



Johnson Student Center

1530 W. 17TH STREET, SANTA ANA, CA 92706

INCREMENT 2

NEW BUILDING



Technical Specifications Volume 3

August 13, 2018



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Johnson Student Center

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SIGNED: 08/06/18

IDENTIFICATION STAMP
DIV. OF THE STATE ARCHITECT

04 116810

ACS PB FLS PF SS TY

DATE AUG 31 2018

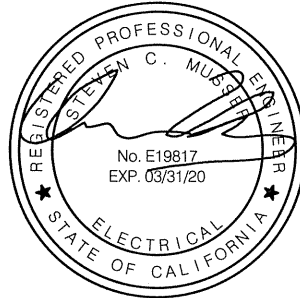
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SANTA ANA COLLEGE
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SECTION 260126 - ELECTRICAL ACCEPTANCE TESTING

PART 1 - GENERAL

1.1 SECTION INCLUDES:

- A. Acceptance testing requirements for electrical power systems.

1.2 APPLICABLE PUBLICATIONS: THE FOLLOWING PUBLICATIONS FORM A PART OF THIS SPECIFICATION TO THE EXTENT REFERENCED. THE PUBLICATIONS ARE REFERRED TO IN THE TEXT BY THE BASIC DESIGNATION ONLY.

- A. American National Standards Institute, Inc. (ANSI) Publication:
 - 1. C2-2002 National Electrical Safety Code
 - 2. C37.16-88 Low-Voltage Power Circuit Breakers and AC Power Circuit Protectors - Preferred Ratings, Related Requirements and Application Recommendations
- B. International Electrical Testing Association Inc. (NETA) Publication:
 - 1. Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems
- C. Institute of Electrical and Electronic Engineers (IEEE) Publications:
 - 1. 141-86 Recommended Practice for Electric Power Distribution for Industrial Plants
 - 2. 242-86 Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
 - 3. 399-90 Recommended Practice for Industrial and Commercial Power System Analysis
 - 4. 446-87 Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications
- D. National Fire Protection Association (NFPA) Publication:
 - 1. 70-National Electrical Code (NEC), California Adopted Edition

1.3 SUBMITTALS

- A. Submit six (6) copies under provisions of Section 26 05 00.
- B. Qualifications: Provide for:
 - 1. Independent testing organization.
 - 2. Certified Engineering Technician(s) to be assigned to the project.
- C. Acceptance Test Procedures: Provide for:
 - 1. Main service switchboard and Power Panelboards
 - 2. Low voltage circuit breakers (>400A)
 - 3. Grounding systems
 - 4. Medium Voltage Cables
 - 5. Low voltage transformers

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6. Medium voltage transformers

- D. Certified Test Reports: The final report shall be signed and shall include the following information: Summary of the project, description of the equipment tested, visual inspection report, description of the tests, test results, conclusions and recommendations, appendix including appropriate test forms, and identification of the test equipment used. Provide bound copies for:
1. Main service switchboard and Power Panelboards
 2. Low voltage circuit breakers (>400A)
 3. Grounding systems
 4. Medium Voltage Cables
 5. Low voltage transformers
 6. Medium voltage transformers

1.4 QUALIFICATIONS

- A. The Contractor shall engage the services of a qualified independent testing organization to provide final inspection, testing, calibration, and adjusting on the electrical distribution system as defined in this Section. The independent testing organization shall have been engaged in full practice for a minimum of five years. The organization shall be corporately independent of the supplier, producer, manufacturer or installer of the equipment.
- B. The independent testing organization shall have a calibration program with accuracy traceable every six months, and in an unbroken chain, to the National Institute of Standards and Technology (N.I.S.T.).
- C. The independent testing organization shall have a designated safety representative on the project. The safety standards shall include OSHA and NFPA 70E.
- D. Testing and inspection shall be performed by an Engineering Technician, certified by a national organization, with a minimum 5 years experience inspecting, testing and calibrating electrical distribution equipment, systems and devices. Information on the qualifications of the Certified Engineering Technician shall be submitted to the Engineer for approval prior to the start of work.
- E. The qualifications of the independent testing organization shall be submitted to the Engineer for approval minimum 30 days prior to the start of testing.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

- 3.1 ALL INSPECTIONS SHALL BE PERFORMED IN ACCORDANCE WITH APPLICABLE CODES AND STANDARDS INCLUDING NEC, ANSI, IEEE, NEMA AND OSHA.

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- A. The independent testing organization shall provide all materials, equipment, labor and technical supervision to perform the inspections and tests.

3.2 INSPECTION

- A. A visual inspection of the installed equipment shall be performed by the independent testing organization to verify that the distribution equipment installed and to be tested is the equipment denoted on the approved shop drawings. The inspection shall check the equipment designations, device characteristics, special installation requirements, applicable codes and standards.
- B. After completion of the visual inspection, a report shall be developed stating any discrepancies that may have been found.

3.3 TESTING, CALIBRATION AND ADJUSTMENT

- A. The independent testing organization shall perform tests on each item of distribution equipment identified in accordance with the latest edition of the International Electrical Testing Association's (NETA) Acceptance Testing Specification for Electrical Power Distribution Equipment and Systems.
- B. Field acceptance testing shall be accomplished on each item of electrical distribution equipment installed or connected as part of this contract. This shall include:
 - 1. Main service switchboard and Power Panelboards
 - 2. Low voltage circuit breakers (>100A)
 - 3. Grounding systems
 - 4. Medium Voltage Cables
 - 5. Low voltage (480V) transformers
 - 6. Medium voltage (12kV) transformers
- C. Systems shall be energized or otherwise placed in service only after completion of all required tests and an evaluation of the test results has been completed.

3.4 CORRECTION OF DEFICIENCIES

- A. Any deficiencies found shall be rectified, and work affected by such deficiencies shall be completely re-tested at the Contractor's expense. Final acceptance of the electrical power system is contingent upon satisfactory completion of the acceptance and system function tests.

END OF SECTION 260126

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SECTION 260500 - ELECTRICAL GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SCOPE:

- A. Electrical General Requirements specifically applicable to Division 26 Sections, in addition to Division 1 - General Requirements. Work includes but is not necessarily limited to the following:
- B. Definitions, guarantees, submittals, clean-up, "As-Builts" and all other applicable requirements of and Division 1 apply to the work of this section.
- C. Examine all other sections for work related to those sections which are required to be included as work under this section.
- D. Coordinate all work in this Division with related trades.
- E. The work includes but is not limited to the following:
 - 1. Provide underground duct banks, including excavation, shoring, backfill and surface repair;
 - 2. Provide SF6 selector switch
 - 3. Provide a medium voltage liquid filled transformer
 - 4. Provide medium voltage cables, connectors, splices, etc.
 - 5. Provide main service switchboard and power panelboards
 - 6. Provide a central lighting inverter
 - 7. Provide UPS for data rooms
 - 8. All equipment and facilities required to provide temporary and permanent services;
 - 9. All electrical work for the building power, lighting, signal, control and life safety; except as specified herein to be designed, furnished and installed as part of other sections of the specifications;
 - 10. Incidental items not indicated in the Specifications that belong to the work described, or are required to provide complete and operable systems, as though called out here in every detail.
- F. Work related to the mechanical trade as listed below shall be included in this Division of the work. Furnish and install the following:
 - 1. All conduits, outlets, line voltage wiring and disconnect switches required for the specified operation of the equipment.
 - 2. Connect all HVAC equipment per equipment installation diagrams.
- G. Furnishing and installing of all hangers, anchors, sleeves, chases and supports, for all electrical materials and equipment.
- H. Excavation, shoring, backfill and concrete work required to complete items of this section.

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- I. Cleaning, cutting patching, repairing and painting.

1.2 APPLICABLE PUBLICATIONS:

The following publications form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

- A. American National Standards Institute, Inc. (ANSI) Publications:
1. C2-2002 National Electrical Safety Code
 2. C37.20-81 Switchgear Assemblies, including supp. C37.20A, C37.20B, Interfiled; C37.20D-78
- B. State of California Administrative Codes:
1. Title 8, Industrial Relations
 2. Title 19, State Fire Marshal Regulations
 3. Title 24, Part 2, California Energy Code, California Adopted Edition
 4. Title 24, Part 3, CCR, California Electrical Code, California Adopted Edition
 5. Title 24, Part 9, CCR, California Fire Code, California Adopted Edition
- C. National Electrical Manufacturers Association (NEMA) Publication:
1. ICS6-83 (R86) Enclosures for Industrial Controls and Systems
- D. National Fire Protection Association (NFPA) Publications:
1. 70-National Electrical Code (NEC), California Adopted Edition
 2. 70B-Electrical Equipment Maintenance, California Adopted Edition
 3. NFPA 101- Life Safety Code, California Adopted Edition
- E. State of California Public Utilities Commission (Cal. P.U.C.) Publication:
1. G.O. 128 Rules for Construction of Underground Electrical Supply and Communications Systems

1.3 WORK SEQUENCE

- A. Install work in phases to accommodate specified occupancy requirements. During the construction period, coordinate and update electrical outage schedule and operations with the Construction Administrator on a weekly basis.

