with applicable codes and regulations and as shown on the structural plans and details.
- B. Fasten support channels, hanger rods, raceway clamps, and outlet and junction boxes to building structure using expansion anchors, beam clamps, metallic brackets, supports and bolts and spring steel clips.
- C. Provide supports at each connection point, at the end of each run, and at other points to maintain spacing between supports as called out in the plans and details. Provide additional supports on each side of bends.
- D. Use metallic toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls; metallic expansion anchors or preset inserts in solid masonry walls; sheet metal screws in sheet metal studs and wood screws in wood construction; and channel supports clamped or bolted to joists, purlins, steel angles and beams.
- E. Do not fasten supports to piping, ductwork, mechanical equipment, or raceway.
- F. Do not use powder-actuated anchors.
- G. Do not drill holes or weld attachments to beams and other structural members without prior written approval from the Engineer.
- H. Fabricate supports from structural steel or steel channel, rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under all nuts.
- I. Do not use nylon or plastic tie wraps, wood or plastic expansion inserts or adhesives as principal or secondary support means.
- J. Install enclosures and panel-boards with minimum of four anchors.
- K. Do not support raceway from ceiling wire supports.
- L. Where multiple runs of conduit can be run grouped together, run conduit in racks supported from the building structure. Form racks from strut-channel supported by at least two threaded rods, secured to the structure above.
- M. Cap top of open channel and pipe supports to prevent ingress of moisture and dirt.

3.06 SLEEVE INSTALLATION FOR COMMUNICATIONS PENETRATIONS

- A. Communications penetrations occur when pathways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Each pipe sleeve, horizontal or vertical, shall have a plastic type "end-bushing" on both ends to protect cables from abrasion when pulled through sleeves. The "end-bushing" shall be installed prior to install cables through sleeve.
- E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- F. Cut sleeves to length for mounting flush with both surfaces of walls with respect to plastic "end-bushings". The plastic "end-bushing" shall be plenum rated if applied in plenum space.
- G. Extend sleeves installed in floors 2" above finished floor level with respect to plastic "end-bushings". The plastic "end-bushing" shall be plenum rated if applied in plenum space.
- H. Size pipe sleeves to provide 1/4" annular clear space between sleeve and pathway or cable, unless indicated otherwise.
- I. Seal space outside of sleeves with grout for penetrations of concrete and masonry. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
- J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint.
- K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pathway and cable penetrations. Install sleeves and seal pathway and cable penetration sleeves with firestop materials. Comply with requirements in Section 07 84 00 – Firestopping.
- L. Roof-Penetration Sleeves: Weather seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing Work.

3.07 SLEEVE-SEAL INSTALLATION

- A. Install to seal exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals, and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- C. Provide sleeves for new conduit and cable penetrations of building construction.

1. Openings to accept sleeves in new building construction will be formed in building construction by the Contractor for General Construction Work. Openings to accept sleeves in existing building construction shall be provided under this division of the Specifications. Refer to Article, CUTTING AND PATCHING in this section.
 2. Use galvanized rigid conduit sleeves for penetrations through exterior masonry/concrete walls and foundations, concrete floor slabs on grade and above grade, and concrete-filled decks.
 3. Use only fire-rated listed assemblies for the type of sleeve being installed through CMU walls or gypsum walls for communications penetrations. Sleeve type shall be galvanized rigid conduit.
- D. Where conduits are installed before building construction being penetrated, install sleeves loose around conduits. Split, fit, and weld steel sleeves over existing conduits, with respect to anything flammable in the surrounding environment.
- E. Secure sleeves firmly in place using filling and patching materials (grout) that match with surrounding construction.
- F. In floor penetrations, extend sleeve 4 inches above finished floor unless noted otherwise. In wall penetrations, cut sleeves flush with wall surface and use metal escutcheon plates in finished interior areas.
- G. Seal voids between sleeves and building construction with joint sealants. Make allowances for and coordinate the Work with installation of firestopping, conduit insulation, and waterproofing as applicable.
- H. The Contractor shall be fully responsible for final and correct location of sleeves. Sleeves which are omitted or incorrectly located in existing building construction, shall be corrected and provided by the Contractor, at no additional costs to the Port.

3.08 PENETRATION OF BUILDING SURFACES

- A. Above Grade Level or Non-waterproof Areas
1. Seal each annular space between conduits or cable and building surfaces. Pack space with Oakum, other rope packing, or backer rod materials and cover with fire-resistant sealant or other protection materials.
 2. Provide sleeves as specified in Article, SLEEVE-SEAL INSTALLATION in this section for conduit and cable penetrations. Seal each space between conduit or cable and sleeve. Sealing shall be as specified in above paragraph.
- B. Waterproof Areas (Above and Below Grade)
1. In new and existing construction for penetrations through concrete below grade, ground water level, or in other waterproof areas, provide through-wall and floor seals having galvanized fittings, sealing assemblies, and sleeves as specified.
 2. In existing construction when core bore drilled openings are used for conduit penetrations below grade, ground water level, or in other waterproof areas, provide sealing.
- C. Fire-resistant Areas

1. Provide through-penetration firestop systems for penetrations through fire-rated walls, floors, and other partitions of building construction. Comply with requirements in Section 07 84 00 – Firestopping.
2. In walls or partitions with 2-hour or less fire ratings, provide only metallic outlet or device boxes installed per UL Fire Resistance Director, NEC, and other national building code requirements.

3.09 TESTING

- A. Test cable trays to ensure electrical continuity of bonding and grounding connections, and to demonstrate compliance with specified maximum grounding resistance. Refer to Section 26 05 26 – Grounding for testing and test methods.
- B. Manufacturer shall provide test reports witnessed by an independent testing laboratory of the “worst case” loading conditions outlined in this specification and performed in accordance with the latest version of NEMA VE-1.

3.10 CUTTING AND PATCHING

- A. Provide openings, cutting, coring, and patching of openings in existing building construction as required.
- B. Perform cutting as not to impair structural stability of the building system. Do not drill holes or weld attachments to beams and other structural members without prior written approval from the Engineer.
- C. When penetrating fire walls, a UL listed, Or Approved Equal, fire stopping method shall be used at the penetration to maintain the fire rating of the wall.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.
- B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of “Communications Standard for Labeling and Nomenclature” Work is shown in the Contract Documents. This section includes the label formatting and structure requirements, and is intended to work in conjunction with Port of Seattle specification Section 27 05 53 - Identification and Labeling and TIA-606 “The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings”.

1.02 GOVERNING CODES, STANDARDS AND REFERENCES

- A. TIA-606 “The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings”
- B. Table "Termination Hardware" TIA-606

1.03 SUBMITTALS

- A. Submit materials data in accordance with of Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.

1.04 ELEMENTS REQUIRING LABELS

- A. The following elements of the telecommunications infrastructure shall require identifiers and labels:
 - 1. Spaces
 - a. A telecommunications space shall refer to any area used for housing the installation and termination of telecommunications equipment and cable. Telecommunications spaces include, but are not limited to, entrance facilities, racks and cabinets, equipment rooms, work areas and hand holes.
 - 2. Pathways
 - a. A pathway shall refer to the facility or element used for the placement of telecommunications cable. Examples of pathways include cable tray, conduit and innerduct.
 - 3. Cabling
 - a. Cabling shall include all fiber and copper conductor media used for the transmission of voice, video and data signals. Examples of cable includes, backbone, tie and horizontal cables and jumpers.
 - 4. Termination Hardware
 - a. Termination hardware refers to the discrete point or element where telecommunications conductors are terminated. Termination hardware includes but is not limited to patch panels, punch down blocks, interconnections units, voice/data jacks and protector panels.
 - 5. Splices
 - a. A splice is any joining of fiber or copper conductors in a splice enclosure meant to be permanent.

6. Grounding System

- a. Grounding system elements include but are not limited to bonding conductors and grounding busbar.

1.05 TELECOMMUNICATIONS IDENTIFIERS

A. Spaces “sp”

1. Space labels shall take the following form: [sp.fczz.nnnnn]

- a. “sp” represents the unique space code as identified in section 1.05.A.2.
- b. “fc” represents the Port of Seattle (POS) facility code as identified in section 1.06.
- c. “zz” represents the level in the particular facility as identified in section 1.07.
- d. “nnnnn” represents:
 - (1) For all Spaces excluding Pull Boxes a (5) five digit sequence number.
 - (2) For Pull Boxes the nearest north-south followed by east-west gridlines.

2. Space Codes “sp”

MD	Main Distribution room
ER	Equipment Room
TC	Telecommunications Closet
EQ	Equipment Rack or Cabinet
EF	Entrance Facility
WF	Wall Field
WA	Work Area
HH	Handhole
MH	Manhole
JT	Junction - cable Tray
PB	Pull Box

3. Space Label General Application Notes

- a. Main distribution room sequence numbers shall be unique. All other sequence numbers shall restart with each level of the facility.
- b. For Equipment Racks and Cabinets (space type EQ) located in a room a five digit number (ABCDE) shall be determined as follows:

- (1) A: Is determined by the last digit of the room sequence number in which the rack or cabinet is located. For equipment racks or cabinets not within a room, “A” shall be represented by a “0”
 - (2) BC: Is the row designator for the room
 - (3) DE: Is the sequence designator for the row.
 - c. For Wall Fields (space type WF) located in a room, a seven digit number (ABCDE.pp) shall be determined as follows:
 - (1) A: Is determined by the last digit of the room sequence number in which the rack or cabinet is located. For wall fields not within a room, “A” shall be represented by a “0”
 - (2) BC: Is the wall designator for the room (note that most rooms have 4 sides).
 - (3) DE: Horizontal position of the wall field
 - (4) pp: Vertical position of the wall field.
 - d. Additionally, a suffix “.pp” shall be appended to ABCDE to designate vertical position within the wall field. Example: ABCDE.pp
 - e. For Existing cable vaults, man holes or handholes, use the existing name if available.
- B. Pathways “ptw”
 - 1. Pathway labels shall take the following form: [ptw.fc.nnnnn]
 - a. “ptw” represents the unique pathway code as identified in section. 1.05.B.2.
 - b. “fc” represents the POS facility code as identified in section 1.06.
 - c. “nnnnn” represents a (5) digit sequence number.
 - 2. Pathway Codes “ptw”
 - a. CDB ConDuit Backbone
 - b. CDO ConDuit Other
 - c. CTB Cable Tray Backbone
 - d. CTO Cable Tray Other
 - e. CDT ConDuit Telecom
 - f. CTT Cable Tray Telecom
 - g. DDO innerDuct Other
 - h. DDT innerDuct Telecom
 - i. SLT SLeeve Telecom
 - 3. Pathway Label Application Notes
 - a. For a pathway occupying two or more facilities use the facility code “fc” with the majority of the run in it.

C. Cables “cb”

1. Cable labels shall be identified by two or three text lines, as illustrated below.
 - a. Composite (multimode and singlemode) Backbone Cables: The POS cable management system treats composite cable as if each cable type were an individual cables.
 - (1) 1st text line: cb.st.fc.nnnnn.ss (1st cable type)
 - (2) 2nd text line: cb.st.fc.nnnnn.ss (2nd cable type)
 - (3) 3rd text line: sp.fczz.nnnnn-sp.fczz.nnnnn (from- to)
 - b. Non-composite Backbone Cables:
 - (1) 1st text line: cb.st.fc.nnnnn
 - (2) 2nd text line: “Blank”
 - (3) 3rd text line: sp.fczz.nnnnn-sp.fczz.nnnnn (from- to)
 - c. Horizontal Cables:
 - (1) 1st text line: cb.st.fczz.nnnnn
 - (2) 2nd text line: “Blank”
 - (3) 3rd text line: sp.fczz.nnnnn-th.fczz.nnnnn (from- to)
 - (4) “cb” represents the cable type code identified as follows in section 1.05.C.2.
 - (5) “st” represents the cable subtype code identified as follows in section 1.05.C.3.
 - (6) “fc” represents the POS facility code identified as follows in section 1.06.
 - (7) “zz” represents the level in the particular facility identified as follows in section 1.07.
 - (8) “nnnnn” represent a (5) five digit sequence number
 - (9) “ss” represents the composite cable sub-subtype identified as follows in section 1.05.C.4.
2. Cable Type Codes “cb”
 - a. CB Copper cable Backbone
 - b. FB* Fiber cable Backbone (also used for composite fiber cable Backbone)
 - c. CH Copper cable Horizontal
 - d. FH Fiber cable Horizontal (also used for composite fiber cable Horizontal)
 - e. CO Copper cable Other
 - f. FO* Fiber cable Other (also used for composite fiber cable Other)

- g. * Indicates cable types that require a unique sequence number
3. Cable Subtype Codes “st”
- a. XM composite cable
 - b. M6 Multimode, 62.5 Micron fiber cable
 - c. M5 Multimode, 50 Micron fiber cable
 - d. SM Single mode, Matched clad
 - e. SD Single mode, Depressed clad
 - f. SA Single mode, Allwave
 - g. UT Uncategorized unshielded Twisted pair
 - h. U3 category 3 Unshielded twisted pair
 - i. U5 category 5 Unshielded twisted pair
 - j. U6 category 6 Unshielded twisted pair
 - k. ST Shielded Twisted pair
 - l. CX Co-axial copper cable
 - m. MU Unshielded multi-conductor copper cable
 - n. MS Shielded multi-conductor copper cable
 - o. RX Radiating Coax
 - p. US Universal Station cable
 - q. FX Fiber station cable
 - r. JS fiber Jumper, Simplex
 - s. JD fiber Jumper, Duplex
 - t. CC Copper cross Connect
 - u. WC Wireless Coax
4. Composite Cable Sub-Subtype Codes “ss”
- a. M5 Multimode, 50 Micron fiber cable
 - b. M6 Multimode, 62.5 Micron fiber cable
 - c. SM Single mode, Matched clad
 - d. SD Single mode, Depressed clad
 - e. SA Single mode, Allwave
5. Cable Label General Application Notes
- a. Backbone or riser cables do not require the level “zz” code; all other cables require it
 - b. For a cable occupying two or more facilities (or levels), use the facility “fc” and level “zz” where the cable originates or where most of the cable resides.

D. Termination Hardware “th”

1. Termination hardware labels other than cross connects shall take the following form: [th.fczz.nnnnn]
 - a. “th” represents the unique space code identified as follows in para. 1.05.D.2.
 - b. “fc” represents the POS facility code identified as follows in section 1.06.
 - c. “zz” represents the level in the particular facility as identified in section 1.07.
 - d. “nnnnn” represent a (5) five digit sequence number.
2. Termination Hardware Codes “th”
 - a. AT Antenna
 - b. CD Copper Data jack
 - c. FD Fiber Data jack
 - d. CV Copper Voice jack
 - e. FV Fiber Voice jack
 - f. CU Copper Universal Outlet
 - g. PP Protector Panel
 - h. TV Video
 - i. CM Intercom
 - j. VP Voice Paging
3. Cross connect termination hardware labels shall take the following form: [t.stc.fczz.nnnnn.nn]
 - a. t” represents the cross connect type code identified as follows in section 1.05.D.4.
 - b. “stc” represents the cross connect subtype code as identified in section 1.05.D.5.
 - c. “fczz.nnnnn is determined by the rack or cabinet where the termination hardware resides.
 - d. “nn” represents the (2) two digit sequence position within the rack or cabinet. The numbers shall be determined by labeling the equipment in sequential order starting at the top of the rack or cabinet.
4. Cross connect type code “t”
 - a. Main cross connect
 - b. Intermediate cross connect
 - c. Horizontal cross connect
5. Cross connect subtype code “stc”
 - a. CPP Copper Patch Panel (RJ45)

- b. CPB Copper Punchdown Block (66, 110)
- c. FPP Fiber optic Patch Panel
- d. FSS Fiber Splice Shelf
- e. XPP hybrid Patch Panel with copper RJ45 and fiber optic ports
- f. FIU Fiber optic Interconnection Unit
- g. CES Network Switch
- h. CXP Coaxial Patch Panel
- i. CPT CoPper Terminal block/strip
- j. FCS Fiber optic Combination Shelf splice/termination or interconnection unit

E. Splices “sc”

- 1. Splice labels shall take the following form: [sc.fczz.nnnnn]
 - a. “sc” represents the unique splice code identified as follows in section. 1.052.E.2.
 - b. “fc” represents the POS facility code identified as follows in section 1.06.
 - c. “zz” represents the level in the particular facility identified as follows in section 1.07.
 - d. “nnnnn” represent a (5) five digit sequence number.
- 2. Splice Codes “sc”
- 3. CS Copper Splice
- 4. FS Fiber Splice

F. Grounding System “gs”

- 1. Grounding system labels shall take the following form [gs.fczz.nnnn]
 - a. “gs” represents the unique grounding system code identified as follows in para. 1.05.F.2.
 - b. “fc” represents the POS facility code as identified in section 1.06.
 - c. “zz” represents the level in the particular facility identified as follows in section 1.07.
 - d. “nnnnn” represent a unique (5) five digit sequence number.
- 2. Grounding System Codes “gs”

BC	Bonding Conductor
EG	Equipment bonding conductor
GB	Grounding Busbar
TG	Telecom. Grounding busbar
TM	Telecom. Main grounding busbar

1.06 Facility Codes "fc" - 2 characters as required for POS facility

MT	Main Terminal
AD	Admin Building
PT	Parking Terminal
CA	Concourse A
CB	Concourse B
CC	Concourse C
CD	Concourse D
NS	North Satellite
SS	South Satellite
CT	Central Terminal
NZ	North Toll Plaza
RC	Rental car Facility
A4	Air Cargo 4
EX	Exterior

1.07 Facility Level Codes "zz" 2 digits as required for POS facility

A. MT Main Terminal

00	Utility Tunnel
01	Transit (STS)
02	Interstitial Space / GTX Tunnel
03	Baggage Claim
04	Bridge
05	Ticketing (Concourse)
06	Mezzanine
07	Mechanical Penthouse

B. AD Administration Building

00	Ground
01	Not Used

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02	Second Floor
03	Third Floor
04	Fourth Floor
05	Fifth Floor
06	Sixth Floor
07	Seventh Floor
08	Eighth Floor
09	Ninth Floor

C. PT Parking Terminal

00	Basement
01	First Floor
02	Second Floor
03	Third Floor
04	Fourth Floor
05	Fifth Floor
06	Sixth Floor
07	Seventh Floor
08	Eighth Floor
09	Ninth Floor

D. CA Concourse A

01	Transit (STS)
02	Interstitial Space
03	Baggage Claim
04	Ramp/Bridge
05	Concourse (Ticketing)
06	Mezzanine
07	Mechanical Penthouse

E. CB Concourse B

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01	Transit (STS)
03	Ramp
05	Concourse
07	Mechanical Penthouse

F. CC Concourse C

01	Transit (STS)
03	Ramp
05	Concourse
07	Mechanical Penthouse

G. CD Concourse D

01	Transit (STS)
03	Ramp
05	Concourse
07	Mechanical Penthouse

H. NS North Satellite

01	Transit (STS)
03	Ramp
05	Concourse
07	Mechanical Penthouse

I. SS South Satellite

00	Tunnel (Basement)
01	Transit (STS)
02	Mezzanine (FIS)
03	Ramp
04	International Corridor
05	Concourse

	07	Mechanical Penthouse
J.	CT	Central Terminal
	01	Transit (STS)
	03	Baggage Claim
	04	Bridge
	05	Concourse (Ticketing)
	06	Mezzanine
	07	Mechanical Penthouse
K.	NZ	North Toll Plaza
	01	Floor 1
	02	Floor 2
L.	RC	Rental Car Facility
	01	Ground Level
	02	Floor 2
	03	Floor 3
	04	Floor 4
	05	Floor 5
M.	AC	Air cargo 4
	01	Grade Level
N.	EX	Exterior location
	01	Grade Level

PART 2 APPLICATION

- 2.01 Labeling products shall be applied to spaces, pathways, cables, termination hardware, splices, grounding busbars, and grounding conductors as indicated in the table below:

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IDENTIFIER CATEGORY	WHAT TO LABEL	PRODUCT TO USE	WHERE TO LABEL	HOW TO ATTACH	NOTES
Space	Entrance Facility (EF)	Phenolic space label	On backboard or wall in approved location	Screws	
	Equipment Rack (EQ) for open relay racks	Phenolic rack label and phenolic cabinet label	Rack label on front of top angle, centered horizontally. Cabinet label on front of self-supporting base angle, centered horizontally and low on base.	Screws or metal rivets	
	EQ for cabinets and enclosures	Phenolic cabinet label	On front of all cabinet/enclosure doors, centered horizontally in door panel, 6" below top of door panel.	Screws or metal rivets	
	WF for wall fields	Phenolic	On wall, above wall field area.	Screws	
	Equipment Room (ER), Main Distribution Room (MD), and Telecommunications Closet (TC)	Phenolic space label	Above door on outside of room in approved location	Screws	
	Handhole (HH) and Manhole (MH)	Embossed, engraved, imprinted, or etched in cover	Integral to handhole or manhole cover		Submit method for approval
	Pull Box (PB)	Phenolic space label	Space label: At top-front of outside of cover if cover is hinged; otherwise on	Space label: Screws	

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Pathway		Pathway warning label	body of box in approved location. Pathway warning label: At center of outside of cover if cover is hinged and on inside of box where visible; otherwise on body of box on outside and inside where visible	Pathway warning label: Self adhesive	
	Work Area (WA)	None			Not applicable
	Conduit Backbone (CDB), Conduit Telecom (CDT)	Conduit label	Within 12" on both sides of penetrations, within 12" of box entry, at ends, at intervals of 25 feet	Self-adhesive with clear overlay	
	Cable Tray Backbone (CTB), Cable Tray Telecom (CTT)	Cable tray label	Cable tray label: Within 12" of tray ends, within 12" of intersections (tees, etc.), within 12" on both sides of penetrations, at each floor level in risers, where entering/exiting risers, at intervals of 25 feet.	Cable tray label: Self-adhesive with clear overlay	Place where visible on bottom of tray for overhead tray, or on both sides of tray at specified intervals where bottom of tray is not easily visible.
		Pathway warning label	Pathway warning label: At intervals of 25 feet for horizontal runs, at intervals of 6 feet for vertical runs.	Pathway warning label: Self-adhesive	
	Innerduct Telecom (DDT)	Innerduct label	Within 12" of end of run, in boxes, in manholes, in handholes, at tray intersections, at end of tray runs, where entering/exiting trays, within 12" of penetrations, at each floor level in risers, where entering/exiting risers	Plastic cable tie	

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	Sleeve Telecom (SLT)	Sleeve label	Depends on field conditions. May be similar to conduit label, innerduct label, phenolic label, or other approved type.	Depends on field conditions	Submit proposed method for approval
Cable	All backbone cables, tie cables, outdoor cables, and cables of O.D. greater than 0.28"	Cable tag	At each end of cable, in boxes*, handholes ¹ , and manholes ¹ , at cable tray intersections ¹ , where entering/exiting tray ¹ or conduit ¹ , where entering/exiting innerduct, and where entering/exiting ER ¹ , MDR ¹ , or TC ¹ .	Plastic cable tie	
	All other cables with O.D. of 0.28" or less.	Cable label	At each end of cable, in boxes, handholes ¹ , and manholes ¹ , at cable tray intersections ¹ , where entering/exiting tray ¹ or conduit ¹ , where entering/exiting innerduct, and where entering/exiting ER ¹ , MDR ¹ , or TC ¹ .	Self-adhesive with clear overlay	
Termination hardware	CD, FD, CV, FV, CU, PP, TV, CM	Jack label	Use labels supplied with, or compatible with faceplates	Slip-in or self-adhesive	Use slip-in when label has plastic label cover on faceplate. Use self-adhesive only when faceplate is not used or has no label provision
Termination hardware	CPP, CPB, FIU, FCS, FPP, XPP, FSS	Termination label	For 110 blocks: Label block using label supplied with, or compatible with block. Label with block number and label all pairs. For RJ45 patch panels: Label patch panel	Slip-in or self-adhesive	For all termination types: Use color-coded termination

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			using label supplied with, or compatible with patch panel. Label with patch panel number and label patch ports with outlet number on front, and label 110 terminations with outlet number on back. For fiber optic patch panels and protector panels: Label panel on front of cover and on inside of housing with panel number. Label protector panel positions with cable number(s) and pair(s).	Slip-in or self-adhesive Slip-in and self-adhesive	labels per color coding standards of TIA-606. Submit proposed products and labeling method for approval.
Splice	Type CS	Wire tag	Within 6" of splice	Small plastic wire tie through pair twist	
	Type FS	As provided with or compatible with splice connector	Label splice block, cables, and pairs	Slip-in or self-adhesive	Submit proposed products and methods for approval
	Type FCG, FCN, FWG, FWN	Cable tag	Attached to closure or on cable within 6" of closure	Plastic cable tie	Obtain approval of attachment location
	Type FCS, FSS	Termination label	Label enclosure on front of cover and on inside of housing.	Self-adhesive	
Grounding system	BC, EG	Cable label	At each end of conductor, in boxes*, handholes ¹ , and manholes ¹ , at cable tray intersections ¹ , where	Self-adhesive with clear overlay	

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		Ground warning	entering/exiting tray1 or conduit1, where entering/exiting innerduct, and where entering/exiting EF1, ER1, MDR1, or TC1. Within 3” of each end of conductor, at any tee splice	Plastic cable tie	
	GB, TG, TM	Cable tag	Attached to busbar	Plastic cable tie	

*If a conductor is within an innerduct or conduit that runs without interruption through these locations, the cable does not require a label at this location.

PART 3 EXECUTION - NOT USED

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.

B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of "Port of Seattle Color Code Requirement" Work is shown in the Contract Documents. Section includes: Products and requirements for color coding cables for the Port of Seattle's Communications Infrastructure.

1.02 HORIZONTAL CABLE COLOR CODE SYSTEM

- A. The color code system for fixed cable plant, 4-pair horizontal cables shall be per Table 27 05 53.23B-1.

TABLE 27 05 53.23B-1

TC/IC TERMINATION TYPE	CABLE TYPE	CABLE COLOR	OUTLET TYPE	OUTLET COLOR	GENERAL USAGE	USE FOR NEW CONSTRUCTION
RJ45 Patch Panel	Category 6	Red	RJ45	Red	Data/ Universal	Yes

1.03 COPPER AND FIBER JUMPER CORD COLOR CODE SYSTEM

- A. The jacket color for copper and fiber jumper cords shall be per Table 27 05 53.23B-2.

TABLE 27 05 53.23B-2

CABLE TYPE	CABLE JACKET COLOR
Singlemode Fiber	Yellow
Multimode Fiber	Orange
Multimode Fiber (used for DDC support system)	Gray with Brown marker tape
Cat 5 and 5e	Blue
Category 6	Red
Category 6a	Orange
Category 7	Lilac
Coax / RF (1/2" diameter or greater)	Black jacket with Green marker tape*

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Coax / RF (1/2" diameter or less)	White jacket with Green marker tape*
Coax / CATV	Black jacket with White marker tape*
Coax / CCTV	Black jacket
Coax / Wireless Systems (1/2" & 7/8" hardline plenum)	Blue jacket
Coax / Wireless Systems (1/2" & 7/8" hardline non-plenum)	Black jacket
Reserved	Gray
Reserved	Green
Special purpose	Sable (Brown)

*Marker Tape Color. Black marker tape shall not be used to identify jumper cable purpose. Apply black marker tape as a background "color" when using a system identification marker tape of the same color as the jumper cable. Marker tape color shall be per Table 27 05 53.23B-3.

TABLE 27 05 53.23B-3

SYSTEM TYPE	SYSTEM	MARKER TAPE COLOR
None	None	Black (use for background contrast only)
Passenger information systems	Electronic information video display, voice messaging system	Blue
Support systems	Master clock, network management system, supervisory control and data acquisition, building management system	Brown
Airline operational systems	Common use terminal equipment, gate management, baggage reconciliation. Also, OPSLAN fiber jumpers.	Green
Port of Seattle corporate airport systems	Information Technology local area network, maintenance local area network	Gray
Passenger service systems	Common use self service	Orange

Critical systems	To be determined	Red
Wireless access points	All	Violet
Voice systems	Telephone, paging, intercom	White
Tenant-owned systems	All	Yellow

1.04 COMMUNICATIONS INNERDUCT COLOR CODE SYSTEM

A. The communications innerduct color shall be per Table 27 05 53.23B-4.

TABLE 27 05 53.23B-4

INNERDUCT TYPE	INNERDUCT COLOR
Plenum	White
Riser	Orange
General purpose	Orange
Outdoor	Orange

1.05 COMMUNICATIONS CONDUIT COLOR CODE SYSTEM

A. POS has standardized on the following conduit color codes for communications systems. The color shall be applied with a clearly visible ring of paint on both ends of the conduit, in addition to the conduit connectors. The paint ring shall be 1" width, marked with oil-based primer and oil based paint.

SYSTEMS	COLOR	FEDERAL STANDARD NO. 595A COLOR CODE
Tel/Data	Orange	32473
Security/Intercom /Access Control	Pink	31638
CATV	White	37886
CCTV	Green	34138
Paging	Brown	30140

Controls	Black	37038

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

PART 4 MEASUREMENT & PAYMENT - NOT USED

End of Section

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of “Identification and Labeling” Work is shown in the Contract Documents. Section includes: Products and requirements for cable and equipment Identification and labeling for the Port of Seattle's Communications Infrastructure.
- B. General: Label all spaces, pathways, cables, termination hardware, terminations, ground buses, and ground conductors using the Port of Seattle (Port) Section 27 05 53.13 - Communications Standard for Labeling and Nomenclature. See Part 3 – Execution of this section for application of label products. Coordinate specific label content and products with the Construction Manager prior to labeling. Coordinate labels with data entered in the Cable Management System.

1.02 GOVERNING CODES, STANDARDS, AND REFERENCES – NOT USED

1.03 SUBMITTALS

- A. Submit materials data in accordance with of Section 01 33 00 - Submittals. Furnish manufacturers’ technical literature, standard details, product specifications, and installation instructions for all products.
- B. Submittals shall include the following:
 - 1. Product data
 - 2. Label Schedule

PART 2 PRODUCTS

2.01 GENERAL

- A. Label product names used herein are coordinated with applicable product names used in the Section 27 05 53.13 - Communications Standard for Labeling and Nomenclature. Product names are generally categorized herein but are not intended to limit the use of those products to that category only.

2.02 SPACE LABELS

- A. Phenolic Space Label:
 - 1. White core laminated phenolic plastic. White lettering on black background, same style throughout.
 - 2. Single line of 5/8” high lettering, all capitals. Background to be 1.0” high, width as required. Leave minimum of 1” margin on left and right of text, text to be centered horizontally and vertically on background. Text style shall be equivalent to Windows™ TrueType™ Arial font, black. The letter “O” shall be distinct from the numeral “0” and the letter “I” shall be distinct from the numeral “1”.
- B. Phenolic Rack Label:
 - 1. White core laminated phenolic plastic. White lettering on black background, same style throughout.
 - 2. Single line of 3/8” high lettering, all capitals. Background to be 3/4” high, width as required. Leave minimum of 1” margin on left and right of text, text to be centered horizontally and vertically on background. Text style shall be

equivalent to Windows™ TrueType™ Arial font, black. The letter “O” shall be distinct from the numeral “0” and the letter “I” shall be distinct from the numeral “1”.

C. Phenolic Cabinet Label:

1. White core laminated phenolic plastic. White lettering on black background, same style throughout.
2. Single line of 1/2” high lettering, all capitals. Background to be 1.0” high, width as required. Leave minimum of 1” margin on left and right of text, text to be centered horizontally and vertically on background. Text style shall be equivalent to Windows™ TrueType™ Arial font, black. The letter “O” shall be distinct from the numeral “0” and the letter “I” shall be distinct from the numeral “1”.

2.03 PATHWAY LABELS

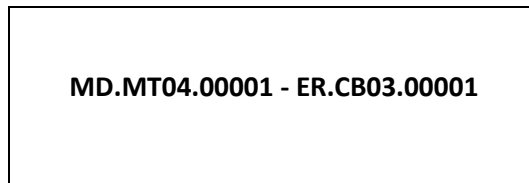
A. Pathway labels shall be placed at all ends or breaks in conduit run such as communication rooms, cabinets pull boxes, maintenance holes, fire penetrations, etc. Label conduit every 25 feet on continuous runs.

B. Conduit Label:

1. Label material: Water and chemical resistant material, “bright yellow” in color, ultraviolet (UV) resistant, suitable for indoor and outdoor use, permanent self-adhesive, suitable for use with indelible ink printing.
2. Ink: Indelible ink, black in color, resistant to UV radiation, abrasion, and chemicals.
3. Lettering: One line of text, containing “source”, “destination” lettering per table below, all capitals, and text to be centered horizontally and vertically on background. Text style shall be equivalent to Windows™ TrueType™ Arial font, bold face, black. The letter “O” shall be distinct from the numeral “0” and the letter “I” shall be distinct from the numeral “1”. Size of font shall be as indicated under “Label size” below.
4. Label size: Label size and font size shall be determined by the application per the table below:

CONDUIT TRADE SIZE	TYP. LABEL SIZE (W X H)	MIN. FONT SIZE IN POINTS	ROWS OF TEXT	NOTES
½” & ¾”	3.00” x 0.50”	12	2	Source/Destination. Center all text on label (refer to figure 1 below)
1”, 1-1/4” & 1-1/2”	4.00” x 0.75”	14	2	Same as above
2” and up	7.50” x 1.00”	20	2	Same as above

FIGURE-1 (example text)



C. Cable Tray Label:

1. Label material: Water and chemical resistant material, “bright yellow” in color, UV resistant, suitable for indoor and outdoor use, permanent self-adhesive, suitable for use with indelible ink printing.
2. Ink: Indelible ink, black in color, resistant to UV radiation, abrasion, and chemicals.
3. Lettering: Single line of lettering, all capitals, and text to be centered horizontally and vertically on background. Text style shall be equivalent to Windows™ TrueType™ Arial font, 48 point, bold face, black. The letter “O” shall be distinct from the numeral “0” and the letter “I” shall be distinct from the numeral “1”.
4. Label size: Labels shall be 7.50” wide x 1.00” high.

FIGURE-2 (example text)



D. Pathway Warning Label (refer to Figure 3):

1. Typical placement is on closed cable trays, Backbone conduit entry/exit points within communication rooms and any other area(s) requested by the Port of Seattle
2. Label material: Water and chemical resistant material, “day-glow orange” in color, UV resistant, suitable for indoor and outdoor use, permanent self-adhesive.
3. Ink: Indelible ink, black in color, resistant to UV radiation, abrasion, and chemicals.
4. Label size: Labels shall be 5.0” wide x 4.0” high.
5. Lettering: Text style shall be equivalent to Windows™ TrueType™ Arial font. The word “WARNING” shall appear centered at the top of the label in 48-point bold, all capitals, centered horizontally. The body of the text shall be in 20-point normal and bold lettering, all capitals, left and right justified, and laid out with line breaks.

FIGURE-3 (actual text)

WARNING

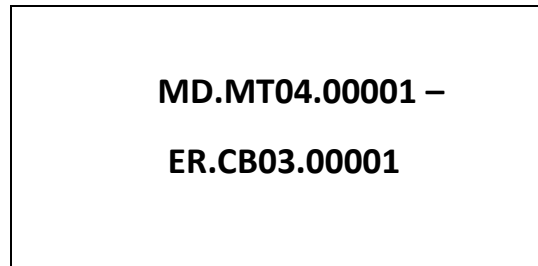
THIS CABLE PATH IS A MANAGED RESOURCE OF THE PORT OF SEATTLE. **UNAUTHORIZED CABLES MAY BE CUT AND REMOVED WITHOUT NOTICE.** CALL PORT AV/NETWORK CONTROL AT 206-787-7638 (**787-PNET**) FOR INFORMATION OR TO REPORT PROBLEMS.