1.4 DEFINITIONS:

The following definitions apply to terms used in the narrative and in the specifications.

- A. The words "work" or "electrical work" herein include products, labor, equipment, tools, appliances, transportation and all related items, directly or indirectly required to complete the specified and indicated electrical installation.

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- B. The word "concealed" shall mean that the installation will not be visible when all permanent or removable elements of the construction are in place. The word "exposed" shall mean that the installation is visible when all permanent or removable elements of the construction are in place.
- C. The word "code" shall mean any and all regulations and requirements of regulatory bodies, public and private, having jurisdiction over the work involved.
- D. The word "product" used in Division 26 means all material, equipment, machinery, and/or appliances directly or indirectly required to complete the specified and/or indicated electrical work.
- E. The words "standard product" shall mean a manufactured product, illustrated and/or described in catalogs or brochures, which are in general distribution prior to the date of issue of construction documents for bidding. Products will generally be identified by means of a specific catalog number and manufacturer's name.
- F. The word "provide" shall mean furnish and install and where applicable shall also mean connect, complete installation and test.
- G. The word "remove" shall mean remove and dispose of equipment or material off-site.
- H. The words "powered equipment", as used in Division 26, shall mean a complex product converting an electrical energy source to Mechanical power.
- I. In each standard referenced to in the technical sections, consider the advisory provisions to be mandatory, and as though the word "shall" have been substituted for "should" wherever it appears. Interpret references in these standards to "authority having jurisdiction," or other words of similar meaning, to mean Owner.
- J. The word "Authorized" or "Authorization" shall mean authorized or authorization by the Construction Administrator.
- K. Refer to Division 1, General Requirements, for additional definitions of words and phrases used to describe Division 26, Electrical Work.

1.5 DISCREPANCIES

- A. Where a conflict in requirements occurs between the specifications and narrative and a resolution is not obtained from the Construction Administrator before the bidding date, the more expensive alternate will become the contractual requirement.
- B. Omissions from the narrative or specifications or the misdescription of details of work which are manifestly necessary to carry out the intent of the narrative and specifications, or which are customarily performed, shall not relieve the Contractor from performing such omitted or misdescribed details of the work but they shall be performed as if fully and correctly set forth and described in the narrative and specifications.

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- C. The Contractor shall check narrative furnished him immediately upon their receipt and shall promptly notify the Construction Administrator of any discrepancies.

1.6 CHANGES

- A. The Contractor shall be responsible to make and obtain approval for all necessary adjustments in conduit and equipment layouts as required to accommodate the relocations of equipment and/or devices which are affected by any approved authorized changes or Product substitutions. All changes shall be clearly indicated on the "Record" drawings.

1.7 COOPERATION WITH WORK UNDER OTHER DIVISIONS

- A. The arrangement of and connection to equipment shall be shown on design drawings.
- B. Cooperate with other trades to facilitate general progress of Work. Allow all other trades every reasonable opportunity for installation of their work.
- C. Work under this Division shall follow general building construction closely. Set conduit sleeves and inserts and verify that openings for chases and conduits are provided before concrete is placed or masonry installed.
- D. Work with other trades in determining exact location of outlets, conduit, lighting fixtures, and pieces of equipment to avoid interference with lines required to maintain proper installation of work.
- E. Make such progress in the work to not delay work of other trades.

1.8 SUBMITTALS:

- A. Submit electronic (PDF format) sets of shop drawings, manufacturer's data certificates for equipment, materials and finish, and pertinent details for each system where specified in each individual section, and obtain approval before procurement, fabrication, or delivery of the items to the job site. Partial submittals are not acceptable and will be returned without review. Include the manufacturer's name, trade name, catalog model or number, nameplate data, size, layout dimensions, capacity, project specification and paragraph reference, applicable technical society publication references, and other information necessary to establish contract compliance of each item the Contractor proposes to furnish. Photographs of existing installations and data submitted in lieu of catalog data are not acceptable and will be returned without approval. Contractor shall be responsible for reviewing and certifying submittals as conforming to the narrative and specifications prior to submittal and shall verify conformance of equipment as delivered with final shop submittals, specifications and plans. Contractor shall report to Construction Administrator any deviations prior to initiation of construction. Contractor is responsible for promptly reporting to Construction Administrator any news of late equipment delivery which is likely or certain to delay installation.

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- B. Submit shop drawings and product data grouped and referenced by the technical Section numbers.
- C. Proposed Products List: Include Products as required by the individual section in this Division.
- D. The Contractor shall be responsible for all equipment ordered and/or installed prior to receipt of shop drawings returned from the Construction Administrator bearing the stamp of "reviewed". All corrections or modifications to the equipment as noted on the shop drawings shall be performed and equipment removed from the job site when required by the Construction Administrator, without additional compensation.
- E. Shop Drawings: Drawings shall be a minimum of 8.5 inches by 11 inches in size with a minimum scale of 1/8-inch per foot, except as specified otherwise. Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, duct work, and other items that must be shown to assure a coordinated installation. In wiring diagrams, identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. If equipment is disapproved, revise drawings to show acceptable equipment and resubmit.
- F. Manufacturer's Data: For each manufactured item, provide current manufacturer's descriptive literature of cataloged products, equipment drawings, diagrams, performance and characteristic curves if applicable, and catalog cuts.
- G. Standard Compliance: When materials or equipment provided by the Contractor must conform to the standards of organizations such as American National Standards Institute (ANSI) or Underwriters' Laboratories (UL), submit proof of such conformance to the Construction Administrator for approval. If an organization uses a label or listing to indicate compliance with a particular standard, the label or listing will be acceptable evidence, unless otherwise specified. In lieu of the label or listing, submit a certificate from an independent testing organization, which is competent to perform acceptance testing and is approved by the Construction Administrator. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item conforms to the specified organization's standard.
- H. Certified Test Reports: Before delivery of materials and equipment, certified copies of all test reports specified in individual sections shall be submitted for approval.
- I. Certificates of Compliance or Conformance: Submit manufacturer's certifications as required on products, materials, finish, and equipment indicated in the technical sections. Certifications shall be documents prepared specifically for this contract. Pre-printed certifications and copies of previously submitted documents will not be acceptable. The manufacturer's certifications shall name the appropriate products, equipment, or materials and the publication specified as controlling the quality of that item. Certification shall not contain statements to imply that the item does not meet requirements specified, such as "as good as"; or "achieve the same end use and results as materials formulated in accordance with the referenced publications"; or "equal or exceed the service and performance of the specified material." Certifications shall simply

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state that the item conforms to the requirements specified. Manufacturer shall use Form 26 05 00-A for equipment installation certification. Certificates shall be printed on the manufacturer's letterhead and shall be signed by the manufacturer's official authorized to sign certificates of compliance or conformance.

1.9 REGULATORY REQUIREMENTS

- A. Electrical: Conform to NFPA 70, CA PUC G.O. 95, CA PUC G.O. 128, ANSI C2, CAC Title 24, NFPA 101 and all other utility company requirements, state and local codes.
- B. The electrical requirements shall be the minimum acceptable requirements for the work and nothing described in these Specifications or Narrative shall be construed to permit work not conforming to the most stringent of the applicable codes and regulations. When narrative or specifications call for materials or construction of better quality of larger size than required by codes, laws, rules and regulations, the specifications and narrative shall take precedence.
- C. Equipment not complying with applicable codes shall be removed and replaced with approved equipment at Contractor's expense. UL listing labels, where applicable, shall be installed prior to shipment from factory.
- D. Obtain permits, and request inspections from authority having jurisdiction.

1.10 GUARANTEE

- A. Except as may be specified under other sections in the Specifications, guarantee all equipment furnished under the Specifications for a period of one year from date of project acceptance against defective workmanship and material and improper installation. Upon notification of failure, correct deficiency immediately and without cost to the Owner.
- B. Standard warranty of manufacturer shall apply for replacement of parts after expiration of the above period. Manufacturer shall furnish replacement parts to the Owner for their service agency as directed. Furnish manufacturer's warranties for all equipment furnished under this project.

1.11 PROJECT/SITE CONDITIONS

- A. Prepare drawings showing proposed rearrangement of work to meet project conditions, including changes to work specified in other Sections. Obtain approval of design drawings before proceeding with the work.

1.12 OPERATION AND MAINTENANCE MANUAL:

- A. Provide operation and maintenance manual of all equipment and lighting fixtures furnished on this project.