E. Innerduct Label:

1. Label material: Data plate labels of polyester/polycarbonate composite material, semi-rigid non-adhesive film with excellent strength properties and flame resistance, water and chemical resistant, white in color, UV resistant, suitable for indoor and outdoor use, suitable for use with indelible ink printing, with two slot holes at each end for attachment using two plastic cable ties for each label.

2. Ink: Indelible ink, black in color, resistant to UV radiation, abrasion, and chemicals.
3. Lettering: Two lines of text, follow with “source –” field, final row is the “destination” field. Center all text on label (refer to figure 4 below). Text style shall be equivalent to Windows™ TrueType™ Arial font, 12 or 14 point, bold face, black. The letter “O” shall be distinct from the numeral “0” and the letter “I” shall be distinct from the numeral “1”.
4. Label size: Labels shall be 2.50” wide x 1.00” high.

FIGURE-4 (example text)



2.04 CABLE AND WIRING LABELS

A. Cable Tag:

1. Label material: Data plate labels of polyester/polycarbonate composite material, semi-rigid non-adhesive film with excellent strength properties and flame resistance, water and chemical resistant, white in color, UV resistant, suitable for indoor and outdoor use, suitable for use with indelible ink printing, with two slot holes at each end for attachment using two plastic cable ties for each label.
2. Ink: Indelible ink, black in color, resistant to UV radiation, abrasion, and chemicals.
3. Lettering: Two lines of lettering with line of text split at “from-to” hyphen with hyphen at end of 1st line, all capitals, and text to be centered horizontally and vertically on background. Text style shall be equivalent to Windows™ TrueType™ Arial font, 14 point, bold face, black. The letter “O” shall be distinct from the numeral “0” and the letter “I” shall be distinct from the numeral “1”.
4. Label size: Labels shall be 2.00” wide x 0.75” high. Utilize two labels in series in order to achieve 4” overall width.

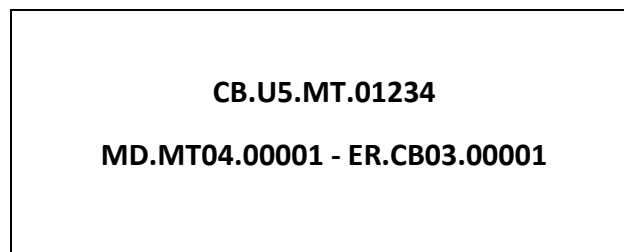
B. Cable Label:

1. Label material: Self-extinguishing and meets or exceeds 94V-0 flammability requirements, water and chemical resistant, white in color, UV resistant, suitable for indoor and outdoor use, suitable for use with indelible ink printing, self-adhesive with self-laminating overlap.
2. Ink: Indelible ink, black in color, resistant to UV radiation, abrasion, and chemicals.
3. Lettering: One, two or three lines of lettering per table below, all capitals, and text to be centered horizontally and vertically on background. Text style shall be equivalent to Windows™ TrueType™ Arial font, bold face, black. The letter “O” shall be distinct from the numeral “0” and the letter “I” shall be distinct from the numeral “1”. Size of font shall be as indicated under “Label size” below.

CABLE TYPE (AS DEFINED IN “COMMUNICATIONS STANDARDS FOR LABELING AND NOMENCLATURE”)	FONT SIZE IN POINTS	ROWS OF TEXT	NOTES
CB, CF, CO, CS, FB, FO and FT (Backbone) Refer to Figure 5	9 to 14; size per CBL O.D.	2 or 3 as needed	Split line(s) of text after (each) cable. Last row to be “to-from” field
CH and FH (Horizontal) Refer to Figure 6	9	1	Wrap around label: Three lines of text, split first line at end of Conduit name, follow with “from –” field, final row is the “to” field. Center all text on label

4. Label size: Label size shall be 1.00” wide by 1.38” high with print-on area to be 2.00” wide by 0.50” high. Utilize two labels in series in order to achieve 2” overall width.

FIGURE-5 (example text)



Or

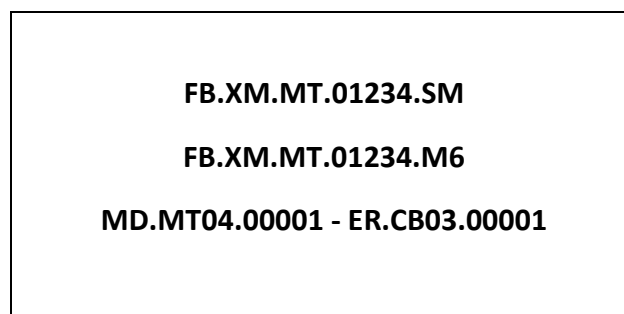
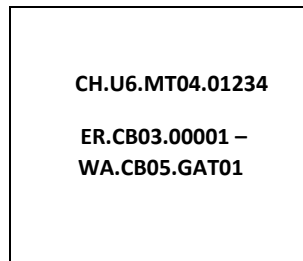


FIGURE-6 (example text)



C. Wire Tag:

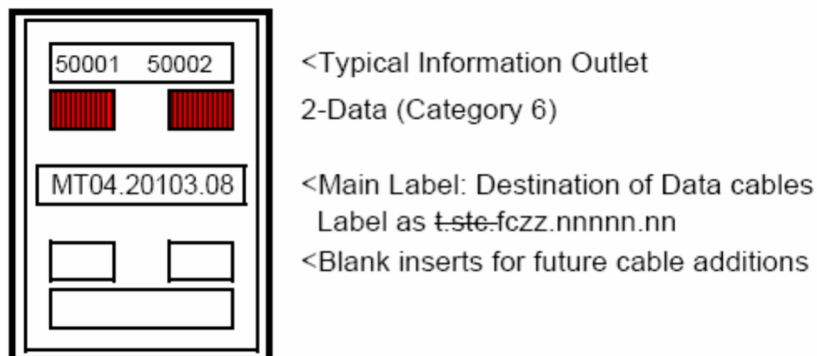
1. Label material: Data plate labels of polyester/polycarbonate composite material, semi-rigid non-adhesive film with excellent strength properties and flame resistance, water and chemical resistant, white in color, UV resistant, suitable for indoor and outdoor use, suitable for use with indelible ink printing, with one pinfeed hole at each end that also is used to attach the label using one plastic cable ties for each label.
2. Ink: Indelible ink, black in color, resistant to UV radiation, abrasion, and chemicals.
3. Lettering: One line of lettering, all capitals, text to be centered horizontally on background, and text to be vertically aligned to miss pinfeed holes. Text style shall be equivalent to Windows™ TrueType™ Arial font, 10 point, bold face, black. The letter "O" shall be distinct from the numeral "0" and the letter "I" shall be distinct from the numeral "1".
4. Label size: Labels shall be 3.00" wide x 1.0" high including pinfeed holes.

2.05 TERMINATION HARDWARE LABELS

A. Jack Label:

1. Label material: Use labels supplied with jack or compatible label. Submit proposed products for approval.
2. Ink: Black in color.
3. Lettering: One line of lettering, all capitals, and text to be centered horizontally and vertically on background. Text style shall be equivalent to Windows™ TrueType™ Arial font, 10 point, bold face, black. The letter "O" shall be distinct from the numeral "0" and the letter "I" shall be distinct from the numeral "1".
4. Label size: As required to fit label holder.

FIGURE-7 (example text)



B. Termination Label:

1. Label material: Use labels supplied with termination hardware or compatible label. Labels shall be color coded per TIA-606 color-coding standards. Submit proposed products for approval.
2. Ink: Black in color.
3. Lettering: One line of lettering, all capitals, and text to be centered horizontally and vertically on background. Text style shall be equivalent to Windows™ TrueType™ Arial font, 10 point, bold face, black. The letter "O" shall be distinct from the numeral "0" and the letter "l" shall be distinct from the numeral "1".
4. Label size: As required to fit label holder.

FIGURE-8 (example text for all below figures)

Copper Terminations-

110 BLOCK: HORIZONTAL Cables

30001	30002	30003	30004	30005	30006
30007	30008	30009	30010	30011	30012

110 BLOCK: BACKBONE Cables

(1-25) CB.U5.MT.15001	(26-50) CB.U5.MT.15002
MD.MT04.00001 - ER.CB03.00001	MD.MT04.00001 - ER.CB03.00001

(51-75) CB.U5.MT.15003	(76-100) CB.U5.MT.15004
MD.MT04.00001 - ER.CB03.00001	MD.MT04.00001 - ER.CB03.00001

110 Block Notes:

1. Continued on to end of block count, typically 100pr. or 300pr.
2. The (# - #) is pair count on block that the 25pr. cable is terminated to

Copper Patch Panels (6-port modules)

50001	50002	50003	50004	50005	50006	<Req. Horizontal "CH.U6.fczz.nnnnn" or Backbone "CB.U6.fc.nnnnn" assigned seq. #
1	2	3	4	5	6	<Port count on panel label system (1-6, 7-12, 13-18 and so on)
						<Individual CPP data ports
TO: EQ.B-1234-R (Tenant XYZ)						<Use space below data ports to call out destination space and owner of BACKBONE demarcation cables; Space not used for HORIZONTAL cable

C. Fiber Terminations

1. No figures currently available; seek Sea-Tac/Seaport Telecommunications Architectural Review Team (START) direction. Typical backbone layout is to attach a label as seen in Figure-5 which details cable name followed by To-From field. Attached to FPP lid on specific ports terminated to.

2.06 GROUNDING SYSTEM LABELS

- A. Ground Warning: Ground warning tag, UV resistant legend printed on both sides, semi-rigid polyethylene material, 2.75" wide by 1.38" long, one attachment slot of 0.13" x 0.63", bright yellow background color, black lettering, text to read "WARNING, GROUND WIRE, DO NOT REMOVE".

PART 3 EXECUTION

3.01 GENERAL

- A. Contractor shall ensure that spaces, pathways, cables, termination hardware, terminations, splices, grounding buses, and grounding conductors have been correctly installed prior to labeling and testing.
- B. Pathway labels require a source/destination label only.
 1. Source refers to MDR, ER, EQ, in that order.
 2. Designations are a description of device (WAP, camera), EQ name, room number, or grid line.
- C. Contractor shall supply labels, labeling equipment, and labor as required to create and apply labels as specified and per the Port of Seattle Section 27 05 53.13 - Communications Standard for Labeling and Nomenclature.

3.02 LABEL APPLICATIONS

- A. Apply labels in accordance with the “Application” section of the Port of Seattle Section 27 05 53.13 - Communications Standard for Labeling and Nomenclature.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.

- B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of “Communications Infrastructure Commissioning” Work is shown in the Contract Documents.
 - 1. Commissioning shall be completed for the following Work in this Contract:
 - a. Construction of cable trays and raceways, backboards, and other communications cabling equipment indicated in Section 27 05 28 - Pathways for Communications Systems and Section 27 15 00 – Communications Horizontal Cabling.
 - b. .
 - c. Construction and testing of the horizontal cable plant as mandated in Section 27 15 00 – Communications Horizontal Cabling.
 - d. Completion of cable administration documentation using the Cable Administration System as mandated in Section 27 15 00 – Communications Horizontal Cabling.
 - 2. Commissioning shall include Work not performed under any contract, but required for completion and commissioning of Work in any specific contract.
 - a. Cable trays installed as required for backbone cable installation or extension.
 - b. Backbone cable elements installed and tested that are integrated with the cable system in this Contract.
 - c. Cable conduit, shafts, and communications rooms that are used to route and install backbone branch cable to communications rooms.
 - d. Branch cable installed between communications rooms and Security Master Plan assigned locations designated in this Contract.
 - 3. Port will contract with an independent test contractor for full commissioning and testing of Work performed under this contract.

1.02 GOVERNING CODES, STANDARDS AND REFERENCES – NOT USED

1.03 SUBMITTALS

- A. Submit materials data in accordance with of Section 01 33 00 - Submittals. Furnish manufacturers’ technical literature, standard details, product specifications, and installation instructions for all products.
- B. Submittals shall be compatible with the latest version of the authoring software.
 - 1. Submittals shall include:
 - a. All documents, reports, and drawings required for commissioning by the Contractor:
 - (1) Microsoft Word and/or Excel
 - (2) AutoCAD drawing files

- b. PDF of testing and cable administration information.
- C. Test results are required to be submitted to the Port of Seattle no later than 14 days from the date of the individual test.

1.04 INSPECTIONS AND TESTING

- A. Inspection of the quality of Work completed is the primary commissioning tool for communications infrastructure.
- B. Testing and documentation are the commissioning methods for communications cable plant and termination equipment.
- C. Testing and documentation shall be executed per this section and other Division 27 Communications sections in this contract.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION

3.01 INSPECTION OF WORK

- A. Contractor inspections shall be conducted of all Work in the Work area to be commissioned, and a punch list of corrections shall be prepared and submitted to the Engineer for review.
- B. The Contractor shall execute the punch list corrections prior to requesting Port commissioning inspections of the Work area.
- C. Port pre-test inspections shall begin upon notice that the Contractor's punch list Work is completed or at a point of completion mutually agreeable to the Engineer. The request to start the Port inspection shall be provided in writing by the Contractor.
- D. The Contractor shall coordinate Port inspections with the Engineer with at least three (3) days notice.
- E. Depending upon the Work quality determined by the Port inspection, the Engineer may authorize the Contractor to start testing prior to completion of inspection of the entire Work area to be commissioned.
- F. The Engineer will provide the Contractor with a correction punch list after each Port inspection. The Contractor shall provide an action plan for each punch list within 5 calendar days, and begin corrections within the same 5-day period.

3.02 CONTRACTOR TESTING

- A. Contractor tests may not start without Engineer approval of the Contractor Test Plan and Procedures.
- B. Prior to the testing Work in the first Work area to be commissioned, the Contractor shall provide a demonstration to the Engineer of the testing process for ten (10) of each type of test being performed.
- C. Upon completion and approval of the demonstration tests, the Contractor shall complete testing.
- D. Testing may be executed in stages within a Work area depending upon the progress of pre-test inspections.

- E. If the Contractor finds more than 2% of the tests do not meet specifications, testing shall stop, the Engineer shall be notified, and the Contractor shall immediately take corrective actions and reschedule testing.
- F. Test results and cable administration information shall be submitted to the Engineer only when all testing in the Work area being commissioned is complete.
- G. Test results shall be provided to the Port on both disk and hardcopy.
- H. Upon receipt of the independent test report and Work or identification deficiency report, a correction plan shall be submitted within 5 working days.
- I. Work and identification deficiencies shall be corrected in a professional and timely manner. Each correction shall be documented and reported to the Engineer.

3.03 FINAL CLOSURE OF WORK

- A. Final closure of infrastructure facilities shall not occur until after Engineer approval of the commissioning of each designated Work area.
- B. Closure sequence shall be:
 - 1. Closure of pull boxes and junction boxes after final inspection and approval of cable, cable labels, and box identification. Pull and junction boxes shall be cleaned prior to closure.
 - 2. Closure of cable trays after final inspection and approval of innerducts, cables, cable labels, flex joint treatment, cable tray grounding, and cable tray labeling. Cable trays shall be cleaned prior to closure.
 - 3. Closure of ceilings after cable tray approval and closure. Inspection locations in ceilings shall be identified at ceiling closure.
 - 4. Closure of patch panels and splice panels after post-testing inspection and approval of terminations, identification, cable dressing, patch panel labeling, and patch panel security. Patch panels and rack areas shall be cleaned prior to final closure.
 - 5. Repair of finishes and disposal of all waste material.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontrator (of any tier) or Supplier.
- B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support

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Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

END OF SECTION

PART 1 GENERAL**1.01 SUMMARY OF WORK**

- A. The extent and location of "Communications Cabinets, Racks, Frames, and Enclosures" Work is shown in the Contract Documents.

1.02 GOVERNING CODES, STANDARDS, AND REFERENCES

- A. References to codes and standards called for in the Specifications refer to the latest edition, amendments, and revisions to the codes and standards in effect on the date of these Specifications.
1. ANSI/TIA-569 (American National Standards Institute/Telecommunications Industry Association) Telecommunications Pathways and Spaces
 2. ANSI/TIA-606 (American National Standards Institute/Telecommunications Industry Association) Administration Standard for Telecommunications Infrastructure
 3. ANSI/TIA-607 (American National Standards Institute/Telecommunications Industry Association) Generic Bonding and Grounding (Earthing) for Customer Premises
 4. ANSI/TIA-758 (American National Standards Institute/Telecommunications Industry Association) Customer-Owned Outside Plant Telecommunications Infrastructure Standard
 5. TIA-862 (Telecommunications Industry Association) Structured Cabling Infrastructure Standard for Intelligent Building Systems
 6. ASTM A36 (American Society for Testing and Materials) Standard Specification for Carbon Structural Steel
 7. ASTM A513 (American Society for Testing and Materials) Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing
 8. ASTM A1011 (American Society for Testing and Materials) Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
 9. BICSI (Building Industry Consulting Service International) Telecommunications Distribution Methods Manual (TDMM)
 10. FCC (Federal Communications Commission) 47 Part 68 Code of Federal Regulations, Title 47, Telecommunications
 11. IEEE (Institute of Electrical and Electronics Engineers) National Electrical Safety Code (NESC)
 12. NECA (National Electrical Contractors Association) National Electrical Installation Standards
 13. NETA (National Electrical Testing Association)
 14. NFPA 70 (National Fire Protection Agency) National Electric Code
 15. UL (Underwriters Laboratories)

16. Washington State Department of Labor & Industries

1.03 SUBMITTALS

- A. Submit materials data in accordance with of Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.
- B. Submittals shall include the following:
 - 1. Product Data: For cable runways, equipment frames, termination wallboards, and associated accessories.
 - 2. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.
 - a. Detail equipment assemblies, and location and size of each field connection.
 - b. Equipment frames: Include workspace requirements and access for cable connections.
 - c. Termination wallboards: Include workspace requirements.
 - 3. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

1.04 QUALITY ASSURANCE – NOT USED

1.05 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install equipment frames and cable trays until spaces are enclosed and weather-tight, wet work in spaces is complete and dry, and work above ceilings is complete.