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1.13 POSTED OPERATING INSTRUCTIONS:

- A. Furnish approved operating instructions for systems and equipment indicated in the technical sections for use by operation and maintenance personnel. The operating instructions shall include wiring diagrams, control diagrams, and control sequence for each principal system and equipment. Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions as directed. Attach or post operating instructions adjacent to each principal system and equipment including startup, proper adjustment, operating, lubrication, shutdown, safety precautions, procedure in the event of equipment failure, and other items of instruction as recommended by the manufacturer of each system or equipment. Provide weather-resistant materials or weatherproof enclosures for operating instructions exposed to the weather. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal or peeling.

1.14 MANUFACTURER'S RECOMMENDATIONS:

- A. Where installation procedures or any part thereof are required to be in accordance with manufacturer's recommendations, furnish printed copies of the recommendations prior to installation. Installation of the item shall not proceed until recommendations are received. Failure to furnish recommendations shall be cause for rejection of the equipment or material.

1.15 DELIVERY AND STORAGE:

- A. Handle, store, and protect equipment and materials in accordance with the manufacturer's recommendations and with the requirements of NFPA 70B P, Appendix I, titled "Equipment Storage and Maintenance during Construction." Replace damaged or defective items with new items. Refer to Contract General Conditions for additional requirements.

1.16 ELECTRICAL REQUIREMENTS:

- A. Furnish internal wiring for components of packaged equipment as an integral part of the equipment.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

- 3.1 OBTAIN AND PAY FOR ALL PERMITS, AND INSPECTIONS, INCLUDING ANY INDEPENDENT TESTING REQUIRED TO VERIFY STANDARD COMPLIANCE, AND DELIVER CERTIFICATES FOR SAME TO CONSTRUCTION ADMINISTRATOR. ALL WORK SHALL CONFORM TO THE REQUIREMENTS OF NFPA 70, CA PUC G.O. 95, CA PUC G.O. 128, TITLE 24, CALIFORNIA CODE OF REGULATIONS (CCR) & UBC

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3.2 WORK RESPONSIBILITIES

- A. Proper judgment must be exercised in executing the work so as to secure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference with structural conditions. The Contractor is responsible for the correct placing of his work and the proper location and connection of his work in relation to the work of other trades. Advise appropriate trade as to locations of access panels.
- B. In the event changes in the indicated locations or arrangements are necessary, due to developed conditions in the building construction or rearrangement of furnishings or equipment, such changes shall be made without extra cost, providing the change is ordered before the conduit runs, etc. and work directly connected to same is installed and no extra materials are required.
- C. Where equipment is furnished by others, verify dimensions and the correct locations of this equipment before proceeding with the roughing-in of connections.
- D. Do not install light outlets or fixtures until mechanical piping and duct work is installed; then lights shall be installed in locations best suited for equipment arrangement or as directed by the Construction Administrator.
- E. All scaled and figured dimensions are approximate of typical equipment of the class indicated. Before proceeding with any work, carefully check and verify all dimensions, sizes, etc. with the shop drawings to see that the equipment will fit into the spaces without violation of applicable codes.
- F. Should any changes to the work in narrative and specifications be necessary in order to comply with the above requirements, notify the Construction Administrator immediately until approval for any required modifications to the construction has been obtained from Construction Administrator.
- G. Be responsible for any cooperative work which must be altered due to lack of proper supervision or failure to make proper provisions in time. Such changes shall be under direction of the Construction Administrator and shall be made to his satisfaction.
- H. Perform all work with competent and skilled personnel.
- I. All work, including aesthetic as well as electrical and mechanical aspects of the work, shall be of the highest quality consistent with the best practices of the trade.
- J. Replace or repair, without additional compensation, and any work which, in the opinion of the Construction Administrator, does not comply with these requirements.

3.3 CONTINUITY OF SERVICE

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- A. No interruption of service to any part of existing facilities will be permitted without express permission in each instance from Construction Administrator. Request for outages shall state specific date and hours and the maximum duration, with outages kept to these specific date and hours and the maximum duration. Contractor is responsible to provide adequate temporary power (Portable Generator) for unforeseen cases when the outage period exceeds permitted outage duration at no cost to the Owner.
- B. If overtime is necessary, there will be no allowance made by Construction Administrator for extra expense for such overtime or shift work, due to maintaining continuity of service herein required.
- C. Organize work to minimize duration of power interruption.

3.4 PAINTING OF EQUIPMENT

- A. Factory Applied: Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA ICS 6 corrosion-resistance test, except equipment specified to meet requirements of ANSI C37.20 shall have a finish as specified in ANSI C37.20.
- B. Field Applied: Paint electrical equipment as required to touch up, to match finish on other equipment in adjacent spaces or to meet safety criteria.

3.5 RECORD DRAWINGS

- A. Shop drawings shall be provided detailing location of all electrical panels, equipment, junction boxes, conduit, lighting, receptacles, and other connected devices. Panel schedules, circuit numbers and all other electrical information shall be clearly indicated on drawings. Drawings shall be in AutoCAD format meeting Campus standards

3.6 SHORT CIRCUIT, COORDINATION, AND ARC FLASH STUDY

- A. The contractor shall engage the services of a qualified organization to provide a building system short circuit and protective device coordination study for the electrical distribution system. The coordination study shall coordinate with the Owner's medium voltage distribution system and include all components down to and including panelboards. The independent organization shall have been engaged in full practice for a minimum of ten years, and be submitted for approval.
- B. Provide arc flash label and calculations per IEEE 1584 and NFPA 70E recommendations and requirements.
 - 1. Arc Flash label shall consist of, but not limited to:
 - a. "DANGER – Arc Flash and Shock Hazard, Appropriate PPE Required"
 - b. Calculated values of flash protection boundary, incident energy, working distance, required PPE level, shock hazard voltage, limited approach, restricted approach and prohibited approach and equipment ID.

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2. The Contractor shall provide and install all required Arc Flash labels on equipment for this project. Arc Flash label content shall be approved by the Engineer prior to installation.

END OF SECTION 260500

SECTION 260513 - MEDIUM-VOLTAGE CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes cables and related cable splices, terminations, and accessories for medium-voltage (2,001 to 35,000 V) electrical distribution systems.

1.3 DEFINITIONS

- A. Jacket: A continuous nonmetallic outer covering for conductors or cables.
- B. NETA ATS: Acceptance Testing Specification.
- C. Sheath: A continuous metallic covering for conductors or cables.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of cable. Include splices and terminations for cables and cable accessories.
- B. Samples: 16-inch lengths for each type of cable specified.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Material Certificates: For each type of cable and accessory.
- C. Source quality-control reports.
- D. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Installer: Engage a cable splicer, trained and certified by splice material manufacturer, to install, splice, and terminate medium-voltage cable.

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- 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.

1.7 FIELD CONDITIONS

- A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify College no fewer than 14 days in advance of proposed interruption of electric service.
 - 2. Do not proceed with interruption of electric service without Owner's written permission.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- 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. Cables:
 - a. General Cable Technologies Corporation.
 - b. Okonite Company (The).
 - c. Southwire Company.
 - 2. Cable Splicing and Terminating Products and Accessories:
 - a. Thomas & Betts Corporation.
 - b. Thomas & Betts Corporation/Elastimold.
 - c. 3M; Electrical Markets Division.
 - d. Tyco Electronics; Raychem Products.
- B. Source Limitations: Obtain cables and accessories from single source from single manufacturer.

2.2 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with IEEE C2 and NFPA 70.

2.3 CABLES

- A. Cable Type: Type MV 105.
- B. Comply with UL 1072, AEIC CS8, ICEA S-93-639/NEMA WC 74, and ICEA S-97-682.
- C. Conductor: Copper.
- D. Conductor Stranding: Compact round, concentric lay, Class B.

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- E. Strand Filling: Conductor interstices are filled with impermeable compound.
- F. Conductor Insulation: Ethylene-propylene rubber.
 - 1. Voltage Rating: 5 kV.
 - 2. Insulation Thickness: 133 percent insulation level.
- G. Shielding: Copper tape, helically applied over semiconducting insulation shield.
- H. Shielding and Jacket: Corrugated copper drain wires embedded in extruded, chlorinated, polyethylene jacket.
- I. Cable Jacket: Sunlight-resistant PVC.

2.4 CONNECTORS

- A. Comply with ANSI C119.4 for connectors between aluminum conductors or for connections between aluminum to copper conductors.
- B. Copper-Conductor Connectors: Copper barrel crimped connectors.

2.5 SOLID TERMINATIONS

- A. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Insulation class shall be equivalent to that of cable. Include shield ground strap for shielded cable terminations.
 - 1. Class 1 Terminations: Modular type, furnished as a kit, with stress-relief tube; multiple, molded-silicone-rubber, insulator modules; shield ground strap; and compression-type connector.