1.06 COORDINATION

- A. Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier or telecommunications service provider.
 - 1. Meet jointly with 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 them to other participants.
 - 3. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.
 - 4. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.
- B. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cable Runway:
 - a. CPI Chatsworth
 - b. Commscope
 - c. B-Line, Eaton
 - d. Or Approved Equal.
 - 2. Equipment Frames:
 - a. CPI Chatsworth
 - b. APC
 - c. Commscope
 - d. Middle Atlantic
 - e. Or Approved Equal
 - 3. Cable Management:
 - a. CPI Chatsworth
 - b. Leviton
 - c. Commscope
 - d. Or Approved Equal

2.02 CABLE RUNWAY

- A. Cable Runways: Cable runways shall have the following characteristics, at a minimum:
 - 1. Type: UL Classified tubular steel stringer cable runway.
 - 2. Stringers: 3/8" x 1-1/2" steel tube.
 - 3. Rungs: 1/2" x 1" steel tube, welded rungs, welded on interior face of stringers at 9" spacing.
 - 4. Width: 18"
 - 5. Finish: Black powder coat.
- B. Fittings:
 - 1. General: Materials shall be heavy duty, UL Classified, and black finish when available for use with 1-1/2" tubular steel stringer cable runway.
 - 2. Stringer butt splices: Heavy duty, UL Classified, steel, black finish, (4) 3/8"-16 bolts, nuts, lock washers per splice, for 1-1/2" tubular steel stringer.
 - 3. Junction splice: Heavy duty, UL Classified, steel, black finish, minimum (1) 3/8"-16 bolts, nuts, lock washers per splice, for 1-1/2" tubular steel stringer.

4. Runway support bracket: Accommodates 5/8" all threaded rod, steel, for 1-1/2" tubular steel stringer.
5. Standoff supports: Provides 12" spacing between decks, accommodates parallel or perpendicular runways, steel, black finish, minimum (2) 3/8"-16 bolts, nuts, washers per support, for 1-1/2" tubular steel stringer.
6. Cable retaining posts: Removable, minimum 7" height above stringer, steel, black finish, for 1-1/2" tubular steel stringer.
7. Cable runway radius drops: Removable, metallic construction, compatible with stringer or rung mounting.

2.03 EQUIPMENT FRAMES

- A. General: Equipment frames shall have the following characteristics at a minimum:
 1. Equipment mounting channels:
 - a. Punched on the front and rear flange with the 19" EIA-310-D Universal Mounting hole pattern.
 - b. Factory marked and numbered RMU (Rack Mounted Unit) locations.
 2. Factory provided grounding lug.
 3. UL Classified
 4. Equipment frames shall be powder coated black in color.
- B. Equipment racks 2-post:
 1. Dimensions: 45 RU (Rack Unit) 7' high, 19" wide rack spacing.
 2. Construction: 6061-T6 high strength aluminum extrusion, two (2) top angles, two (2) base angles, two (2) mounting channels, self-support base, and heavy-duty assembly hardware.
 3. Two post frame shall be rated for 2-post rack: 1500 lbs of equipment
- C. Swinging wall mount cabinets:
 1. Dimensions: 26 RU, 19" wide rack spacing.
 2. Construction: Aluminum extrusion.
 - a. Access: Hinged front door. Hinged rear panel.
 - b. Side Panels: Steel sheet.
 - c. Cable Access: Top and bottom of rear panel.
 3. Swinging wall mount cabinet shall be rated for 300 lbs of equipment.

2.04 TERMINATION WALLBOARDS

- A. Wallboards: 8' x 4' x 3/4" AC Marine Grade fire retardant pressure treated plywood. Wallboards shall be free of surface defects such as knots and cracks.
- B. Paint: White, non-conductive, and fire retardant.
- C. Cabling restraints and routes:

1. 6-inch D-Ring-type cable restraints shall be utilized for backbone and horizontal cabling on the wallboards.
2. Nylon saddles shall be used to secure the 25 pair cables to the wallboards.

PART 3 EXECUTION

3.01 GENERAL

- A. Install system components and appurtenances in accordance with the manufacturer's installation instructions and as shown on plans and details.
- B. Each device shall be mounted such that its horizontal dimension is level and in no case out of level by 0.03" over 3' in any direction. In cases where more than one device is mounted, they shall be aligned vertically.
- C. Contractor shall provide structural support and seismic bracing for cable runways as specified in Section 27 05 28 – Pathways for Communications Systems.
- D. Comply with mounting and anchoring requirements specified in Section 26 05 48 - Seismic Controls for Electrical and Communication Work.

3.02 EQUIPMENT FRAMES

- A. Interior floor mounted:
 1. Provide galvanized steel plate between floor and rack such that there is no direct contact between aluminum and concrete.
- B. Micro Distribution Cabinets:
 1. 120 VAC receptacles, (2) 4-plex from (2) circuits.
 2. Install Rack mounted power distribution unit in bottom third and rear of cabinet.
 3. Conduit shall be bottom entry, or penetrate bottom third of side panel. If conduit penetrations deviate approval must be obtained from Resident Engineer.
 4. Do not penetrate the roof of the cabinet.
 5. Telecom grade Condulet is allowed for conduit penetrations into the MDC cabinet.

3.03 TERMINATION WALLBOARDS

- A. Communication rooms shall be furnished with communication distribution backboards and accessories on all wall surfaces.
- B. Coordinate power outlet locations prior to placement of plywood backboards.
 1. Existing Conditions: Cutouts shall be provided around existing power and telecommunication outlets.
 2. New Construction: power and telecommunications outlets and light switches shall be surface mounted on the plywood backboards.
- C. Unless detail drawings illustrate differently, each backboard shall be installed and oriented with the 8' dimension vertical, and "A" side exposed.

- D. Provide two layers of white, non-conductive, and fire retardant paint. Do not paint over fire rating seal.
- E. Cabling restraints and routes: Each cable termination location shall be provisioned with industry standard, cable restraint hardware. Provide sufficient quantities to ensure cables routed on plywood backboards are restrained at intervals not exceeding 1 foot. All cables shall be routed parallel and perpendicular to communication room floors.

3.04 GROUNDING SYSTEM AND CONDUCTORS

- A. Bonding and grounding shall meet the requirements specified in:
 - 1. Section 27 05 26 – Grounding and Bonding for Communications Systems

3.05 IDENTIFICATION AND LABELING

- A. Identification and labeling shall meet the requirements specified in:
 - 1. Section 27 05 53 – Identification and Labeling

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.
- B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of "Communications Horizontal Cabling" Work is shown in the Contract Documents. This section includes the construction, test, documentation, and warranty of a fiber optic cable unshielded, twisted-pair (UTP) copper horizontal cabling and RG-11 Coaxial cable in accordance with the Contract Documents.
- B. This work specified in this Section includes installation of horizontal cabling for Port wide installations. For this work, the Contractor shall:
 - 1. Provide optical fiber horizontal cable and associated accessories.
 - 2. Provide UTP horizontal cable and associated accessories.
 - 3. Provide RG-11 Coaxial cabling
 - 4. Termination
 - 5. Conduct testing
- C. Definitions For Port Of Seattle Infrastructure
 - 1. Refer to Section 27 05 00 – Common Work Results for Communications.
- D. SCOPE OF WORK
 - 1. The Contractor shall provide materials and labor required to deliver a complete horizontal cable system as indicated on the Contract Drawings, schedules, and these Specifications.
 - 2. This work shall include, but may not be limited to, the following tasks. The Contractor shall:
 - a. Provide horizontal optical fiber cable that is pre-installation tested, correctly installed and terminated, and Contractor or systems contractor tested prior to final acceptance testing by POS.
 - b. Provide horizontal data and voice and audio-related copper cable that is correctly installed and terminated, and Contractor or systems contractor tested prior to final acceptance testing by POS.
 - c. Provide patch panels, termination blocks, face plates and end point termination devices to enable the termination and identification of the horizontal cable system.
 - d. Install Contractor-furnished cable devices and accessories, such as patch panels, in racks installed by other contracts and in racks provided by the Contractor.
 - 3. Label devices, cables, and ports per Section 27 05 53 – Identification and Labeling and enter data in the cable management system. The Port may elect to enter data into the Port cable management system based on data from the Contractor. This does not alleviate the Contractor from their responsibility to provide personnel to manage cable management system such as maintaining Excel spreadsheets of all necessary installed cable data.

- 1.02 Conduct testing on horizontal cabling per Port of Seattle specifications. GOVERNING CODES, STANDARDS AND REFERENCES
- A. ICEA S-90-661 Category 3, 5, & 5e Individually Unshielded Twisted Pair Indoor Cables (with or without an Overall Shield) for use in General Purpose and LAN Communication Wiring Systems Technical Requirements
 - B. TIA-440 - Optic Fiber Terminology
 - C. TIA-455 - General Requirements for Standard Test Procedures for Optical Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and other Fiber Optic Components
 - D. TIA-455-78 - FOTP-78 IEC 60793-1-40 Optical Fibres – Part 1-40: Measurement Methods and Test Procedures - Attenuation
 - E. TIA-526 - Standard Test Procedures for Fiber Optic Systems
 - F. TIA-568 (Set) - Commercial Building Telecommunications Cabling Standard
 - G. TIA-569 - Telecommunications Pathways and Spaces
 - H. TIA-598 – Optical Fiber Cable Color Coding
 - I. TIA-606 – Administration Standard for the Telecommunications Infrastructure
 - J. TIA-758 – Customer-Owned Outside Plant Telecommunications Infrastructure Standard
 - K. NFPA 70 - National Electrical Code (NEC)
 - L. NFPA 262 – Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces
 - M. UL 444 – Communication Cables
 - N. UL 910 – Test Method for Fire and Smoke Characteristics of Electrical and Optical Fiber Cables Used in Air-Handling Spaces.
 - O. UL 1666 – Standard Test for Flame Propagation Height of Electrical and Optical Fiber Cables Installed Vertically in Shafts.
 - P. Washington State Department of Labor & Industries
- 1.03 SUBMITTALS
- A. Submit materials data in accordance with of Section 01 33 00 – Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.
 - B. The Contractor shall provide the following technical submittals: If required in the scope of work in Work Authorization.
 - 1. Manufacturer's complete product data and specifications, with drawings as applicable for materials furnished by the Contractor.
 - 2. Optical Loss Tester (OLT) - submit the OLT model number and calibration certificates prior to testing.
 - 3. Unshielded twisted pair (UTP) cable tester. The Contractor shall submit UTP cable tester model number and calibration certificates prior to testing.
 - 4. Horizontal cable test results

- a. The Contractor shall provide test results in soft copy format. The format, content, and graphic scales shall be submitted to the Resident Engineer for approval prior to performing tests.
 - b. Contractor shall furnish to the Resident Engineer the licensed software required to view electronic copies of test results.
 - c. Results of pre-installation optical fiber reel tests.
 - d. Results of post-installation horizontal cable tests.
 - e. Final testing shall use Port of Seattle cable naming convention in all test records.
 - f. Test results are required to be submitted to the Port of Seattle no later than 14 days from the date of the individual test.
 5. Conduit and cable tray fill plan indicating initial cable fill percentages and the use of innerduct. The plan may be submitted by installation area if this method is more effective.
 6. Shop drawings and single-line schematic diagrams showing final device placements, cable groups, termination details and cross-connections.
 7. Contractor's test plan for the required optical fiber and metallic (copper) cable tests.
 8. Requests for inspections and substantial completion inspection for acceptance testing by the Port-designated test contractor.
 9. Final as-built horizontal wiring drawings and documentation per Port of Seattle standards.
 10. Cable management system data entry submittals shall include:
 - a. Contractor to provide as-built labeling information to Port of Seattle within two (2) weeks of project completion.
 - b. Data Entry provided to the Port of Seattle: Data shall be provided in a consistent and accurate manner in a format approved by the Engineer. Data provided shall include, but not be limited to:
 - (1) Tabular nomenclature data for spaces, pathways, cables and termination hardware.
 - (2) Diagrammatic drawings and data for spaces, pathways, cables and termination hardware.
 - (3) Status data for installation, tests, defects, and corrections.
- C. The Contractor shall provide the following administrative submittals:
1. Certification that the cable will be installed by a Washington State Systimax Solutions-certified value-added reseller or installation contractor.
 2. Documentation that termination crafts-people are properly trained for optical fiber termination and testing, and high-performance data cable termination and testing. Documentation may be from a technical school, manufacturer's school, or labor union training.

3. Discrepancy report describing existing horizontal cable, equipment, and rack conditions that would affect the ability of the Contractor to successfully complete the work.
4. Systimax Solutions 20-year approved warranty on the completed Systimax Solutions portions of the horizontal cable system.
5. Warranty documentation on non-Systimax Solutions products.

1.04 PROJECT CONDITIONS

- A. Verification: Obtain specific cable lengths and location of racks and equipment by field measurement and by contractor's shop drawings after contract award. Do not vary from the routes indicated in the drawings without prior approval from the Construction Manager.

1.05 QUALITY ASSURANCE

- A. Contractor Qualifications for Systimax:
 1. All Systimax fiber optic communications products , including but not limited to cables, patch panels, splice panels, splices, and connectors, shall be installed, terminated, tested and documented by a Systimax Washington Business Partner. The active Business Partner list can be located at the Systimax webpage.
 2. All Systimax® copper communications products, including but not limited to TIA-568 Category 5 or higher performance cables, patch panels, terminal blocks, and connectors, shall be installed, terminated, tested, and documented by a Systimax® Washington Business Partner. The active Business Partner list can be located at the Systimax webpage.
- B. Contractor Qualifications for other manufacture sources:
 1. Manufacturer shall have a certified installer program; installers shall have valid certification from specific Manufacturer.
 2. Communication material shall have the ability to physically terminate to Systimax termination hardware to maintain existing cross connect fiber patch cord usage, architectural aesthetics and end user ergonomics established in the Port of Seattle communication rooms.
 3. Installed communication infrastructure shall provide a minimum 20 year warranty.
- C. Manufacturer's Recommendations: Install items per manufacturer's recommendations. Recommendations shall include, but not be limited to, cable handling, bending, and pulling requirements or limits; termination methods and materials; and use of specific tools and disposables.
- D. Tests: Perform tests as specified in Part 3 – Execution of this section.

1.06 DELIVERY, HANDLING, AND STORAGE

- A. Materials shall be delivered in original packages with labels intact and identification clearly marked.
- B. Protect equipment and materials from foreign objects such as dirt, dust, paint, fumes, liquids, construction debris, and other contaminants. Protect from weather, humidity, temperature, and sunlight. Protect from physical damage.

- C. Keep dust caps in place on patch panels and replace after testing. Protect 110 blocks with masking until construction is complete.
- D. Equipment damaged prior to system acceptance shall be replaced with new at no additional cost to the Port.
- E. Port-furnished Material: Port-furnished material will be made available to the Contractor at the airport logistics site. The Contractor shall be responsible for inspection, testing, or other verification of the condition of the materials upon receipt from the Port. By accepting materials from the Port, the Contractor warrants that said materials are free from defects. Remedy for subsequent discovery of damage or defects shall be the responsibility of the Contractor.

1.07 WARRANTY

- A. General: Refer to Division 1 for general warranty requirements.
- B. Systimax Solutions Extended Warranty: In addition to the general warranty requirements, the fiber optic cable and UTP copper cable and termination hardware shall have an overall Systimax Solutions Systimax manufacturer's warranty for a period of 20 years covering the entire system as a whole. The warranty shall cover the cost of materials and labor for repair or replacement of cables and terminations due to defects in materials or installation. The Port shall receive a Systimax Solutions certificate of warranty for the project prior to final closeout.
- C. Other approved manufacturer's warranty shall be equal to or greater than 20 years. The warranty shall cover the cost of materials and labor for repair or replacement of cables and terminations due to defects in materials or installation. The Port will expect a certificate of warranty for the project prior to final closeout.

PART 2 PRODUCTS

2.01 GENERAL

- A. Horizontal cabling infrastructure shall be manufactured by Systimax Solutions; any substitutions must be approved by the Resident Engineer.

2.02 UTP HORIZONTAL CABLE

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Systimax Solutions; a CommsScope Inc. brand
 - a. 4-pair indoor rated
 - (1) Commscope/Systimax GigaSPEED XL 1071E, Cat 6 U/UTP, non-plenum, red jacket
 - (2) Commscope/Systimax GigaSPEED XL 2071E, Cat 6 U/UTP, plenum, red jacket
 - (3) Commscope/Systimax GigaSPEED XL 1091B, Cat 6a U/UTP, non-plenum, orange jacket

- (4) Commscope/Systimax GigaSPEED XL 2091B, Cat 6a U/UTP, plenum, orange jacket
 - b. 4-pair outdoor and indoor/outdoor rated
 - (1) Commscope/Systimax 1572A- Outdoor Cat 6 F/UTP, black jacket
 - (2) Commscope/Systimax 1592A- Outdoor Cat 6a F/UTP, black jacket
 - 2. 25-pair and greater outdoor rated
 - a. Superior Essex MegaPic OSP
 - b. Mohawk LAN-Trak OSP
 - c. Or Approved Equal
- B. Description: 100-ohm, 4-pair UTP, covered with a Red thermoplastic jacket. For all different systems cabling refer to Section 27 05 53 – Identification and Labeling – Color Code requirement.
 - 1. Comply with ICEA S-90-661 for mechanical properties.
 - 2. Comply with ANSI/TIA-568-C.0 for performance specifications and Port of Seattle Cabling specifications for new installations.
 - 3. Comply with ANSI/TIA-568-C.2, Category 6.
 - 4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
 - a. Communications, Plenum Rated: Type CMP, complying with NFPA 262.
 - b. For locations not requiring plenum rated, provide CMR rating.
- C. Description: 100-ohm, 4-pair UTP, covered with a thermoplastic jacket – used at wireless access point (WAP) locations only. Coordinate cable color with owner.
 - 1. Comply with ICEA S-90-661 for mechanical properties.
 - 2. Comply with TIA/EIA-568-C.0 for performance specifications.
 - 3. Comply with TIA/EIA-568-C.2, Category 6A.
 - 4. Listed and labeled by an ETL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 262 for the following types:
 - a. Communications, Plenum Rated: Type CMP, complying with NFPA 262.

2.03 FIBER OPTIC CABLE

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Systimax Solution; a CommsScope Inc. brand
 - a. TeraSPEED singlemode fiber optic cable

2.04 UTP CABLE HARDWARE

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Systimax Solution; a CommsScope Inc. brand
- B. General Requirements for Cable Connecting Hardware: Comply with ANSI/TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.
- C. Angled Patch Panel: Modular angled panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.
 - 1. Number of Jacks per Field: One for each four-pair UTP cable indicated, plus spares and blank positions adequate to suit specified expansion criteria.
 - 2. 24-port Angled Patch Panel
 - a. Systimax 360 Evolve 24-port angled patch panel
 - 3. 48-port Angled Patch Panel
 - a. Systimax 360 Evolve 48-port angled patch panel
- D. Flat Patch Panel: Flat panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.
 - 1. Number of Jacks per Field: One for each four-pair UTP cable indicated, plus spares and blank positions adequate to suit specified expansion criteria.
 - 2. 24-port Flat Patch Panel
 - a. Systimax PatchMax 24-port flat patch panel
 - b. Systimax 360 Evolve 24-port flat patch panel
 - 3. 48-port Flat Patch Panel
 - a. Systimax PatchMax 48-port flat patch panel
 - b. Systimax 360 Evolve 48-port flat patch panel
- E. Jacks and Jack Assemblies: Custom length Cat 5e 25-pair cable assemblies to be used with the Telco style panels; match connector type with the connector at the back of the panel.
- F. Patch Cords: Factory-made, four-pair cables in 48-inch (1200 mm), 72" (1800-mm), 96" (2400 mm), and 120" (3000 mm) lengths; terminated with eight-position modular plug at each end.
 - 1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
 - 2. Supply one patch cord for each outlet.
 - 3. Supply station cords in 96"(90%) and 120"(10%) lengths

4. Supply various lengths of patch cords at the IC end as to assure a neat installation.
5. Supply various colors for the different systems; coordinate colors with the owner.
6. Provide add alternate price to install patch cords at one end and at both ends of the cord.
7. Provide unit prices for each length of patch cords to be used for additional patch cords as needed.
8. Provide unit prices to install patch cords at one end and both ends.

2.05 TELECOMMUNICATIONS OUTLET/CONNECTORS

- A. Jacks: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with ANSI/TIA-568-C.0. Match connector type and category with the cable being connectorized.
- B. Port-connector assemblies mounted in single faceplate.
 1. Plastic Faceplate: High-impact plastic. Coordinate color with Division 26 Section 26 27 26 – Wiring Devices.
 2. Metal Faceplate: Stainless steel, complying with requirements in Division 26 Section 26 27 26 – Wiring Devices.
 3. For use with snap-in jacks accommodating any combination of UTP work area cords.
 - a. Flush mounting jacks, positioning the cord at a 45-degree angle.
 4. Factory labeled by silk-screening or engraving for stainless steel faceplates.
 5. Machine printed, in the field, using adhesive-tape label.
 - a. Snap-in, clear-label covers and machine-printed paper inserts.
 6. Workstation: Systimax GigaSPEED XL; MGS400 (Red) information outlet.
 7. WiFi: Systimax GigaSPEED XL; MGS600 (Orange) information outlet.
- C. Protector Blocks: used for protection of outdoor station cables.
 1. Configuration of outdoor station cable protectors:
 - a. Category 6/6a, PoE (Power Over Ethernet) compliant protector.
 - b. Shall comply with ANSI/TIA standards for Category 6/6a performance.
 - c. Shall be UL listed.
 - d. Multi-port (8-16 port in 1RU) rack mountable at the TR/TE end of the cable; single/dual port at the device location.
 2. Acceptable manufacturers:
 - a. ITW Linx.
 - b. Porta Systems.

- c. Emerson.
- d. Or Approved Equal.

2.06 FIBER OPTIC CABLE HARDWARE

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Systimax Solution; a CommsScope Inc. brand
- B. General Requirements for Cable Connecting Hardware: Comply with ANSI/TIA-568-C.3.
- C. Existing environments to accept:
 - 1. Systimax SC duplex connectors
 - 2. OFS 144 port, 5 RU Fiber Optic shelf, w/ (6) 24 strand adapter panels
- D. New environments/installations to accept:
 - 1. Systimax LC duplex connectors
 - 2. Commscope/Systimax SD-4U-FX, w/ (12) 12 strand 1000 style adapter panels, furnishing up to 144 strands per FOPP (or approved Commscope/Systimax equal)

PART 3 EXECUTION

3.01 GENERAL

- A. Products and materials shall be new and fit the intended purpose.
- B. Damaged or defective products and components shall be replaced by the Contractor at no additional cost to the Port.
- C. Cabling and termination hardware damaged prior to system acceptance shall be replaced by the Contractor at no additional cost to the Port.
- D. Miscellaneous materials required for a complete and operational cabling system shall be provided by the Contractor.
- E. As required, utilize necessary Fiber optic cables, patch panels, splice shelves, adapters, connectors, buffer kits, breakout kits, consumables, and accessories.

3.02 SCHEDULING AND COORDINATION

- A. Scheduling of work shall be coordinated with the Construction Manager and tenant representatives to minimize impact on operations and the traveling public.
- B. Scheduling of cable installation shall be coordinated with other trades within the Contract and through the Construction Manager with trades working other projects.

3.03 SURVEY AND PREPARATION

- A. The Contractor shall survey existing cable trays, conduit paths and routes, and report discrepancies and issues with the use of these for cable installation. Failure to perform this inspection and submit the report holds the Contractor at cost risk for corrective actions and schedule impacts later in the work.

- B. Contractor shall be responsible for storage of all materials until installation.

3.04 INSTALLATION OF PATCH PANEL AND ASSOCIATED DEVICES

- A. The Contractor shall inspect patch panels, associated devices, and materials for compliance with these Specifications and with the Contractor's orders.
- B. Patch panels and associated devices shall be installed according to manufacturer's instructions.
- C. Patch panels and termination hardware shall be installed with matching mounting screws at each location.

3.05 GENERAL CABLE INSTALLATION

- A. The system shall be installed to comply with all applicable standards, codes, and regulations. In general, where the specifications, drawings, standards, regulations, and codes conflict, the most stringent requirement shall apply; however, the Contractor shall notify the Construction Manager immediately of conflicts for determination of a resolution.
- B. Cables shall be installed in conduits, raceways, pull boxes, cable trays, or cable runways as shown on the Drawings. No aerial or unsupported cables are permitted unless specifically indicated on the drawings and approved by START.
 - 1. Refer to Section 27 05 28 – Pathways for Communications Systems.
- C. Horizontal cable shall be installed with no splices.
- D. The Contractor shall protect cables from dirt and moisture by laying cables on a clean, new ground covering.
- E. The Contractor shall inspect and clean as necessary existing and new cable trays and conduits to ensure that they are clean and free of obstructions prior to installing pull strings or pulling cable.
- F. The Contractor shall not install damaged or defective cables or components. The Contractor shall carefully inspect cable jacket for defects as cable is pulled off the reel or box.
- G. Cable Pulling:
 - 1. Pull cable in accordance with manufacturer's recommendations and industry-accepted practices, and within the limits of cable bend radius and pulling tension specifications.
 - 2. Use of pulling lubricants is not allowed on horizontal cable runs
 - 3. Horizontal cables shall be hand pulled as required by manufacture.
 - 4. Hand feed and guide cable through each 90-degree corner, through pull boxes, and as otherwise required for a free-flowing cable pull.
 - 5. Cable installation methods shall not exceed the cable manufacturer's specified pull tension for the specific cable.
 - 6. The mechanical stress placed upon a cable during installation shall be such that the cable is not twisted or stretched, nor shall the process kink or crush the cable.

7. A cable feeder guide shall be used between the cable reel and the face of the cable tray or conduit to protect the cable and guide it into the cable tray or conduit as it is played off the reel.
8. The Contractor shall hand feed and guide cable through each cable tray 90-degree corner and as required for a proper, free-flowing cable pull.
9. The Contractor shall follow the manufacturer's installation instructions and its specifications for minimum bend radius; the bend radius shall not exceed the manufacturer's minimum bend radius
10. Cable fill shall not exceed BICSI standard.
- H. Station cables and tie cables used in this project shall be routed at right angles to electrical power circuits and supported in accordance with the Contract Drawings.
- I. Riser and tie cables extended between communication rooms shall use inter-floor conduit sleeves per Section 27 05 28 – Pathways for Communications Systems.
- J. Use of ceiling tiles, grid, or hanger wires for support of cables shall be prohibited. Cable shall be installed in cable tray, cable runway, conduit, hangers, hooks, or other means of approved support.
- K. Penetrations of fire zones shall be sealed to rating of the separation (1 hour, 2 hour, etc.).
- L. Routing of any metallic media cabling such as voice, data or coaxial in the same conduit as power conductors is not allowed.
- M. Cabling in ceiling interstice (i.e. - between false ceiling and structure) shall be one of the following:
 1. Riser or plenum rated when cable is installed in metallic conduit or fully enclosed metal tray. Plenum rating is optional in this case.
 2. Plenum rated when cable is installed in open tray, ventilated tray, or ladder tray, or otherwise exposed.
- N. Communication room entry
 1. Horizontal cable runs shall be routed on the lower tier of overhead ladder racking where there are multiple tiers. Contactor shall confirm these locations prior to installing cable.
 2. Optical fiber cable shall be routed from the conduit or cable tray entry point in communication rooms or equivalent spaces in the room tray system without innerduct (when transitioning into room from installed in conduit/tray), but in combed and tied bundles to the termination locations. Service loops of at least 10m in length. For communication rooms, provide a minimum of one lap around the lower cable tray.
 3. Copper cable shall be routed from the conduit or cable tray entry point in communication rooms or equivalent spaces in the room tray system without innerduct, but in combed and tied bundles to the termination locations. Service loops of at least 10m in length. For communication rooms, provide a minimum of one lap around the lower cable tray. Exception on length is the necessity to maintain Data cable limitation of 90m.

- 4. Cable being routed through communications rooms shall be installed in innerduct or conduit.
 - O. All strands of fiber optic cables shall be terminated to patch panels unless indicated otherwise in the drawings. All pairs of UTP copper cables shall be terminated to patch panels or 110 blocks.
 - P. Fiber optic cable and UTP copper cables shall be 100% usable after installation, termination, and testing. Replace defective or damaged cables and terminations with new at no additional cost to the Port. Repair splicing of damaged cables is not permitted.
 - Q. Contractor shall patch WAP (Wireless Access Point) devices at “ethernet port” and “console port”.
- 3.06 VERTICAL CABLE RUNS
- A. When possible, the Contractor shall use gravity to assist in cable pulling; cable shall be pulled from the top of the run to the bottom of the run.
 - B. The Contractor shall provide sufficient tools, equipment, and manpower at required pull points to prevent damaging cables.
 - C. After installation, the vertical tension on the cable shall be relieved at maximum intervals of 20' using a split support grip or hook-and-loop straps.
- 3.07 SERVICE LOOPS (applications outside of communication room)
- A. At the information outlet the Contractor shall provide service loops 24” in length minimum, or as indicated on the Contract Drawings, for outlet locations in back boxes.
 - B. At locations using surface mount boxes, service loops shall be placed in locations indicated on the Contract Drawings or per Construction Manager’s instructions.
 - C. The Contractor shall provide service loops of 36” in length minimum, or as indicated on the Contract Drawings, for “Consolidation Point” boxes.
 - D. Service loops shall not be smaller than the minimum bend radius of the cable.
- 3.08 CABLE DRESSING
- A. Cables shall be neatly dressed and routed at termination points.
 - B. Cables shall be combed and each cable shall run parallel with the other cables.
 - C. Bundles shall be secured with hook-and-loop strap material.
 - D. Cable ties manufactured from a hard polymer material, such as plastic or nylon, shall not be used.
 - E. The Contractor shall begin to bundle and strap cables within 2” of exit from conduit, and bundles shall have cable straps applied at intervals not greater than 12” for entire length of vertical and horizontal run in communications closets.
- 3.09 CABLE TERMINATION
- A. Optical fiber cable termination
 - 1. Optical fiber terminations shall be made by personnel trained and certified by the manufacturer of the fiber and connectors and shall be installed using the appropriate tool kit and equipment approved by manufacture.

2. Existing environments to accept Systimax SC duplex connectors.
 3. New environments to accept Systimax LC duplex connectors.
 4. Optical fiber connectors shall not exceed manufacturer's acceptable loss budget.
- B. Category 6/6a cable termination
1. Terminated cables shall meet the required performance with no degradation due to termination.
 2. Category 6 cables shall be terminated in RJ45 female plugs or information outlets at the field ends in T568B configuration. Field termination of male ends will not be accepted, nor will it pass proper horizontal Link testing.
 3. Category 6 cables shall be terminated in patch panel units and 110-block units in T568B configuration.
- 3.10 SEISMIC JOINT PENETRATIONS
- A. When conduit or pathway penetrates a building expansion joint, the Contractor shall furnish and install a seismic coupling.
- 3.11 FIRE AND SMOKE PARTION PENETRATIONS
- A. The Contractor shall install cables so as to maintain the fire and smoke spread-rating of all building surfaces penetrated.
- 3.12 FIELD QUALITY ASSURANCE
- A. The Contractor shall perform inspections per Section 27 05 00 – Common Work Results for Communications
- B. The Contractor shall perform horizontal cable testing as part of the field quality assurance for this work.
- C. The Construction Manager may arrange for interim inspections by a manufacturer's representative as conditions deem necessary.
- 3.13 SYSTEM PERFORMANCE
- A. Fiber Optic Cable and Terminations: The maximum attenuation of each fiber strand, not including terminations, shall be no greater than the manufacturer's specified maximum attenuation for the cable. The maximum attenuation of a mated pair of connectors shall be no greater than the manufacturer's specified average attenuation of a mated pair of connectors plus 0.3 dB. The maximum attenuation of a fiber strand, terminated at both ends, shall be no greater than the actual measured attenuation of the fiber strand plus the manufacturer specified average attenuation of the mated connectors plus 0.5 dB. The average attenuation of all connectors on a fully terminated cable shall be no greater than the manufacturer's specified average attenuation of the mated connectors.
- B. UTP Copper Cable and Terminations: The UTP copper system, including cables and terminations, shall meet the requirements of TIA-568-B, including all applicable addenda and service bulletins.
- 3.14 GENERAL REQUIREMENTS FOR HORIZONTAL CABLING TESTING
- A. The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform specified testing.

- B. Prior to testing the cable, the Contractor shall verify that the components and systems being tested have been installed in accordance with the Contract Documents.
- C. Cable testing shall be completed by the Contractor and accepted by the Resident Engineer as a condition of Substantial Completion.
- D. Test results are required to be submitted to the Port of Seattle and accepted before any network switch or network device activation will occur.

3.15 HORIZONTAL CABLE TEST PLAN

- A. The Contractor shall submit a general horizontal cable test plan to the Construction Manager for review and approval 20 working days prior to the start of on-site cable installation work, and 20 working days prior to pre-installation optical fiber reel testing.
- B. The test plan shall include:
 - 1. Schedules for the following:
 - a. Optical fiber pre-installation reel testing by the Contractor.
 - b. Optical fiber terminated cable testing by the Contractor, by area.
 - c. Copper cable terminated cable testing by the Contractor, by area.
 - d. Release of optical fiber and copper cables for acceptance testing by the systems contractor.
 - 2. The test plan shall include a list of the test equipment to be used by the Contractor, including model number of sample test reports and wave forms, manufacturer training certificates for technicians operating test equipment and calibration certificates, for approval by the Construction Manager prior to the start of testing. Test equipment shall have the latest firmware upgrades installed prior to testing. Port-specified test equipment shall be as follows:
 - a. Level 5 test meter, or equivalent.
 - b. A Tier 1 Optical Loss Tester (OLT) shall be used to produce test results. The OLT is used to certify the fiber optical terminations as warrantable.
 - c. An OTDR shall not be used to record link loss.
 - 3. Summary of the tests that are to be performed by the Contractor, and the test results that are to be submitted.
- C. Test results are required to be submitted to the Port of Seattle before any network switch or network device activation will occur.

3.16 OPTICAL FIBER PRE-INSTALLATION REEL TESTING

- A. The Contractor shall compare factory test data with data obtained by conducting a pre-installation reel test as follows.
- B. The Contractor shall pre-test singlemode fiber at 1550 nm in one direction.
- C. Dual-pulse Function A fiber shall be tested at a single wavelength with two pulse widths.

- D. Two traces shall be displayed, one for each pulse width. (The short pulse provides optimal event resolution, while the longer pulse provides excellent distant measurements.)