2.6 SEPARABLE INSULATED CONNECTORS

- A. Description: Modular system, complying with IEEE 386, with disconnecting, single-pole, cable terminators and with matching, stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture.
- B. Terminations at Distribution Points: Modular type, consisting of terminators installed on cables and modular, dead-front, terminal junctions for interconnecting cables.
- C. Load-Break Cable Terminators: Elbow-type units with 200-A-load make/break and continuous-current rating; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.
- D. Dead-Break Cable Terminators: Elbow-type unit with 200-A continuous-current rating; designed for de-energized disconnecting and connecting; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.
- E. Dead-Front Terminal Junctions: Modular bracket-mounted groups of dead-front stationary terminals that mate and match with above cable terminators. Two-, three-, or four-terminal

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units as indicated, with fully rated, insulated, watertight conductor connection between terminals and complete with grounding lug, manufacturer's standard accessory stands, stainless-steel mounting brackets, and attaching hardware.

1. Protective Cap: Insulating, electrostatic-shielding, water-sealing cap with drain wire.
 2. Portable Feed-Through Accessory: Two-terminal, dead-front junction arranged for removable mounting on accessory stand of stationary terminal junction.
 3. Grounding Kit: Jumpered elbows, portable feed-through accessory units, protective caps, test rods suitable for concurrently grounding three phases of feeders, and carrying case.
 4. Standoff Insulator: Portable, single dead-front terminal for removable mounting on accessory stand of stationary terminal junction. Insulators suitable for fully insulated isolation of energized cable-elbow terminator.
- F. Test-Point Fault Indicators: Applicable current-trip ratings and arranged for installation in test points of load-break separable connectors, and complete with self-resetting indicators capable of being installed with shotgun hot stick and tested with test tool.
- G. Tool Set: Shotgun hot stick with energized terminal indicator, fault-indicator test tool, and carrying case.

2.7 SPLICE KITS

- A. Splice Kits: Comply with IEEE 404; type as recommended by cable or splicing kit manufacturer for the application.
- B. Splicing Products: As recommended, in writing, by splicing kit manufacturer for specific sizes, materials, ratings, and configurations of cable conductors. Include all components required for complete splice, with detailed instructions.
1. Combination tape and cold-shrink-rubber sleeve kit with re-jacketing by cast-epoxy-resin encasement or other waterproof, abrasion-resistant material.
 2. Heat-shrink splicing kit of uniform, cross-section, polymeric construction with outer heat-shrink jacket.
 3. Premolded, cold-shrink-rubber, in-line splicing kit.
 4. Premolded, EPDM splicing body kit with cable joint sealed by interference fit of mating parts and cable.
 5. Separable multiway splice system with all components for the required splice configuration.

2.8 MEDIUM-VOLTAGE TAPES

- A. Ethylene/propylene rubber-based, 30-mil splicing tape, rated for 130 deg C operation. Minimum 3/4 inch wide.
- B. Silicone rubber-based, 12-mil self-fusing tape, rated for 130 deg C operation. Minimum 1-1/2 inches (38 mm) wide.
- C. Insulating-putty, 125-mil elastic filler tape. Minimum 1-1/2 inches wide.

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2.9 ARC-PROOFING MATERIALS

- A. Tape for First Course on Metal Objects: 10-mil- thick, corrosion-protective, moisture-resistant, PVC pipe-wrapping tape.
- B. Arc-Proofing Tape: Fireproof tape, flexible, conformable, intumescent to 0.3 inch thick, and compatible with cable jacket.
- C. Glass-Cloth Tape: Pressure-sensitive adhesive type, 1 inch wide.

2.10 FAULT INDICATORS

- A. Indicators: Automatically reset fault indicator, arranged to clamp to cable sheath and provide a display after a fault has occurred in cable. Instrument shall not be affected by heat, moisture, and corrosive conditions and shall be recommended by manufacturer for installation conditions.
- B. Resetting Tool: Designed for use with fault indicators, with moisture-resistant storage and carrying case.

2.11 SOURCE QUALITY CONTROL

- A. Test and inspect cables according to ICEA S-97-682 before shipping.
- B. Test strand-filled cables for water-penetration resistance according to ICEA T-31-610, using a test pressure of 5 psig.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install cables according to IEEE 576.
- B. Proof conduits prior to conductor installation by passing a wire brush mandrel and then a rubber duct swab through the conduit. Separate the wire brush and the rubber swab by 48 to 72 inches on the pull rope.
 - 1. Wire Brush Mandrel: Consists of a length of brush approximately the size of the conduit inner diameter with stiff steel bristles and an eye on each end for attaching the pull ropes. If an obstruction is felt, pull the brush back and forth repeatedly to break up the obstruction.
 - 2. Rubber Duct Swab: Consists of a series of rubber discs approximately the size of the conduit inner diameter on a length of steel cable with an eye on each end for attaching the pull ropes. Pull the rubber duct swab through the duct to extract loose debris from the duct.
- C. Pull Conductors: Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

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1. Where necessary, use manufacturer-approved pulling compound or lubricant that does not deteriorate conductor or insulation.
 2. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips, that do not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.
 3. Use pull-in guides, cable feeders, and draw-in protectors as required to protect cables during installation.
 4. Do not pull cables with ends unsealed. Seal cable ends with rubber tape.
- D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.
- E. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."
- F. Install "buried-cable" warning tape 12 inches below grade.
- G. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit; support cables at intervals adequate to prevent sag.
- H. Install sufficient cable length to remove cable ends under pulling grips. Remove length of conductor damaged during pulling.
- I. Install cable splices at pull points and elsewhere as indicated; use standard kits. Use dead-front separable watertight connectors in manholes and other locations subject to water infiltration.
- J. Install terminations at ends of conductors, and seal multiconductor cable ends with standard kits.
- K. Install separable insulated-connector components as follows:
1. Protective Cap: At each terminal junction, with one on each terminal to which no feeder is indicated to be connected.
 2. Portable Feed-Through Accessory: At each terminal junction, with one on each terminal.
 3. Standoff Insulator: At each terminal junction, with one on each terminal.
- L. Arc Proofing: Unless otherwise indicated, arc proof medium-voltage cable at locations not protected by conduit, cable tray, direct burial, or termination materials. In addition to arc-proofing tape manufacturer's written instructions, apply arc proofing as follows:
1. Clean cable sheath.
 2. Wrap metallic cable components with 10-mil pipe-wrapping tape.
 3. Smooth surface contours with electrical insulation putty.
 4. Apply arc-proofing tape in one half-lapped layer with coated side toward cable.
 5. Band arc-proofing tape with two layers of 1-inch- wide half-lapped, adhesive, glass-cloth tape at each end of the arc-proof tape.
- M. Seal around cables passing through fire-rated elements according to Section 078413 "Penetration Firestopping."
- N. Install fault indicators on each phase where indicated.

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- O. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware.
- P. Ground shields of shielded cable at one point only. Maintain shield continuity and connections to metal connection hardware at all connection points.
- Q. Identify cables according to Section 260553 "Identification for Electrical Systems." Identify phase and circuit number of each conductor at each splice, termination, pull point, and junction box. Arrange identification so that it is unnecessary to move the cable or conductor to read the identification.

3.2 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
 - 2. After installing medium-voltage cables and before electrical circuitry has been energized, test for compliance with requirements.
 - 3. Perform direct-current High Potential test of each new conductor according to NETA ATS, Ch. 7.3.3. Do not exceed cable manufacturer's recommended maximum test voltage.
 - 4. Perform Partial Discharge test of each new conductor according to NETA ATS, Ch. 7.3.3 and to test equipment manufacturer's recommendations.
 - 5. Perform Dissipation Factor test of each new conductor according to NETA ATS, Ch. 7.3.3 and to test equipment manufacturer's recommendations.
- D. Medium-voltage cables will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

END OF SECTION 260513

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SECTION 260515 - SF6 SELECTOR SWITCH

PART 1 - GENERAL

- 1.1 SECTION INCLUDES: SF6 selector switches including all labor, materials, appliances, tools, equipment necessary for and incidental to performing all operations in connection with furnishing, delivery and installation of the work of this Section, complete, as shown on the drawings and/or specified herein. The switch shall consist of manually operated load interrupting, SF6 insulated, 600A linear puffer switches and manually operated vacuum interrupter fault interrupting tap switches, electronically controlled. The switch manufacturer shall be ISO 9001:2000 and 14001 certified.
- 1.2 RELATED SECTIONS:
- A. Section 260500, "Electrical General Requirements," applies to this section, with the additions and modifications specified herein.
 - B. Section 260126 - Acceptance Testing.
 - C. Section 260513 - Medium Voltage Cables
 - D. Section 260526 - Grounding and Bonding
- 1.3 APPLICABLE PUBLICATIONS: The following publications form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.
- A. American National Standards Institute, Inc. (ANSI) Publications:
 - 1. C2-97 National Electrical Safety Code
 - 2. C37.20.3-87(R96) Metal-Enclosed Interrupter Switchgear
 - 3. C37.38-89 Gas-Insulated Metal-Enclosed Disconnecting, Interrupter, and Grounding Switches
 - 4. C37.60-81(R92) Requirements for Overhead, Pad-Mounted, Dry-Vault and Submersible Automatic Circuit Re-closers and Fault Interrupters for AC Systems
 - 5. C37.71-84 Three-Phase, Manually Operated Subsurface Load-Interrupting Switches for AC Systems
 - B. Institute of Electrical and Electronic Engineers, Inc (IEEE) Publication:
 - 1. 48-90 Standard Test Procedures and Requirements for High Voltage Alternating Current Cable Terminations
 - C. National Electrical Manufacturer's Association (NEMA) Publication:
 - 1. SG6-95 Power Switching Equipment