3.17 OPTICAL FIBER TERMINATED CABLE TESTING

- A. The Contractor shall test and record measurements for the following:
 - 1. Link loss. Testing shall consist of a bidirectional, dual wave length end to end test. The system loss measurements shall be provided at 1310 and 1550 nm.
 - 2. Fiber attenuation (dB/km)
 - 3. Splice and connector loss
 - 4. Reflectance and optical return loss
 - 5. Length
- B. Optical fiber cable shall comply with the following Singlemode standards:
 - 1. ANSI 2136.2
 - 2. EIA-440-A
 - 3. Fiber optic test procedure (FOTP) FOTP-8 (TIA/EIA-455-8)
 - 4. FOTP-61 (TIA/EIA-455-61-A)
 - 5. FOTP-77 (TIA/EIA-455-77)
 - 6. FOTP-78 (TIA/EIA-455-78A)
 - 7. FOTP-95 (TIA/EIA-455-95)
 - 8. FOTP-171 (TIA/EIA-455-171)
 - 9. TIA/EIA-455-B
 - 10. TIA/EIA-526
- C. Optical fiber cable shall comply with the following multimode standards:
 - 1. ANSI 2136.2
 - 2. FOTP-77 (TIA/EIA-455-77)
 - 3. FOTP-171 (TIA/EIA-455-171)
 - 4. TIA/EIA-568-A

3.18 CATEGORY 6/6a TERMINATED CABLE TESTING

- A. The Contractor shall test and record measurements for the following:
 - 1. TIA Category 6 per TIA addendum #1 to TIA/EIA-568B
 - 2. IEEE 802.3 1000 Base-T
 - 3. For special systems as defined in POS Communication Design principles, IEEE 802.3 100Base-T shall be allowed.
- B. Category 6/6a terminated cable shall comply with the following standards:
 - 1. Category 6 per Addendum #1 to TIA/EIA-568-B

2. ISO/IEC 11801, Class C and D
 3. ANSI INCITS 263 (TP-PMD)
 4. IEEE 802.3 (for 10BASE-T, 100BASE-TX, and 1000BASE-T)
 5. IEEE 802.5
- C. The Contractor shall use Level 5 permanent link adapters on test equipment.
- D. Refer to POS "Communications System Standards Design Principles" for Acceptance Testing.

3.19 POST-INSTALLATION TESTING

- A. General: Perform post-installation tests on fiber optic cables and terminations, and on UTP copper cables and terminations as required by the Systimax Solutions Systimax or others extended warranty programs.
- B. Final testing shall use Port of Seattle cable naming convention in all test records.
- C. Third Party Testing: The Port may use an Independent Cable Test contractor for independent testing of the fiber optic cable and UTP copper system in addition to the testing required by the installation Contractor. This independent testing is not included in the Work of this contract. Coordination with the Port and the Independent Cable Test contractor is required as Work of this contract and shall be required as follows:
1. The Contractor shall notify the Construction Manager when terminated cables have passed the tests necessary to satisfy the requirements of the Systimax Solutions extended warranty program.
 2. The Port will schedule an Independent Cable Test contractor thereafter. It is anticipated that testing by this contractor will closely follow the progress by the Contractor. The Contractor shall coordinate with and assist the Independent Cable Test contractor to the maximum extent possible.
 3. Cables and terminations found by the Independent Cable Test contractor to be damaged, defective, improperly installed, or that fail to meet performance requirements shall be remedied by the Contractor to the satisfaction of the Construction Manager and shall be retested by the Contractor to meet the Systimax Solutions extended warranty program requirements, at no additional cost to the Port.

3.20 HORIZONTAL CABLING RECERTIFICATION

- A. Re-certification requirements for existing horizontal infrastructure
1. Horizontal cabling infrastructure shall be manufactured by Commscope/Systimax, No Equal, any substitutions or variances must be approved by START committee.
 2. Products and materials shall be new and fit the intended purpose.
 3. Damaged or defective products and components shall be replaced by Contractor at no additional cost to the Port.
 4. Cabling and termination hardware damaged prior to system acceptance shall be replaced by Contractor at no additional cost to the Port.

5. Miscellaneous materials required for a complete and operational cabling system shall be provided by the Contractor.
6. All communication materials shall be subjected to final approval by the Port of Seattle START committee.
7. Contractor is responsible to re-certify existing infrastructure when re-installed, relocated, and ALL existing infrastructure in immediate location to be operational prior to system acceptance, and at no additional cost to the Port.

3.21 LABELING AND COLOR CODES

- A. Identification, labeling, and product color selection shall comply with Section 27 05 53 – Identification and Labeling, Section 27 05 53.13 – Communications Standard for Labeling and Nomenclature, and Section 27 05 53.23 – Port of Seattle Color Code Requirement.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by a Subcontractor (of any tier) or Supplier.

- B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. The extent and location of “Basic Electronic Safety and Security” Work is shown in the Contract Documents. This Section includes general requirements for accomplishing Basic Electronic Safety and Security Work as specified herein and indicated on the Drawings.

1.02 GOVERNING CODES, STANDARDS AND REFERENCES

- A. American Standard Code for Information Interchange (ASCII)
- B. American Society for Testing and Materials (ASTM)
- C. CBC & 2010 ADA Standards (DOJ)
- D. FCC Regulations Part 15 – Radio Frequency Devices & Radiation Limits
- E. National Electric Code (NEC), NFPA 70
- F. National Electrical Manufacturers' Association (NEMA)
- G. National, State, Local and any other binding building and fire codes
- H. Underwriter's Laboratories (UL)
- I. UL 294: Access Control System Units
- J. UL 1076: Proprietary Burglar Alarm Units and Systems
- K. Electronic Industry Association (EIA) testing standards

1.03 SUBMITTALS

- A. Submit materials data in accordance with of Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions.
- B. Product Data
 - 1. General: Product data submittals must be approved by the Engineer prior to release of order for equipment and prior to installation.
 - a. Include product data consisting of manufacturer's technical data, product literature, "catalog cuts", data sheets, specifications, and block wiring diagrams (if necessary). This data shall clearly describe the product's characteristics, physical and dimensional information, electrical performance data, materials used in fabrication, material color & finish, and other relevant information such as test data, typical usage examples, independent test agency information, and storage requirements.
 - b. Clearly indicate by arrows or brackets precisely what is being submitted on and those optional accessories, which are included and those which are excluded.
 - c. Include delivery dates for equipment.
- C. Shop Drawings
 - 1. General: The Engineer must approve shop drawings prior to release of order for equipment and prior to installation.
 - 2. Quantity & Media: Furnish quantity and on media specified in Division 1.

3. Content:
 - a. Floor Plans:
 - (1) Floor and site plans showing the locations of all devices associated with each door locations (ex: contacts, REX locks, card readers) and cable routing paths with cable type and quantity called out. Prepare cable schedule if required to simplify sheet plan notation
 - (2) Provide termination information for each device on the plans or in a schedule that identifies the physical connections to the equipment panels. Include the panel address, and the termination point ID that is consistent and reflective of the programming fields.
 - (3) Point-to-Point Diagrams: Include all wiring, points of connection and interconnecting devices.
 - b. Include all miscellaneous control relays.
 - c. Include all devices connected to the system.
 - d. Identify all conductors on the point-to-point diagrams with the same tag as the installed conductor.
 4. Block Diagram/Riser Diagram: Show the system components and all conduit and wire types and sizes between them including all cabling interface between termination hardware.
 5. Installation Details: Include installation details for all devices.
 6. Seismic Calculations: As part of the shop drawings submittal where applicable, the manufacturer shall provide anchorage calculations for floor mounted fully loaded distribution frames such that it shall remain attached to the mounting surface after experiencing forces per Section 26 05 48 - Seismic Controls for Electrical and Communication Work
 7. Calculations:
 - a. Battery calculations for all batteries.
 - b. Voltage-drop calculations for all lock circuits and fire alarm Notification Appliance Circuits.
- D. Labeling Sample
1. Quantity & Media: Furnish quantity indicated in Division 1.
 2. Submit two sets of physical product samples for review and comment by the Port prior to the installation of equipment:
 3. Content:
 - a. Provide panel label
 - b. Provide cable label on a cut length of cable.
- E. Record Drawings: Submit record drawings per Division 1 Requirements.
1. Drawings become the Port's property. The Port shall maintain all ownership rights.

a. Content:

- (1) All system components (devices, cable routes, etc.) and text shall be plotted at a sufficient line weight to stand out against background information.
- (2) Fully represent actual installed conditions and incorporate all revisions made during the course of construction.
- (3) Include drawings submitted as part of the Shop Drawing package, plus any additional information required to accurately document installed conditions.
- (4) Device addresses & IP address information.
- (5) Floor plans shall show:
 - (a) Locations and identifiers of all devices.
- (6) Size, quantity, location, and routes of all pathways (such as cable trays, conduits, J- hangers, and other cable support devices).
- (7) Equipment room floor plans scaled at 1/2"=1'-0" showing exact placement of all equipment cabinets/frames, rack bays, and other equipment.
- (8) Wall elevations scaled at 1"=1'-0" showing exact placement of all security system hardware.
- (9) Installation details.

F. Operation and Maintenance Manuals per Division 1

1.04 DRAWINGS

- A. The basic electronic safety and security drawings are diagrammatic and are not intended to show all raceway, wiring, exact locations of equipment, terminations, or number or types of fittings required by the electronic safety and security system. Provide all related basic electronic safety and security Work which is specified herein, diagrammed or scheduled on the contract drawings, required by code enforcing agencies and as indicated on other details or elevations for complete and operating electronic safety and security systems. Since the drawings of floor, wall, and ceiling installation are made at a small scale, outlets, devices, equipment, etc. are indicated only in their approximate location unless dimensioned or otherwise indicated. Locate outlets and apparatus symmetrically on floors, walls and ceilings where not dimensioned and coordinate such locations with the Work of other trades to prevent interferences. Verify all dimensions on the job. Do not scale the electronic safety and security drawings. Refer to Architectural and Mechanical shop drawings and project drawings for dimensions as applicable.

1.05 QUALITY ASSURANCE

- A. All materials shall be new, unless noted otherwise. Properly store all materials and equipment for protection from physical damage or damage due to corrosion.
- B. Review accessibility of equipment for operation, maintenance and repair prior to installation. Proceed with installation only after unsatisfactory conditions have been corrected
- C. Equipment Manufacturer Qualifications: Equipment manufacturers shall have at

least 10 years experience in manufacturing products and accessories similar to those for this Project, with a record of successful in-service performance.

- D. All equipment supplied shall be listed by a nationally recognized test laboratory where applicable.
- E. All items of a given type shall be the products of the same manufacturer.
- F. All items shall be of the latest technology; no discontinued models or products are acceptable.
- G. The manufacturer, or their Authorized Representative, shall confirm that within 300 miles of the project site there is an established agency which:
 - 1. Stocks a full complement of parts
 - 2. Offers service during normal working hours as well as emergency service on all equipment to be furnished
 - 3. Will supply parts and service without delay and at reasonable cost.
- H. Contractor shall be capable of performing service or maintenance work on these specified or accepted systems. Contractor shall be factory-certified where such certification is available.

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery

- 1. Do not deliver products to the site until protected storage space is available. Coordinate delivery of materials with scheduled installation date to allow minimum storage time at jobsite.
- 2. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels (name of the manufacturer, product name, type, grade, UL classification, etc.) intact.
- 3. Replace materials damaged during shipping at no cost to the Port of Seattle.

B. Storage

- 1. Store materials in clean, dry, ventilated space free from temperature and humidity conditions (as recommended by manufacturer) and protected from exposure to harmful weather conditions.
- 2. Comply with manufacturer's requirements for each product. Comply with recommended procedures, precautions or remedies as described in the Safety Data Sheets (SDS) as applicable.
- 3. Maintain factory wrapping or provide a heavy canvas/plastic cover to protect units from dirt, water, construction debris, and traffic.
- 4. Storage outdoors covered by rainproof material is not acceptable.
- 5. Provide heat where required to prevent condensation or temperature related damage.

C. Handling

- 1. Handle in accordance with manufacturer's written instructions.

2. Damaged equipment shall not be installed.

1.07 SUBSTITUTIONS

A. Comply with Section 01 25 00 - Substitutions.

1.08 WARRANTY

A. Warranty: Comply with Section 01 78 36 - Warranties and Bonds. Warranty shall be manufacturer's standard or a minimum of one year unless noted otherwise in Division 28 Electronic Safety and Security Sections.

PART 2 PRODUCTS

2.01 NETWORK SWITCHES

A. The POS has standardized on Cisco Hardware and no exceptions to that hardware will be accepted.

PART 3 EXECUTION

3.01 REQUIREMENTS

- A. Systems shall be complete and operational in all respects.
- B. Contractor shall furnish and install all conduit, conductors, etc. for all building Systems. All wiring shall be in conduit unless shown otherwise on the drawings.
- C. Wiring and conduit shown on drawings represents a minimum requirement. Contractor shall furnish and install all wiring and conduit recommended by submitted system manufacturers' for optimum system performance at no additional cost to the Port of Seattle.
- D. Connect power to Systems as required.
- E. All equipment, junction boxes, terminal cans, etc., in accessible locations shall be installed utilizing tamper proof mounting hardware. Provide a minimum of 2 driver bits or hand tools for each type of security fastener provided.
- F. Provide seismic restraint for all equipment, including equipment racks, consoles, etc. Refer to Section 26 05 48 – Seismic Controls for Electrical and Communication Work, for seismic restraint requirements.
- G. Refer to individual Security System sub-sections for additional installation requirements.
- H. Provide cable per Section 27 15 00 – Communications Horizontal Cabling.
- I. The Contractor shall provide and install metal conduit as a pathway for the fiber optic cable and the door security cabling as shown on the Drawings. Cabling for door security from the terminal strip at the Interface Termination Box (ITB) Comm./EQ. room will be provided and installed by contractor.
- J. Contractor shall provide and install security hardware, conduit, and wiring at the communications room doors as shown in the Drawings. The security hardware will be connected to an Interface Termination Box (ITB) above each door.

3.02 TRAINING

- A. As a part of this contract, provide training as described herein and detailed under each System sub-section.
- B. Training shall be by engineers or technicians highly skilled in the systems and certified by manufacturer as qualified to train in the particular systems.

- C. Training shall be conducted at dates and times directed by the Port's representative. Initial training shall be provided for the System Administrator and consultant. Upon their approval, a second training session shall be provided for System Operators. An additional training session for Operators shall be provided within the first year after system acceptance. Provide specific training sessions for the Port's maintenance personnel. After-hours training shall be provided at no additional cost if requested by the Port.
- D. Verification of completion of training is required by the Port prior to release of retention compensation.

3.03 COMMISSIONING, ACCEPTANCE TESTING AND REPORTS

- A. All commissioning, acceptance testing shall be coordinated with PORT AVM ET shop.
- B. There are two distinct types of tests for which the Contractor is responsible:
 - 1. The first type is the Pre-functional Performance Test. These tests ensure that all equipment, wiring, and systems are installed in accordance with the Specifications, Drawings, and Manufacturers' requirements.
 - 2. The second type of test is the Functional Performance Test. These tests ensure that all equipment and systems operate in accordance with design intent. These are dynamic tests, and test the systems through all possible modes of operation.
- C. Provide written testing plan describing proposed duration and schedule for performing pre- functional performance test and functional performance test in spreadsheet format listing each and every device, cable/wire, and software point to be tested. Submit within Sixty (60) days of Notice to Proceed for project the testing plans for approval prior to commissioning and acceptance testing.
- D. Perform systems tests using personnel who have attended a manufacturer's training school for installation and testing of the systems as described above. Perform testing with the test instruments as required by the manufacturer; testing by means other than the manufacturer's procedures will not be acceptable unless agreed to by the Port and manufacturer.
- E. Upon completion of the installation of the Security Systems, the contractor shall perform 100% testing and submit pre-functional reports including, but not limited to, the following information in spreadsheet format:
 - 1. A complete list of all equipment installed, including serial numbers of major components and warranties.
 - 2. Certification that all equipment is properly installed and functional, and conforms with contract Specifications and drawings.
 - 3. Test reports of all inputs and outputs, devices, and equipment.
 - 4. Test technician's name, company, and dates of test.
- F. Following review of the test report by the Port's Representative, the contractor shall perform a functional test of all Security System equipment in the presence of the Port and the Port's Representative. Test shall include performance tests of each device, switch, control unit, power supply, battery standby unit, monitor panel, controller, printer, and all other equipment and material required by the contract.

- G. At a minimum, perform tests to demonstrate that:
 - 1. All systems are free from grounding and open circuits.
 - 2. Each alarm-initiating device consistently functions as specified and produces the specified alarm actions.
 - 3. An abnormal condition of any circuit or device required to be electrically supervised will result in activating the specified trouble or tamper alarm signal.
 - 4. Systems operate properly during and while on emergency generator power.
 - 5. Alarm signals are audible at the monitor.
 - 6. The system is operable under specified trouble conditions.
 - 7. System as-built drawings correspond with actual installation.
- H. If retesting is required due to contractor equipment failure, incorrect programming, omission, error, etc., the contractor shall compensate the Port's Representative and the Port for all Port costs associated with retesting.
 - 1. Sixty (60) days prior to expiration of warranty, Contractor shall retest all systems as described above, and submit a test report of findings. All items covered by warranty shall be corrected immediately. Warranty remains in effect until the Contractor corrects 100% of defective items.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontractor (of any tier) or Supplier.
- B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY OF WORK

TASK	THIS CONTRACT	POSFD
Input/Output (I/O) Devices	Install all devices;	No Installation;
	Purchase only for	Purchase only for
	Tenant-Leased Spaces	Port-Owned Spaces
Termination of I/O Wiring		Responsible for
At FACP and DGPs only:		
Termination at I/O Devices	Responsible for	
Fire Alarm Control Panel	Install cans/backboxes	Purchase
Data Gathering Panels for	Install cans/backboxes	Purchase
Gathering I/O Wires:		
Raceway to I/O Devices	Purchase and Install	
Raceway between Data	Purchase and Install	
Gathering Panels & FACP:		
Device Address Settings		Responsible for
Programming		Responsible for
Testing and Commissioning		Responsible for

A. The extent and location of “Fire Alarm” work is shown in the Contract Documents. This Section includes requirements for fire alarm system I/O devices including manual stations, detectors, signal equipment, controls, and devices.

1. [Contractor] [Port] shall provide all components, ancillary equipment, wire pulled to the FACP but not terminated, and conduit terminated to the FACP.
2. The Fire Alarm Control Panel, Data Gathering Panels and associated equipment shall be purchased by the Port and furnished to the Installing Contractor by either the POSFD or SimplexGrinnell Fire Protection Systems Company. Internal panel operating components shall be installed by the POSFD.
3. Greg Carbaugh of the Port of Seattle AV/FIRE Department (Telephone: 206/431-4454) will provide all terminations, programming and assignment of device addresses for the FACP and Data Gathering Panels.

B. DEFINITIONS

1. FACP: Fire Alarm Control Panel.

1.02 GOVERNING CODES, STANDARDS AND REFERENCES

- A. FAA regulations,
- B. NEC,
- C. NFPA 70 - “National Electrical Code”,

- D. NFPA 70, Article 100,
- E. NFPA 72 “National Fire Alarm Code”,
- F. NFPA 72, Chapter 7,
- G. *NFPA 101 - “Life Safety Code”*,
- H. Nationally Recognized Testing Laboratory listing data,
- I. Port of Seattle Fire Department (POSGD) Requirements,
- J. Underwriters Laboratories, Inc.,
- K. UL category UOJZ,
- L. UL label,
- M. UL listed,
- N. UL modular label,
- O. UL, modular labeling requirements,
- P. *UL 38 - “Manually Activated Signaling Boxes”*,
- Q. UL 268 - “Duct Smoke Detectors”,
- R. UL 268A listed,
- S. *UL 346 - “Water Flow Indicators”*,
- T. *UL 464 - “Audible Signaling Appliances”*,
- U. *UL 521 - “Heat Detectors”*,
- V. *UL 1638 - “Visual Signaling Appliances”*,
- W. UL 1971 - “Signaling Devices for the Hearing-Impaired”,
- X. Applicable Local and State Building Codes.

1.03 SUBMITTALS

- A. Submit materials data in accordance with of Section 01 33 00 - Submittals. Furnish manufacturers’ technical literature, standard details, product specifications, and installation instructions for all products.
- B. Submittals shall include the following:
 - 1. Product Data: Submit data for each type of system component specified, including dimensioned plans and elevations showing minimum clearances and installed features and devices. Include list of materials and Nationally Recognized Testing Laboratory listing data.
 - 2. Simple riser diagram showing system configuration and conduit routing.
 - 3. Wiring diagrams differentiating clearly between factory- and field-installed wiring.
 - a. Include diagrams for equipment and for system with all terminals and interconnections identified.
 - b. Make all diagrams specific to this Project and distinguish between field and factory wiring.

4. Device Address List: POSFD will provide all system addressing and programming.
5. Operating instructions for posting at the FACP.
6. Product certificates signed by manufacturers of fire alarm system components certifying that their products comply with specified requirements.
7. Maintenance data for fire alarm systems to include in the operation and maintenance manual specified in Division 1 General Requirements.
8. Include data for each type of product, including all features and operating sequences, both automatic and manual. Include recommendations for spare parts to be stocked at the site.
9. Provide the names, addresses, and telephone numbers of service organizations that carry stock of repair parts for the system to be furnished.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced factory-authorized Installer to perform Work of this Section.
- B. Single-Source Responsibility: Obtain fire alarm components from a single source that assumes responsibility for compatibility of system components.
- C. Comply with NFPA 70, as adopted and administered by the Authority Having Jurisdiction.
- D. Comply with NFPA 72, as adopted and administered by the Authority Having Jurisdiction.
- E. Compliance with Local Requirements: Comply with applicable building codes, local ordinances and regulations, as adopted and administered by the Authorities Having Jurisdiction.
- F. Compliance with Port of Seattle Fire Department (POSFD) Requirements.
- G. Listing and Labeling: Provide products that are Listed and Labeled as defined in NFPA 70, Article 100 and marked for intended use for the location and environment in which they are installed.
 1. All equipment shall be listed under the appropriate category by Underwriters Laboratories, Inc. and shall bare the UL label. All control equipment shall be listed under UL category UOJZ as a single control unit.
 2. The Fire Alarm Control Panel and components shall meet the modular labeling requirements of UL. Each subassembly including all printed circuit boards shall include the appropriate UL modular label. Systems that do not include modular labels may require return to the factory for system upgrades and/or additions and are not acceptable.

1.05 SYSTEM DESCRIPTION

- A. General Description
 1. The Fire Alarm Control Panel (FACP) shall function as a complete, non-coded, analog addressable, microprocessor-based fire alarm and detection

system with manual and automatic alarm initiation. The system shall analyze signals from fire sensors, provide audible and visual information to the POSFD, initiate automatic alarm response sequences and provide the means by which the user interacts with the system.

2. The FACP shall be modular and deadfront in construction to allow for future extension of the system and prevent unauthorized exposure to the FACP control circuits and wiring.
3. The FACP shall be easily configurable so as to meet the exact detection zone and output mapping requirements of the project.
4. The FACP shall allow for loading and editing special instructions and operating sequences as required.
 - a. The system software may be edited and loaded on site to allow for system expansion and expedite changes to the system operation.
 - b. Operating programs and configuration data must be stored in easy-to-update non-volatile programmable memory within the FACP.
 - c. Loss of primary or secondary power shall not cause the software to be erased.
5. The FACP shall incorporate a real-time clock to enable events to be referenced against time and date. This clock shall be accurate to within 1 minute per year.
6. It shall be possible for an Engineer to perform configuration updates on site by plugging a portable personal computer into the FACP.
7. The FACP shall comprise separate processors, cross-monitoring each other's correct operation, for the major functions of the systems. In particular, different processors must be used for the main control functions, the detection input and alarm output functions, and the display and control function.
8. To ensure continuous stability of the system, the entire address code shall be set in the base of all analog addressable detectors.
9. A communications gateway interface device shall be provided for secondary data output to a Facilities Distributed Control System.

B. Functional Description

1. The fire alarm and detection system shall detect all changes in status of monitored points and shall initiate appropriate actions to alert and/or evacuate occupants, provide annunciation and activate auxiliary controls.
2. The system shall accept, process, evaluate, and respond to the following types of signals:
 - a. General alarm.
 - b. Automatic fire detectors (i.e., Smoke or heat detector alarms).
 - c. Manual alarm stations

3. Loss of primary power at the FACP shall sound a trouble signal and provide visual indication at the FACP and remote annunciation equipment that the system is operating on secondary power.
4. All zone alarm signals and zone trouble signals shall be annunciated on the FACP alphanumeric display and on separate discrete visual indicators for each zone in the system.
5. Analog addressable detectors shall have their sensitivity continuously monitored. The control equipment shall evaluate the instantaneous and long-term averages of the environmental conditions present at the detector location and shall compensate for those conditions by shifting the alarm threshold within UL 268 limitations.
6. The FACP shall indicate a trouble condition when an analog addressable detector's alarm threshold can no longer compensate for environmental conditions.
7. The system shall meet the periodic testing and maintenance requirements of NFPA 72, Chapter 7 without the need to manually remove and test each smoke detector in the installed system.
8. It shall be possible to automatically shift the sensitivity of analog addressable detectors based upon specific times, days, and/or special dates.
9. The system shall have the ability to annunciate a pre-alarm condition designed to give the earliest possible warning of a potential fire condition without raising the full alarm condition.
10. The FACP shall communicate with devices over one or more analog addressable Signaling Line Circuits. The circuits shall respond to the following conditions:
 - a. Signaling Line Circuit open and short circuit
 - b. Excessive electrical noise on the signaling line circuit
 - c. Ability to locate short and open circuit
 - d. Detector or device missing
 - e. Improper device type at a specific address
 - f. Un-configured device reporting at a specific address
 - g. Multiple devices reporting on the same address
11. A single address point polling function that shall cause repeated polling of a selected device for system troubleshooting. Single device polling of analog addressable smoke detectors shall command the detector's LED to illuminate steady, allowing for ease of locating the detector or detectors when two detectors are mistakenly programmed with the same address.
12. All Addressable Signaling Line Circuits shall operate over cable distances of up to 6500 feet.
13. The FACP shall interrogate each device on the Signaling Line Circuit at least once every 2 seconds.

14. The FACP shall have a special scanning sequence so that designated manual stations provide alarm indication and warning within 1 second of operation.
15. The FACP shall maintain the function to electrically disconnect a Signaling Line Circuit from the control panel via the front display and control without having to open the FACP enclosure.
16. The FACP shall incorporate system management facilities that can be initiated by operator command.
17. The FACP shall provide summary printouts initiated by operator command that include as a minimum the following information:
 - a. Analog values of all points including instantaneous value and long term average value.
 - b. Points isolated.
 - c. Points tested; failed test.
 - d. Points in detector condition monitoring fault.
 - e. History event log contents.
18. The FACP shall contain an event log capable of storing up to the last 600 events. It shall be possible to view that log on the alphanumeric display.
 - a. Priority of Signals: Automatic response functions shall be accomplished by the first zone initiated. Alarm functions resulting from initiation by the first zone shall not be altered by subsequent alarms. The highest priority shall be an alarm signal. Supervisory and trouble signals shall have second- and third-level priority. Higher-priority signals shall take precedence over signals of lower priority, even though the lower-priority condition occurred first. Annunciate all alarm signals regardless of priority or order received.
 - b. Non-interfering: Zone, power, wire, and supervise the system so that a signal on one zone does not prevent the receipt of signals from any other zone. All zones shall be manually re-settable from the FACP after the initiating device or devices are restored to normal. Systems that require batteries or battery back up for the programming function are not acceptable.
19. The system shall have a Solo Test function that shall allow a single service technician to perform scheduled tests of initiating devices such as smoke detectors and pull stations.
 - a. The system shall allow the technician to select individual devices, a zone of devices or all initiating devices for Solo Test.
 - b. When Solo Test is active, if an input is received from an initiating device that is not in selected Solo Test zone or group, then the system shall interpret the event as real and shall perform the programmed annunciation and output response.
 - c. The system shall allow the technician to select Solo Test of selected notification appliance circuits.

- C. System Alarm Operation
- D. Activation of any initiating device shall initiate the following system alarm responses:
 - 1. Activation of all audible notification appliance circuits with an evacuation signal.
 - 2. Activation of all visual strobe notification appliance circuits. Upon operation of the alarm silence switch the audible signals shall silence but the visual signals shall continue to operate.
 - 3. The alarm condition shall be visually and audibly indicated at the FACP as follows:
 - a. The common dual red Fire Alarm visual indicators shall illuminate.
 - b. A specific red zone fire alarm indicator shall flash until the system is silenced. After the system is silenced the indicator shall change from flashing to steady and remain illuminated until the system is reset.
 - c. Continuously sound an audible buzzer at the FACP that shall sound until the system panel silence switch is pressed. After silenced, the alarm buzzer shall change from a steady tone to a pulsed tone and remain active until the system is reset.
 - d. Display specific information about the alarm on the alphanumeric LCD display as follows:
 - (1) Event type
 - (2) Zone message
 - (3) Addressable point message
 - (4) Circuit identifier
 - (5) Point number
 - (6) Zone number
 - (7) Number of outstanding events in the system
 - 4. All information displayed at the main FACP shall display at the remote operator control panels located throughout the site. All control functions available at the FACP shall be accessible at the remote operator control panel locations.
 - 5. The system shall print a plain-English-language message at all system printers detailed on the plans. Each message shall include the time and date of each event.
 - 6. All fire doors identified on the plans shall be closed automatically. Fire door status shall be continuously monitored and a distinct indication shall be annunciated in the event that a door fails to close when commanded by the system.
 - 7. Activate the release of all electromagnetic door holders identified on the plans.

8. Communicate the alarm to the POSFD proprietary fire alarm system.
 9. Upon the activation of any smoke detector, the system shall initiate the alarm response as described previously with the additional following actions:
 - a. The system shall direct the HVAC system fans, dampers, and other equipment as indicated on the plans.
 - b. If smoke detector is designated as an elevator recall smoke detector, the system shall recall the building elevators indicated on the plans. If the alarm is reported on the primary recall floor a selected alternate floor detailed on the plans will be the elevator destination.
 10. In areas, which contain the automatic release of sprinklers/agent suppression, the FACP shall require the receipt of alarm signals from two different smoke detectors.
- E. Supervisory Operation
- F. Designated supervisory devices as detailed on the plans shall activate a supervisory signal. Supervisory signals shall be visually and audibly indicated on the FACP as follows:
1. Illuminate a yellow system supervisory LED visual indicator.
 2. Pulse an audible buzzer at the FACP that sounds until the panel silence pushbutton is pressed.
 3. Display specific information as described earlier under Alarm Operation at the FACP and all remote OCP locations.
 4. Print specific information as described earlier under Alarm Operation.
 5. Communicate the supervisory signal to POSFD proprietary fire alarm system.
- G. Performance Requirements
1. Initiating Device Circuits shall be wired Class B (Style B)
 2. Notification Appliance Circuits shall be wired Class B (Style Y)
 3. Releasing circuits shall be arranged to supervise the integrity of the solenoid coil.

1.06 SEQUENCING AND SCHEDULING

- A. Existing Fire Alarm Equipment: Maintain fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until new equipment is accepted. Remove tags from new equipment when put into service and tag existing fire alarm equipment "NOT IN SERVICE" until removed from the building.
- B. Equipment Removal: After acceptance of the new fire alarm system, remove existing disconnected fire alarm equipment and restore damaged surfaces. Package operational fire alarm and detection equipment that has been removed and deliver to the Port. Remove from the site and legally dispose of the remainder of existing material.

1.07 WARRANTY

- A. Comply with Section 01 78 36 - Warranties and Bonds. Warranty shall be manufacturer's standard or a minimum of one year unless noted otherwise in Division 26 Electrical Sections.

1.08 COMMISSIONING

- A. Commissioning of the system shall constitute substantial completions.

1.09 EXTRA MATERIALS

- A. Spare and extra parts shall be identified for all products, but not provided. Include spare parts information in Operation and Maintenance Manuals.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturers: Obtain fire alarm system components through a single manufacturer with exception of those components/devices noted in the Compatibility List at the end of Section 2.03.
 - 1. SimplexGrinnell; Division of Tyco International.
 - 2. NO SUBSTITUTIONS ARE PERMITTED.

2.02 Analog Addressable Fire Detectors

- A. General
 - 1. Automatic fire detectors shall consist of a removable head and a fixed base. Each detector base shall provide means to select the reporting address for the detector head.
 - 2. It shall be possible to view the address of the detector from the floor.
 - 3. All automatic detectors shall maintain discrete LED visual indicators.

2.03 EQUIPMENT - PORT FURNISHED

- A. Fire Alarm Control Panel (FACP)
 - 1. Shall be furnished by either the Sea-Tac Airport Fire Department or SimplexGrinnell Fire Protection Systems, and installed by Sea-Tac Airport Fire Department
 - 2. Greg Carbaugh (Fire Alarm Inspector, Fire Department, (206) 787-4454) of the Fire Department provides all terminations and programming for the FACP.
- B. Fire Alarm Control Panel (FACP) and Data Gathering Panels.
 - 1. The FACP and field-mounted data gathering panels shall monitor the status of all connected devices for fire, wiring faults, incorrect addressing, unauthorized device removal or exchange, pre-alarm conditions and contaminated detector conditions.
 - 2. The FACP shall be enclosed in a locked metal enclosure utilizing standard 5-1/4" x 19" rack mounting. Where more than one unit is required the installer shall provide ample gutter spacing to accommodate for interconnection.

3. A key shall be used to open the outer transparent front door and operate the control enable/disable key switch. A separate service key shall be required to open the enclosure to gain access to system components.
4. The FACP shall monitor the status of all internal connection and interfaces, including charger, battery and remote signaling functions.
5. The FACP shall provide a set of pushbutton controls to enable an authorized operator to perform the following:
 - a. Panel Silence
 - b. Alarm Silence
 - c. Reset
 - d. Fire Drill
6. Each pushbutton switch shall provide a tactile feedback to confirm activation. A visual indicator shall be located adjacent to the Alarm Silence pushbutton to confirm that the notification appliances have been silenced.
7. An enable/disable key switch shall be located on the FACP control panel to limit operation to authorized personnel only.
8. The FACP shall provide the following common discrete visual indications:
 - a. Power On (green LED)
 - b. Fire Alarm (dual red LED)
 - c. Trouble (yellow LED)
 - d. Supervisory (yellow LED)
 - e. Disabled/Isolated (yellow LED)
 - f. User Programmable (yellow LED)
9. LED annunciator modules shall be utilized to provide [zonal] [point] alarm and trouble annunciation. The annunciator modules shall be of modular construction utilizing standard rack mounting.
10. The FACP shall have an integral 80-character LCD alphanumeric display. The LCD display shall be arranged as follows:
 - a. Row 1: Event type
 - b. Row 2: Zone message
 - c. Row 3: Addressable point message
 - d. Row 4: Circuit identifier/Point number/Zone number and Number of events in the system
11. Status control modules shall be utilized to provide manual control and monitoring of output functions.
 - a. The status control modules shall be of modular construction utilizing standard rack mounting.
 - b. Membrane style switches with tactile feedback shall be located with adjacent LED indicators.

- c. LED indicator colors shall be field configurable to accommodate different types of control monitoring.
 - d. Clearly legible identification labels shall be located adjacent to each status control switch and indicator.
 - 12. The FACP shall have a labeled Lamp Test facility to manually test all the discrete LED indicators.
 - 13. Remote operator and display units shall be located as shown on the plans.
 - a. To accommodate system expansion the FACP shall support up to 7 remote operator and display units connected to the FACP over a fully supervised twisted shielded conductor pair.
 - b. All information and control functions available at the FACP shall be available from each remote operator and display unit.
 - c. All control functions shall be password protected to prevent unauthorized access.
 - 14. Auxiliary relays located within the FACP shall be used to interface with HVAC equipment, elevators, fire doors, dampers and auxiliary equipment.
 - a. Relay contacts shall be arranged to provide either normally open or normally closed operation.
 - b. Relay contacts shall be rated at no less than 5 Amp at 30Vdc or 277Vac.
 - c. Each relay shall have an associated LED indicator to show the contact status.
 - d. Each module of relays shall include an LED indicator to show operating power is present.
 - 15. The FACP power supply shall receive 120Vac power from a dedicated fused branch circuit backed by emergency power.
 - 16. There shall be sufficient battery capacity to operate the entire system for 24 hours during normal standby conditions and 5 minutes during alarm at the end of the standby period. The power supply battery charger shall be rated for fully charging completely discharged batteries within 48 hours.
- C. Accessories:
- 1. Printers shall be UL listed as compatible with the system and furnished where shown on the plans. The printer shall provide hard copy printout of all events of the system and shall time stamp such printouts with the current time-of-day and date.
 - 2. Strip printers shall be UL listed as compatible with the system and furnished where shown on the plans.
 - a. The strip printer shall be capable of being mounted directly on the system enclosure.
 - b. Alarms shall be printed in easy to read RED, all other messages shall print in black.