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- D. National Fire Protection Association (NFPA) Publication:
 - 1. 70- National Electrical Code (NEC), California Adopted Edition
 - E. State of California Administrative Code:
 - 1. Title 24, Part 3, California Electrical Code, California Adopted Edition
- 1.4 SUBMITTALS: The following information shall be submitted for approval prior to fabrication. Delivery dates and factory test dates of the listed equipment shall be included. The delivery dates shall be coordinated to permit timely installation and testing. The Contractor shall demonstrate to the College that the delivery date will permit adequate time to install and test the equipment.
- A. Manufacturer's Data: Provide for the following items:
 - 1. SF6 selector switches.
 - B. Certified Test Reports: The manufacturer shall submit copies of certified test reports for the SF6 selector switches. Reports shall include test data results confirming compliance with all tests and referenced publications listed in the technical paragraphs of this Section. The testing shall have been performed in a testing laboratory whose functions are testing, analyzing, and inspecting to the requirements of applicable standards. The tests shall have been performed within three years of submittal of the reports for approval. Test reports shall be accompanied by certificates from the manufacturer certifying that materials and equipment proposed to be supplied is of the same type, quality, manufacturer, make and capacity as that tested.
 - C. Shop Drawings: Provide for each switch type. Shop drawings shall contain the following minimum information:
 - 1. SF6 selector switches, three-line diagram
 - 2. Equipment dimensional data and line-up drawings, including front, top and side views and section through assembly showing positions and locations of incoming cables, circuits, landing lugs, bus bars and bus supports.
 - 3. Recommended method of anchoring.
 - 4. Anchor seismic stress calculations.
 - D. Manufacturer's Instructions:
 - 1. SF6 selector switch installation.
 - 2. Field testing of components.
 - E. Manufacturer's Production Tests: Production tests shall be performed at the manufacturer's factory and shall be conducted in accordance with ANSI C37.20.3. Production tests shall be performed prior to shipment to the job site. Six (6) certified copies of each test shall be submitted to the Engineer. Production tests shall include:
 - 1. Mass spectrometer leak tests.
 - 2. Contact resistance tests.
 - 3. AC one minute withstand and corona extinction tests.

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4. SF6 moisture content tests.
5. Mechanical operation tests.
6. Electric operation tests.

F. Operation and Maintenance Manuals (6 sets): Provide per Section 260500.

1. These instruction manuals shall be available to the Inspector during the SF6 selector switch installations.

1.5 MANUFACTURER'S QUALIFICATIONS:

- A. The SF6 selector switches shall be standard catalogued and manufactured equipment per the requirements of this specification. The switches shall be an integrated assembly of coordinated design; constructed, tested and guaranteed by a single manufacturer, assembled at a single location and witnessed, tested and factory inspected prior to shipment to the job site.
- B. Acceptable manufacturers are S&C Electric Company, G&W Electric Company, or Canada Power Products Corporation. Contractor is responsible for modifying pad dimensions as required based on manufacturer.

PART 2 - PRODUCTS

2.1 GENERAL:

- A. This specification outlines the requirements for a three phase, group operated, 60 Hz sectionalizing padmount switch tested to ANSI C37.72 featuring deadfront, compact, sealed, corrosion resistant construction and low profile tamper-resistant enclosures.
- B. Switches must be furnished factory filled with an electrical grade of non-toxic, non-flammable SF6 gas, conforming to ASTM D-2472. A pressure gauge, which provides visual status of the insulating dielectric, must be included.
- C. The completed unit must be capable of withstanding internal failure without explosion or fire and shall be capable of being mounted in any position for best cable training and operation.

2.2 SWITCH CONSTRUCTION:

- A. All switch components and entrances shall be assembled in a totally welded mild steel tank. Entrances shall be internally connected by copper conductors capable of handling momentary and continuous current duty. The switch shall contain no electrically floating metallic parts or components. Construction shall be a deadfront design. Switch tanks shall be painted ASA70 light gray using a corrosion-resistant epoxy paint.
- B. Minimum bushing height shall be 24".

2.3 LOAD BREAK PUFFER SWITCH:

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- A. Each switching way is to be equipped with an internally mounted operating mechanism capable of providing quick-make, quick-break operation in either switching direction. The mechanism must be capable of delivering sufficient torque and shall be provided with latches for each position to assure load interrupting, fault closing and momentary ratings. All switch positions are to be clearly identified, padlockable and adaptable to keylock schemes. The operating mechanism shall be actuated from outside the switch tank with an operating handle. The operating shaft shall be made of stainless steel for maximum corrosion resistance. A double "O" ring type operating shaft seal shall be used for a leak resistant, long life seal.
- B. Switch contacts shall be a tulip-bayonet design and made of plated, high-conductivity copper alloy with arcing tips of copper/tungsten alloy to assure permanent low resistance and to avoid sticking during operation. The contacts shall be designed such that arcing does not occur in the area of main current interchange and contact pressure will increase with increased current flow. The stationary contacts shall be supported independent of the cable entrance bushings, eliminating possible misalignment. The contact nozzle shall have a converging/diverging geometry which improves the flow of SF6 into the arc zone. Contact travel shall be a minimum of 3 inches and have sufficient open contact separation to assure efficient arc extinction and to withstand field DC testing levels and maintain BIL levels. Switch contacts shall be clearly visible in the open position through viewing windows. Auxiliary blades used for load interruption are not acceptable.

2.4 DESIGN RATINGS AND STANDARDS:

- A. Load break Puffer Switches: Switches shall be designed, tested and built per ANSI C37.72-1987 and IEC 265 standards. Certified test reports shall be provided. The switch shall be rated:

Maximum design voltage, kV	15.5
Impulse level (BIL), kV	110
Continuous & load break current, A	630
One minute withstand (dry), AC kV	35
One minute withstand (dry), AC kV Production test rating	34
15 minute withstand, DC kV	53
Momentary current, kA, ASYM	40
Fault-close current, kA, ASYM	40
One second current, kA, SYM	25
Load break operations at 600 A	1200
Mechanical endurance, operations	2000

2.5 CABLE ENTRANCES:

- A. Load break Puffer Switches: Cable entrances shall be tested to ANSI/IEEE 386 and be one or more of the following:
 - 1. 600 amp Apparatus bushing type
- B. Vacuum Interrupters: Cable entrances shall be tested to ANSI/IEEE 386 and be one or more of the following:
 - 1. 200 amp Deepwell bushing type

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2. 600 amp Apparatus bushing type

- 2.6 ENCLOSURE: Enclosures shall be made of 12 gauge mild steel and manufactured to ANSI C37.72 and C57.12.28 standards. The enclosure shall be mounted independent of the switch allowing removal for ease of cable installation or future replacement if required. Enclosures shall be tamper-resistant incorporating hinged access doors with pentahead locking bolts and provisions for padlocking. The enclosure shall be provided with lifting provisions and painted with a Munsell 7.0GY3.29/1.5 green finish.

- 2.7 FACTORY PRODUCTION TESTS: The bulk SF6 gas supply and each individual switch shall be tested for moisture content. Each individual switch shall undergo a mechanical operation check and a leak test. The switch shall be factory filled with SF6 and AC hi-pot tested one minute phase-to-phase, phase-to-ground and across the open contacts. Circuit resistance shall be checked on all ways.
 - A. Switches will be shipped factory filled with SF6 gas. Tank shall be designed to withstand 15 psig internal pressure and an external pressure of 14 psig without affecting the performance of the switch.

- 2.8 STANDARD COMPONENTS: The following shall be included as standard:
 - A. Welded steel tank painted light gray with stainless steel and brass fasteners.
 - B. Lifting provisions.
 - C. Gas pressure gauge and fill valve.
 - D. Grounding provisions for switch tank and all cable entrances.
 - E. Stainless steel three-line diagram and corrosion-resistant nameplates.
 - F. Parking stands.
 - G. Switch operating handle(s) with padlock provision and end stops.
 - H. 12 gauge mild steel padmount enclosure painted Munsell green with stainless steel hinges and pentahead locking mechanisms.
 - I. Insulating caps for all bushings.
 - J. Kirk Key Interlocks.