- c. The printer shall derive operating power from the FACP and shall be provided with battery backup requirements.
 - 3. Video Display Units shall be UL listed as compatible with the system and furnished where shown on the plans. The VDU shall provide display of all events of the system and shall time-stamp such displays with current time-of-day and date.
 - 4. Graphic Annunciators shall be UL listed and furnished where located on the plans.
 - a. Floor drawings as shown on the plan drawings shall be displayed with separate discrete LED visual indicators for detectors and devices indicated.
 - b. The graphic annunciator shall communicate with the FACP via a fully supervised twisted shielded communications conductor pair.
- 2.04 COMPONENTS - CONTRACTOR INSTALLED (FURNISHED FOR TENANT-LEASED SPACES ONLY)
 - A. General:
 - 1. Refer to sub-paragraph F below for the Equipment List for all devices that are approved for the fire alarm system.
 - 2. The use of conventional verses analog devices will be at the discretion of the POSFD.
 - 3. SimplexGrinnell legacy systems (TFX, CDXA, AL-1500) currently installed at the airport are compatible to the fire alarm system shown on the Equipment List. This backward compatibility insures that the current standard system can directly interface to the legacy systems by cabling or SimplexGrinnell interface to components in the legacy system. Hardware interface (i.e. relay to input module) or 3rd party interface hardware of unlike systems shall not be accepted as meeting the interface or backward compatibility requirement.
 - 4. While the panel equipment is compatible, the field devices specific to each system are not and may not be available from the manufacturer. To adhere to our schedule to upgrade and convert from SimplexGrinnell legacy systems, and to insure the contractor has the proper equipment that will function on legacy SimplexGrinnell systems, devices shall be substituted by the Port of Seattle Fire Department. Substituted equipment shall be supplied from POSFD stock, and will be exchanged when necessary and appropriate with contractor supplied items. All exchanged items will be one for one like items (i.e. a 4099 model manual station for the 4100ES will be exchanged for a TFX IXA-RMS model manual station when the system specified for the project is a SimplexGrinnell legacy TFX system.
 - B. Analog Addressable Fire Detectors:
 - 1. General: Automatic fire detectors shall consist of a removable head and a fixed base.
 - a. Each detector base shall provide means to select the reporting address for the detector head.

- b. Detectors that maintain the reporting address in the removable head are not acceptable, as they are prone to unauthorized and potentially dangerous reconfiguration of the system.
 - c. It shall be possible to view the address of the detector from the floor. Detectors that require removal of the head or the need to climb a ladder to verify the reporting address are not acceptable.
 - d. All automatic detectors shall maintain discrete LED visual indicators.
 - (1) The LED shall flash each time the detector is polled by the FACP and shall illuminate steady during the alarm condition.
 - (2) Detectors that do not illuminate steadily during the alarm condition are not acceptable.
2. Ionization Smoke Detectors:
- a. Detectors shall be capable of detecting visible and invisible combustion gasses emanating from fires.
 - b. Design of detectors shall be dual chamber type to offset the effects of temperature and barometric pressure.
 - c. A single radioactive source material of less than 1.0 microcurie shall be used as the ionizing source for the air in the detector.
 - d. Detector shall be fitted with a screen to minimize the effects of small insects.
 - e. Detectors shall utilize tamper-proof hardware to prevent unauthorized removal of the detector from the base.
 - f. Detector sensitivity adjustment shall be possible from the FACP.
3. Photoelectric Smoke Detectors:
- a. Detectors shall be capable of detecting visible particles of combustion emanating from fires.
 - b. Design of detectors shall be light scattering type with an asymmetrical sampling chamber designed to allow smoke to enter while reducing the possibility of nuisance alarms due to dust contamination.
 - c. High performance photoelectric smoke detectors may be used for specific applications. [Delete the subparagraph below unless this requirement exists.]
 - d. Two heat sensors, one placed within the sampling chamber and one directly exposed to the protected environment, shall be used to automatically adjust the sensitivity of the photoelectric element. Rapid increases in ambient temperature normally associated with flaming fires shall cause the automatic increase in sensitivity of the detector allowing it to respond efficiently to both smoldering and fast flaming fires.
 - e. Detector shall be fitted with a screen to minimize the effect of small insects.

- f. Detectors shall utilize tamper-proof hardware to prevent unauthorized removal of the detector from the base.
 - g. Detector sensitivity adjustment shall be possible from the FACP.
 - 4. Heat Detectors:
 - a. Detector shall be capable of detecting heat radiation thresholds of 135°F and 200°F (as well as Rate-of-Rise) operation.
 - b. A negative coefficient thermistor shall be used to sample the ambient environment conditions surrounding the detector.
 - c. Detectors shall utilize tamper-proof hardware to prevent unauthorized removal of the detector from the base.
- C. Detector Bases:
 - 1. Twist-lock designs, fully interchangeable with ionization, photoelectric and heat detectors.
 - 2. Each detector base shall have screw terminals for wire terminations.
- D. Audible Alarm Annunciation:
 - 1. Bases shall contain a prewired piezo electric device that will produce an 85 dbA minimum audible signal at a distance of 10 feet.
 - 2. Units shall be configured to activate automatically and latch when the detector head has reported an alarm condition.
 - 3. It shall be possible to activate an entire zone of audible bases by command from the FACP by reversing the operating voltage polarity to the devices.
- E. Duct-Type Smoke Detectors:
 - 1. Detectors shall be analog addressable type.
 - 2. Detector housing shall be listed per UL 268A for specific use in air handling systems.
 - 3. Photoelectric units shall operate at 300 to 4000 feet/minute. Ionization units shall operate at 1000 to 4000 feet/minute.
 - 4. It shall be possible to view the address of the detector without having to disassemble the duct housing.
 - 5. Two sets of Form-C relay contacts shall be provided within the duct housing.
- F. Fire Alarm Equipment List

DEVICE	NOTE	MANUFACTURER	MODEL
Fire Alarm Panel			
Fire Alarm Panel		Simplex/Grinnell	4100ES
Initiating Devices			
Smoke Detector	Addressable	Simplex/Grinnell	4098 Series

Heat Detector	Addressable	Simplex/Grinnell	4098 Series
Duct Detector	Addressable	Simplex/Grinnell	4098 Series
Duct Detector	Conventional	Simplex/Grinnell	4098 Series
Manual Pull Station	Addressable	Simplex/Grinnell	4099 Series
Manual Pull Station	Conventional	Simplex/Grinnell	2099 Series
Output Devices			
Relay	Addressable	Simplex/Grinnell	4090-0002
Notification Devices			
NAC Panels	System	Simplex/Grinnell	4009-0002
Speaker/Audible/Visual Devices		Simplex/Grinnell	TrueAlert ES Appliances

2.05 ANCILLARY EQUIPMENT - CONTRACTOR FURNISHED AND INSTALLED

A. Manual Pull-Stations:

1. [Single-action] [Double-action] type fabricated of cast metal and finished red with raised-letter operation instructions of a contrasting color.
2. Pull-station shall be fitted with screw terminal for field wire attachment.
3. Operation of the pull-station shall break a glass rod and mechanically latch alarm contacts until the pull-station is manually reset.
4. The reset key shall be a special tool to prevent unwanted tampering.
5. Each station shall contain a unique addressable transmitter for communications.

B. Monitor Modules:

1. Modules shall communicate with the FACP via the addressable Signaling Line Circuit providing identity, location and status information.
2. Modules shall interface with the contact device via a supervised Class [A] [B] Style [D] [B] sub-circuit.
3. Each circuit shall be supervised for grounds and open circuits.
4. Modules shall be designed for surface mount installation using standard electrical mounting hardware.
5. Addressable modules shall include terminal block terminations for field wiring connections and discrete LED visual detectors that display active status and alarm condition.

C. Mini-Monitor Modules:

1. Modules shall communicate with the FACP via the addressable Signaling Line Circuit providing identity, location and status information.
2. Module shall interface with the contact device via a supervised Class B Style B sub-circuit.

3. Each circuit shall be supervised for grounds and open circuits.
 4. Field wire terminations shall be accomplished via wire leads and electrical wire nuts.
 5. Units shall be designed to install inside the same standard electrical box as the contact device it is monitoring.
- D. Conventional Detector Monitor Modules:
1. Detector monitor modules shall communicate with the FACP via addressable Signaling Line Circuit providing identity, location and status information.
 2. The monitor module shall interface to the conventional detectors via a supervised Class B Style B sub-circuit.
 3. Each circuit shall be supervised for grounds and open circuits.
 4. Loss of 24V dc operating power shall be detected and reported by the detector monitor module.
 5. Addressable modules shall include terminations for field wiring connections and discrete LED visual indicators that display active status, alarm (Red LED) and trouble (Yellow LED) conditions.
- E. Addressable Relay Modules:
1. Relay modules shall communicate with the FACP via the addressable Signaling Line Circuit providing relay contact identity, location and status information.
 2. Contacts shall be rated minimum 2.0 Amps at 24V dc and 0.6 Amps at 120V ac.
 3. Addressable modules shall include terminal block terminations for field wiring connections and discrete LED visual indicators that display status condition.
- F. Addressable Loop Line Isolator Modules:
1. Line isolators shall provide protection on the addressable loop by automatically disconnecting the section of wiring between two zones where a short circuit has occurred.
 2. Isolator modules shall be located so that no more than 7 analog addressable devices might be disabled with a single short-circuit fault.
 3. Each module shall provide an LED indication that the module has tripped.
- G. Addressable Notification Appliance Circuit Modules:
1. Modules shall communicate with the FACP via the addressable Signaling Line Circuit providing identity, location and status information.
 2. Modules shall support standard polarity reversal loads notification loads up to 2.0 Amps at 24V dc.
 3. Modules shall support 70.7V speaker circuit loads up to 50 Watts.
 4. NAC modules shall interface with notification circuits via a supervised Class B Style Y sub-circuit.

- H. Audible Notification Appliances:
 - 1. All appliances shall be provided with terminal blocks for field wiring terminations.
 - 2. All audible appliances shall provide sufficient sound pressure to maintain 15 dBA above ambient conditions.
 - 3. Notification appliances shall be electronic and use solid-state components.
 - 4. Each electronic signal shall provide eight field selectable alarm tones: TONE, HORN, MARCH TIME HORN, CODE-3 HORN, CODE-3 TONE, SLOW WHOOP, SIREN AND HI/LO.
 - 5. The device shall provide two output sound levels: Standard and High dBA.
 - 6. Operating voltages shall be either 12V dc or 24V dc. All models shall have provisions for standard reverse polarity type supervision and in/out field wiring using terminals that accept #12 to #18 AWG wiring.
- I. Combination Audible/Visual Signals and Appliances:
 - 1. Incorporate a Xenon flashtube enclosed in a rugged Lexan lens or equivalent with solid-state circuitry.
 - 2. Strobe shall meet UL 1971 and produce a flash rate of one flash per second minimum over the Listed input voltage range.
 - 3. Strobe intensity shall be rated per UL 1971 for 15, 30, 75 or 110 Candela.
 - 4. Combination audible/visual appliances shall be surface or flush mounted indoors using standard electrical hardware requiring no additional trim plate or adapters.

2.06 TESTING EQUIPMENT - PORT FURNISHED

- A. Smoke Detector Test Tool: Provide a smoke detector testing tool that shall attach to an extension pole and provide operational testing of the installed smoke detectors without the need to climb a ladder.
- B. Detector Removal Tool: Provide a detector removal tool that shall attach to an extension pole and provide easy installation of detector heads into the pre-installed base without need of a ladder.
- C. Extension Pole: Provide an extension pole of lightweight non-conductive construction, which telescopes, from 4' to 15' and attaches to detector removal and testing tools.

2.07 WIRE AND CONDUIT - CONTRACTOR FURNISHED AND INSTALLED

- A. Wire: Copper conductors, 600V rated, 75°C insulation, color-coded to correspond with shop drawings and sized as recommended by the equipment manufacturer or as follows:
 - 1. Low-Voltage Circuits: #16 AWG, minimum, solid or stranded.
 - 2. Line-Voltage Circuits: #12 AWG, minimum, stranded only.
- B. Conduit: All fire alarm system wire shall be installed in EMT conduit sized per the NEC.

PART 3 EXECUTION

3.01 EQUIPMENT INSTALLATION

- A. Install cabinets, conduit and wiring from I/O devices to the fire alarm control panel, device and field wiring terminations, electrical boxes and other necessary appurtenances for a complete operating fire alarm system.
- B. Manual Pull Stations: Mount semi-flush in recessed back boxes with operating handles at 48 inches above the finished floor.
- C. Water-Flow Detectors and Valve Supervisory Switches: Connect for each sprinkler valve station required to be supervised.
- D. Smoke Detectors:
 - 1. Install ceiling-mounted detectors not less than 4 inches from a side wall to the near edge.
 - a. For exposed solid-joist construction, mount detectors on the bottom of the joists.
 - b. On smooth ceilings, install detectors not over 30 feet apart in any direction.
 - 2. Install detectors located on the wall at least 4 inches, but not more than 12 inches below the ceiling.
 - 3. Install detectors no closer than 5 feet from air registers.
- E. Duct Detectors: Install duct detectors per manufacturer's requirements.
- F. Audible Alarm-Indicating Devices:
 - 1. Install not less than 80 inches above the finished floor nor less than 6 inches below the ceiling.
 - 2. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.
 - 3. Combine audible and visual notification appliances at the same location into a single unit.
- G. Visual Notification Devices: Install adjacent to each alarm bell or alarm horn and not more than 80 inches above the finished floor and at least 6 inches below the ceiling.
- H. Device Location Indicating Lights: Locate in a public space immediately adjacent to the device monitored.
- I. Fire Control Panel: Surface mount with top of cabinet not more than 72 inches above the finished floor.
- J. Graphic Annunciator: Mount with the top of panel no more than 72 inches above the finished floor.

3.02 WIRING INSTALLATION

- A. Wiring Methods: Install wiring in metal raceway according to Section 26 05 33 - Raceway and Boxes.

1. Conceal raceway except in unfinished spaces and as indicated on Drawings.
 2. Oversize each junction box by 40%.
 3. Splicing within raceways is not acceptable.
- B. Wiring Within Enclosures: Install conductors parallel with or at right angles to the sides and back of the enclosure. Bundle, lace, and train the conductors to terminal points with no excess. Connect conductors that are terminated 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 or outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

3.03 GROUNDING

- A. Comply with installation requirements of Section 26 05 26 - Grounding.
- B. Ground cable shields and equipment according to system manufacturer's instructions to eliminate shock hazard and to minimize ground loops, common mode returns, noise pickup, cross talk, and other impairments.
- C. Signal Ground Terminal: Locate at main equipment rack or cabinet. Isolate from power system and equipment grounding.
- D. Install grounding electrodes of type, size, location, and quantity as indicated on Drawings.
- E. Provide 5-ohm ground at main equipment location. Measure, record, and report ground resistance.

3.04 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals according to Section 26 05 53 - Electrical Identification.
- B. Permanently identify and label fire alarm system wiring in junction boxes.
- C. Fire Alarm Power Supply Disconnect: Paint red and label "FIRE ALARM." Provide with lockable handle or cover.
- D. Color Coding:
1. Color-code fire alarm conductors differently from the normal building power wiring.
 2. Use one color code for alarm circuit wiring and a different color code for supervisory circuits.
 3. Color-code audible alarm indicating circuits differently from alarm-initiating circuits. Use different colors for visual alarm-indicating devices.
 4. Paint fire alarm system junction boxes and covers red.

3.05 FIELD QUALITY CONTROL

- A. Report of Pretesting: After pretesting is complete, provide a letter certifying the installation is complete and fully operable. Include the names and titles of the witnesses to the preliminary tests.
- B. Final Test Notice: Provide a 10-day minimum notice in writing when the system is ready for final acceptance testing.
- C. Minimum System Tests: Test the system according to the procedures outlined in NFPA 72. Minimum required tests are as follows:
 - 1. Verify the absence of unwanted voltages between circuit conductors and ground.
 - 2. Megger test all conductors, other than those intentionally grounded, with electronic components disconnected.
 - 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 the Record Drawings.
 - 4. Verify that the control unit is in the normal condition as detailed in the manufacturer's operations and maintenance manual.
 - 5. Test initiating, notification, and signaling circuits for proper signal transmission under open circuit conditions.
 - a. Open one connection each at not less than 10 percent of the initiating and indicating devices.
 - b. Observe proper signal transmission according to class of wiring used.
 - 6. Measure and record the actual current draw of each Notification Appliance Circuit.
 - 7. Test each initiating device and notification appliance for alarm operation and proper response at the control unit. Test smoke detectors with actual products of combustion.
 - 8. 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.
 - 9. 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.
- D. Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets the Specifications and complies with applicable standards.
- E. Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed test results in the form of a test log. Submit test log to the Port upon the satisfactory completion of testing.

- F. Tag all equipment, stations, and other components at which tests have been satisfactorily completed.

3.06 CLEANING AND ADJUSTING

- A. Remove paint splatters, spots, dirt and debris from work areas.
- B. Touch up scratches and patch areas of finish to match original finish.
- C. Clean equipment internally using methods and materials recommended by the Manufacturer.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

- A. For incidental work:

No separate measurement or payment will be made for work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed Amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope of the Construction Services and performed by an Subcontrator (of any tier) or Supplier.

- B. For Work separately paid:

The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this work.

END OF SECTION