PART 3 - EXECUTION

- 3.1 INSTALLATION: Electrical installation shall conform to requirements of NFPA 70, state codes, and to requirements specified herein.

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- A. Contractor shall make all field verifications necessary to ensure proper installation of all equipment as supplied.
- B. Contractor is responsible for coordinating timely equipment delivery.

3.2 LOCATIONS:

- A. The drawings indicate diagrammatically the desired locations and arrangements of the components of the electrical work. Follow the drawings as closely as possible, but use judgement and coordinate with other trades to secure the best possible installation in the available space and under the developed conditions.
- B. Before installing any equipment, examine the complete set of documents, including shop drawings and specifications, and verify all dimensions and space requirements. Make such minor adjustments as may be necessary to fit the building structure. Install all electrical work to preserve legal headroom, access, work space, clearances and to keep openings and passage ways clear. Arrange for additional space if required for the servicing, maintenance, and replacement of the electrical equipment.
- C. No additional compensation will be allowed for omissions, inadequate space, misunderstandings or rejected work caused by neglect of these requirements.

3.3 SF6 SELECTOR SWITCHES: Installation shall conform to the manufacturer's shop drawings, direction and recommendations. The Contractor shall coordinate the pad size with selector switch shop drawings.

3.4 ANCHOR REQUIREMENTS: Each unit shall be bolted to the concrete slab in conformance with Seismic Zone 4. Manufacturer shall submit anchoring details for review.

3.5 CABLE CONNECTIONS: Cable termination and connection shall cause no stress at connection to the switch.

- A. Terminations of insulated power cables shall be protected at full rated voltage against deterioration of coverings, and moisture by use of terminating devices and materials. Terminations shall be made using materials and methods specified in Section 16122. Contractor shall insulate lug connection per the manufacturer's instructions.

3.6 GROUNDING: Grounding shall be in accordance with ANSI C2. All ground wire shall be copper. Refer to Section 260526 "Grounding and Bonding."

3.7 NAMEPLATES: Nameplates shall indicate the switch number, feeder numbers and destinations.

3.8 FIELD TESTS: Refer to Section 260126, "Acceptance Testing," for additional requirements.

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As an exception to requirements that may be stated elsewhere in the Contract, the Inspector shall be given a minimum 5 working days notice prior to each test. All testing shall comply with ANSI C37.20 and IEEE 48.

- A. Prior to energizing the switches the Contractor shall check the switch assemblies for shipping damage including, but not limited to, interlocking mechanisms, doors and hinges, and all major components. Switchgear shall be re-inspected after installation and prior to energization.

END OF SECTION 260515

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SECTION 260519 - LOW-VOLTAGE WIRES (600V AC)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Building wires and cables rated 600 V and less.
 - 2. Connectors, splices, and terminations rated 600 V and less.
- B. Related Requirements:
 - 1. Section 260513 "Medium-Voltage Cables" for single-conductor and multiconductor cables, cable splices, and terminations for electrical distribution systems with 2,001 to 35,000 V.
 - 2. Section 271500 "Communications Horizontal Cabling" for cabling used for voice and data circuits.

1.3 DEFINITIONS

- A. VFC: Variable frequency controller.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- 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:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. Alpha Wire.
 - 2. General Cable Technologies Corporation.
 - 3. Southwire Incorporated.
- C. Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.
- D. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for Type THHN-2-THWN-2 or Type XHHW-2.

2.2 CONNECTORS AND SPLICES

- 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. Hubbell Power Systems, Inc.
 - 2. Ideal Industries, Inc.
 - 3. O-Z/Gedney; a brand of the EGS Electrical Group.
 - 4. 3M; Electrical Markets Division.
 - 5. Tyco Electronics.
- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger, except VFC cable, which shall be extra flexible stranded.

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3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type THHN-2-THWN-2, single conductors in raceway or Type XHHW-2, single conductors in raceway.
- B. Exposed Feeders: Type THHN-2-THWN-2, single conductors in raceway.
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN-2-THWN-2, single conductors in raceway.
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-2-THWN-2, single conductors in raceway or Type XHHW-2, single conductors in raceway.
- E. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-2-THWN-2, single conductors in raceway.
- F. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-2-THWN-2, single conductors in raceway or Type XHHW-2, single conductors in raceway.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

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- B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
 - 1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.5 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.7 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- D. Test and Inspection Reports: Prepare a written report to record the following:
 - 1. Procedures used.
 - 2. Results that comply with requirements.
 - 3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- E. Cables will be considered defective if they do not pass tests and inspections.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes: Grounding systems and equipment.
- B. Section includes grounding systems and equipment, plus the following special applications:
 1. Overhead-line grounding.
 2. Underground distribution grounding.
 3. Ground bonding common with lightning protection system.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

- A. Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article, including the following:
 1. Test wells.
 2. Ground rods.
 3. Ground rings.
 4. Grounding arrangements and connections for separately derived systems.
 5. Grounding for sensitive electronic equipment.
- B. Qualification Data: For qualified testing agency and testing agency's field supervisor.
- C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 1. Instructions for periodic testing and inspection of grounding features at test wells and grounding connections for separately derived systems based on NETA MTS.

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- a. Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
- b. Include recommended testing intervals.

1.6 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. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 1. Solid Conductors: ASTM B 3.
 2. Stranded Conductors: ASTM B 8.
 3. Tinned Conductors: ASTM B 33.
 4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
- C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches by 12 in (minimum) cross section, with 9/32-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

2.2 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.

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1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- D. Bus-bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2.3 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel; 3/4 inch in diameter by 10 feet long.
- B. Chemical-Enhanced Grounding Electrodes: Copper tube, straight or L-shaped, charged with nonhazardous electrolytic chemical salts.
 1. Termination: Factory-attached No. 4/0 AWG bare conductor at least 48 inches long.
 2. Backfill Material: Electrode manufacturer's recommended material.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare copper conductor, No. 2/0 AWG minimum.
 1. Bury at least 24 inches below grade.
 2. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.
- C. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 1. Install bus on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated.
 2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down to specified height above floor; connect to horizontal bus.
- D. Conductor Terminations and Connections:
 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.

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- B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.
- C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.
- D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches from the foundation.

3.3 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - 1. Feeders and branch circuits.
 - 2. Lighting circuits.
 - 3. Receptacle circuits.
 - 4. Single-phase motor and appliance branch circuits.
 - 5. Three-phase motor and appliance branch circuits.
 - 6. Flexible raceway runs.
 - 7. Armored and metal-clad cable runs.
 - 8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
 - 9. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.
- C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- D. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

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- E. Signal and Communication Equipment: In addition to grounding and bonding required by NFPA 70, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A.
 - 1. For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
 - 2. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-4-by-12-inch grounding bus.
 - 3. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

3.4 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.
 - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
 - 2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- C. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches deep, with cover.
 - 1. Test Wells: Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.
- D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
 - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
 - 3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
- E. Grounding and Bonding for Piping:
 - 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

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2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- F. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.
- G. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.
- H. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70; use a minimum of 20 feet of bare copper conductor not smaller than No. 3/0 AWG.
1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
 2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

3.5 LABELING

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for instruction signs. The label or its text shall be green.
- B. Install labels at the telecommunications bonding conductor and grounding equalizer and at the grounding electrode conductor where exposed.
1. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Tests and Inspections:
1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

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3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without 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.
 - b. Perform tests by fall-of-potential method according to IEEE 81.
 4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. 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. Describe measures taken to improve test results.
- E. Grounding system will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.
- G. Report measured ground resistances that exceed the following values:
1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
 2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
 3. Substations and Pad-Mounted Equipment: 5 ohms.
 4. Manhole Grounds: 10 ohms.
- H. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

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SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.
- B. Related Sections include the following:
 - 1. Section 260548 "Vibration and Seismic Controls for Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

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1.5 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel slotted support systems.
 - 2. Nonmetallic slotted support systems.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze hangers. Include Product Data for components.
 - 2. Steel slotted channel systems. Include Product Data for components.
 - 3. Nonmetallic slotted channel systems. Include Product Data for components.
 - 4. Equipment supports.

1.6 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.7 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 70.

1.8 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete Specifications.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. 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:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.

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- c. ERICO International Corporation.
 - d. Thomas & Betts Corporation.
 - e. Unistrut; Tyco International, Ltd.
 3. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 4. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 5. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 6. Channel Dimensions: Selected for applicable load criteria.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. 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.
- E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - b. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Hilti Inc.
 - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC.
 - 4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
 2. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - a. Manufacturers: 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) Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti Inc.
 - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 5) MKT Fastening, LLC.

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3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 1. Secure raceways and cables to these supports with two-bolt conduit clamps.
- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT and RMC may be supported by openings through structure members, as permitted in NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits.

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Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
1. To Wood: Fasten with lag screws or through bolts.
 2. To New Concrete: Bolt to concrete inserts.
 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 4. To Existing Concrete: Expansion anchor fasteners.
 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
 6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
 7. To Light Steel: Sheet metal screws.
 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "Cast-in-Place Concrete."
- C. Anchor equipment to concrete base.
1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

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2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529

SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. All wiring shall be installed in concealed conduit unless indicated otherwise in these specifications. Surface raceways shall be used in exposed locations in finished areas where conduits cannot be concealed. All surface installation will require College approval.
- B. Separate conduit shall be used for the following wiring:
 - 1. Emergency Power System Wiring.
 - 2. Fire Alarm System.
 - 3. Public Address System.
 - 4. Security System.
 - 5. Telephone/Data Outlets (See Telecom/Data Section).
- C. Boxes shall include:
 - 1. Boxes
 - 2. Cabinets and Enclosures
 - 3. Safety Switches
- D. This section includes the following:
 - 1. Metal conduits, tubing and fittings.
 - 2. Nonmetal conduits, tubing and fittings.
 - 3. Metal wireways and auxiliary gutters.
 - 4. Nonmetal wireways and auxiliary gutters.
 - 5. Surface raceways.
 - 6. Boxes, enclosures, and cabinets.

1.2 DEFINITIONS

- A. EMT: Electrical metallic tubing
- B. ENT: Electrical non-metallic tubing
- C. GRC: Galvanized rigid steel conduit
- D. LFMC: Liquidtite flexible metal conduit
- E. RNC: Rigid non-metallic conduit

1.3 QUALITY ASSURANCE

- A. Each conduit shall bear manufacturer's trademark and UL label.

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- B. Each type of conduit and fittings shall be of a single manufacturer. Multiple manufacturer's of the same material are not acceptable.
- C. Comply with California Electric Code (CEC).

1.4 ACTION SUBMITTALS

- A. Product Data: For all raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Rigid Steel Conduit: Provide standard weight steel that is hot-dipped galvanized, and sherardized both inside and out after threading, with threaded connectors and couplings. Electro galvanizing is not permitted. Intermediate Metal Conduit, IMC, will not be permitted. Comply with ANSI C80.1 and UL 6.
- B. Rigid Steel Conduit Fittings: Fitting shall be zinc coated, ferrous metal and threaded type in accordance with ANSI C80.4.
- C. Electric Metallic Tubing (EMT): Provide tubing of high grade cold rolled steel electrically welded with exterior protective coating of hot galvanized zinc, applied by the electro galvanized process. Interior of surface coated with aluminum lacquer or enamel. Manufactured by Allied Tube and Conduit, Triangle, Republic, Torrance Tubing, Western, Wheatland or equal. Comply with ANSI C80.3 and UL 797.
- D. EMT Fittings: Fitting shall be watertight, gland ring compression type (no set screw type), wrench tightened connectors and coupling. Indenture and Die Cast will not be acceptable. Manufactured by O-Z Gedney, Raco, Appleton, or Steel City.
- E. Aluminum Conduit: No aluminum conduits.
- F. Flexible Steel Conduit: Provide conduit manufactured from single strip, standard weight steel hot-dipped galvanized on all four sides prior to conduit fabrication or aluminum strips. Comply with UL 1.
- G. Flexible Conduit Connectors and Couplings: Provide die cast fittings of the type that screw into the inside of the conduit with threaded edges at 90 degrees to the fitting body to insure a force fit. Binding screw type will not be acceptable. Manufactured by O-Z Gedney, T&B, Steel City or equal.
- H. Flexible Liquidtight Steel Conduit: Liquid-tight conduit shall be manufactured from single strip standard weight steel, hot dipped galvanized on all four sides prior to conduit fabrication, and

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shall be provided with an extruded polyvinyl chloride cover. Liquidtight conduit and fittings shall provide positive ground continuity. Include a separate ground conductor for each circuit. Manufacturer "Sealtite Flexible" Type "UA," "Flex-Seal Type "XL," or equal. Comply with UL 360.

- I. Flexible Liquidtight Fittings: Fittings shall be malleable iron, zinc plated, with locknut and o ring seal and slim diameter with small turning radius. Manufactured by O-Z Gedney-4Q series, T&B- 5200 series or Appleton Flexible Fittings-ST series.
- J. Rigid Plastic Conduit: Provide heavy wall, virgin polyvinyl chloride Schedule 40 with solvent welded joints, conforming to Underwriters Laboratories, Inc. (UL 651) and ANSI C33.91 requirements, listed for exposed and direct burial application.
- K. Rigid PVC Fittings: fittings and cement shall be provided by same manufacturer. All joint shall be solvent welded in accordance with the manufacturer's recommendations.
- L. No conduit shall be smaller than 3/4-inch unless noted otherwise.
- M. Sleeves shall be zinc coated galvanized steel pipe or 16 gauge galvanized sheet metal.
- N. Sealant: Fire rated equal to wall or ceiling penetrated. Silicon foam Dow-Corning #2001, 3M, "Pensil #851," or approved equal. Sealant compound for exterior wall shall be moisture-resistant material made by 3M, GE, Dow-Corning or equal.
- O. Anchors not cast into concrete shall be expansion shield type, Phillips "Red Head," Hilti, or equal.
- P. Conduit seals shall be Crouse-Hinds Type "EYS" or EZS," Appleton Type "ESUF" or "ESUM," or approved equal, with sealing compound as recommended by the manufacturer for hazardous or refrigerated areas.
- Q. Expansion couplings shall be OZ Type "AX" or "DX," Crouse-Hinds Type "XJ" or "SD" or equal, complete with bonding jumper.
- R. Conduit unions shall be "Erickson" couplings manufactured by Thomas and Betts, Type 4-Series manufactured by O-Z/Gedney or equal.

2.2 MINIMUM SIZE:

- A. Metal Conduit: 3/4 inch except 1/2 inch may be used for control wiring (up to 6#14 AWG) if permitted by the Engineer of Record.
- B. Non-metallic conduit: 1 inch.

2.3 RIGID STEEL CONDUIT AND FITTINGS:

- A. Provide standard weight steel that is hot dipped galvanized including threads, with protective coating on inside and outside. Fittings shall be compression type steel insulated. Electro galvanizing is not permitted.

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2.4 ELECTRIC METALLIC TUBING (EMT) AND FITTINGS:

- A. Provide tubing of high grade steel with exterior coating of zinc, applied by electrogalvanized process and enamel coating on inside. Fittings shall be watertight compression type, wrench tightened connectors and couplings.

2.5 FLEXIBLE STEEL CONDUIT AND FITTINGS:

- A. Provide conduit formed from continuous length of spirally wound interlocked zinc-coated strip steel. Flexible aluminum and light weight steel conduit will not be permitted. Fittings shall be die cast type that screw into the inside of the conduit with threaded edges at 90 degrees to the fitting body to ensure a force fit. Maximum length shall be 6'.

2.6 FLEXIBLE LIQUID TIGHT STEEL CONDUIT AND FITTINGS:

- A. Conduit shall be manufactured from single strip, flexible continuous interlocked, and double-wrapped steel; galvanized inside and outside; and shall be provided with an extruded polyvinyl chloride cover. Fittings shall provide positive ground continuity. Maximum length shall be 6'.

2.7 CONDUIT SLEEVES:

- A. Sleeves shall be zinc coated galvanized steel pipe or 18 gauge galvanized sheet steel.

2.8 RIGID PLASTIC CONDUIT AND FITTINGS:

- A. Provide heavy wall, virgin polyvinyl chloride (PVC) schedule 40 with self extinguishing additive conforming to UL requirements.

2.9 OUTLET BOXES

- A. Sheet Metal Outlet Boxes: ANSI/NEMA OS 1, galvanized steel.
 - 1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 1/2 inch male fixture studs where required.
- B. Nonmetallic Outlet Boxes: ANSI/NEMA OS 2.
- C. Cast Boxes: NEMA FB 1, Type FD, cast ferrous alloy. Provide gasketed cover and threaded hubs by box manufacturer.

2.10 2.10 CABINETS: UL 50.

- A. Cabinets for same type of use shall be the product of a single manufacturer.
- B. Construct of cold-rolled drawing quality steel, with metal gages and construction methods conforming to National Electrical Code requirements, and Underwriters Laboratories' standards. Provide 12 gauge G-90 grade galvanized steel minimum, unless otherwise noted.

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- C. Finish doors, trims, and back boxes for surface-mounted cabinets in finished areas by applying a rust-resistant treatment, prime coat, and a final coat of manufacturer's standard enamel or lacquer finish. Galvanize all other sheet metal components of cabinets including back boxes for flush cabinets, excepting non-ferrous metal parts, or steel parts provided with cadmium plating or equivalent protective plating.
- D. Equip doors with concealed or semi-concealed hinges and with flush or semi-flush spring catch type flush cylinder locks. Key cabinet doors of similar use alike, and provide two keys with each lock.
- E. Equip cabinets for use with telephone, alarm or signal systems with a 0.5" thick plywood backboard. Equip cabinets with terminal strips where so specified. Equip cabinets with nameplates.
- F. Surface cabinets shall be furnished without knockouts. Punch or drill required openings during installation. Equip flush back boxes with manufacturer's standard pattern of knockouts.
- G. Equip cabinet doors exceeding 40" in height with vertical bolt three point locking mechanisms.
- H. Acceptable manufacturers: Products of the following manufacturers are acceptable.
 - 1. Cabinets for general use: Hoffman Engineering Co., Square D, or Columbia Manufacturing Co.
 - 2. Cabinets for systems and/or products, use cabinets furnished by manufacturer with system or product. Where system or product cabinets do not comply with these Specifications, submit cabinet shop drawings, indicating deviations, and obtain approval for their use.

2.11 JUNCTION BOXES AND PULL BOXES: UL 50.

- A. Provide pull and junction boxes of Code gauge steel sized as indicated or required. Provide 16 gauge steel minimum, unless otherwise noted. Indoor enclosures shall conform to NEMA ICS 6 for the Type 12, unless otherwise noted.
- B. Size junction and pull boxes to not less than minimum Code requirements. Increase size above Code requirements where necessary to provide space for pulling, racking or splicing enclosed conductors, or where specified or indicated dimensions exceed Code requirements.
- C. Fabricate sheet metal junction and pull boxes of galvanized, Code gauge, sheet steel. Include angle iron framing where required for rigidity. Boxes shall not deflect or deform visibly when covers are removed after conduit and conductors are installed, and any deflection occurring shall not prevent the easy installation and removal of cover attachment screws.
- D. Do not use single covers for junction and pull boxes having cover length or width dimension exceeding three feet unless so specified, indicated, or approved. Sectionalize covers that exceed three feet in either dimension into two or more sections.
- E. Equip metal junction and pull boxes exposed to weather (and not installed in or below grade) with raintight or weatherproof removable covers. Enclosures shall conform to NEMA ICS 6 for the Type 4, unless otherwise noted. Rain tight or weatherproof boxes shall be used threaded

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watertight hubs for top or side entry and may use knockout for bottom entry only. For exterior pull boxes, use a minimum of 14 gage galvanized G-90 grade sheet steel.

- F. Use concrete junction and pull boxes for exterior underground conduit unless otherwise specified or indicated. Use steel plate or cast iron covers and rims in no traffic areas, and cast iron covers and rims designed for AASHTO Class H20 wheel loading wherever vehicular traffic will occur.
- G. For interior junction and pull boxes located in concrete floors, and 24" square or smaller, use cast iron boxes with integral cast tapped conduit hubs, and having recessed cover flush in the box trim placing all elements of the face of the box flush in the plane of the surrounding floor. Equip boxes with watertight covers where so indicated.
- H. For interior pull boxes located in concrete floors and larger than 24" square, use precast concrete boxes or form these boxes at the job site. Equip with angle iron cover rim, and with reinforced steel cover plate set flush with the finish floor plans. Specific plan details shall supersede these general requirements.
- I. Equip grade level exterior pull boxes with a sump, and with knockouts for conduit on sides and ends. Coordinate requirements for conduit openings with underground conduit requirements. Identify the covers of exterior grade level junction and pull boxes with the work "ELECTRIC" cast into or otherwise permanently inscribed in the metal of the cover. Equip exterior grade level pull boxes with pull irons where so indicated.
- J. Equip surface sheet metal junction and pull boxes with covers aligning with the sides of the boxes and equip flush boxes with covers extending 3/4" all around the perimeter of the back box. Provide sufficient cover attachment screws to ensure that box covers will contact the surface of the box for the entire perimeter of the enclosure. Use galvanized or cadmium-plated screws, or brass screws to attach covers to boxes.
- K. Use brass screws to attach junction and pull box covers to interior floor boxes or to boxes located where moisture may be present.
- L. Acceptable manufacturers:
 - 1. Sheet steel junction and pull boxes: Columbia Electric Co., Hoffman Engineering Co., Pico Metal Products Co.
 - 2. Cast iron junction and pull boxes: O.Z. Electric Manufacturing Co., Alhambra Foundry Co., Ltd., Crouse Hinds Co.
 - 3. Concrete junction and pull boxes: Brooks Products Inc., Quickset Co.

2.12 SAFETY SWITCHES

- A. NEMA KS 1. Switches serving as motor-disconnect shall be horsepower rated. Provide heavy-duty type switches. Fused switches shall utilize Class R fuseholders and fuses unless indicated otherwise. Unless otherwise indicated, provide indoor switches in NEMA Type 12 enclosure, per NEMA ICS 6. Provide outdoor switches in NEMA Type 4 enclosure, per NEMA ICS 6.
- B. Unless otherwise indicated or required, use only unfused type for motor or equipment disconnects. Provide switches for the number of poles and the voltage, current and horsepower ratings as required.

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- C. Provide each switch with laminated plastic nameplate indicating panel designation and circuit number of the feeder and equipment controlled.
- 2.13 WIRE CONNECTORS AND TERMINALS: For use with copper conductors. UL 486A.
- 2.14 INSULATING TAPES: UL 510.
- 2.15 NAMEPLATES: Provide as specified in Section 260553, "Identification for Electrical Systems."

PART 3 - EXECUTION

3.1 CONDUIT

- A. Size of conduit shall be as indicated on the drawings but not less than that required by California Electrical Code.
- B. Rigid Steel Conduit:
 - 1. Use permitted for following applications only:
 - a. All outdoor locations including locations exposed to outside air.
 - b. Feeders.
 - c. Electrical and mechanical equipment rooms.
 - d. Indoor exposed locations where subject to mechanical damage and installed within 8 feet above finished floor.
 - e. Recessed in concrete walls and columns.
 - f. All other locations permitted by code.
- C. Electric Metallic Tubing (EMT):
 - 1. Use permitted for following applications only:
 - a. For all sizes up to 4 inches maximum.
 - b. In dry locations as in stud-wall partitions and in suspended ceiling spaces only. Do not use outdoors.
- D. Flexible Metal Conduit:
 - 1. Use permitted for following applications only:
 - a. Final connections to vibrating or noise-generating equipment including transformers.
 - b. Final connections to light fixtures in lay-in type accessible ceiling construction.
- E. Liquid Tight Flexible Conduit:
 - 1. Use permitted for following applications only:
 - a. For final connections to vibrating or noise-generating equipment in damp and wet locations in mechanical rooms.
 - b. For other power and control equipment requiring adjustments or removal for service in damp and wet locations.

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- F. Rigid Plastic Conduit PVC Schedule 40:
1. Use permitted for underground wiring only.
 2. Make all fittings in plastic conduit watertight with solvent-weld cement recommended by conduit manufacturer and specifically manufactured for the purpose. Use a spring mandrel as required to assure full inside diameter at all bends.
 3. Minimum size shall be 1 inch.
- G. Conduit Placement:
1. Support conduits 1-inch and larger with pipe clamps either suspended from structural slabs with a rod at least 3/8 -inch diameter with adjustable pipe ring, or mounted on wall from channel supports. Attach to concrete with drilled anchors. Where two or more conduits 1-1/2-inch and larger are suspended from ceiling, use trapeze type hanger suspended from rods.
 2. Where rigid metal conduits and electrical metallic tubing are supported from Building members, supports shall be installed as follows:

Conduit Sizes:

3/4" to 1-1/4" Within 18" of each outlet inclusive: and on either side of couplings and fittings and at a spacing not to exceed 8 feet;

1-1/2" and larger: Within 3 feet of each junction or pullbox and terminal cabinet and at a spacing not to exceed 8 feet.
 3. When rigid conduits are supported from trapezes, the supports shall be spaced not more than 8 feet apart.
 4. Conduit trapezes shall consist of suitable Unistrut or Kindorf fittings, or equal, in accordance with the manufacturer's printed recommendation.
- H. Provide independent support for all conduit rising from floor for motor connection if over 18 inches above floor. Do not support to motor, to ductwork or mechanical equipment.
- I. Keep bends and offsets in conduit runs to an absolute minimum. Replace all deformed, flattened or kinked conduit, at Contractor's expense.
- J. Ream the ends of all conduits. Conduits shall not be installed in the slab.
- K. Paint fire alarm conduits with a 1-inch wide red band every 5 feet of run. Separate conduits to be provided for fire alarm system.
- L. Install conduit seals on all conduit entering or leaving low temperature area (65 degrees fahrenheit or less) hazardous areas, refrigerated rooms and clean rooms.
- M. Seal all conduit from exterior outlets at first interior junction box to prevent moisture from entering the building through the conduit.
- N. All exposed conduits shall be installed parallel to and perpendicular to the building structure.
- O. Vertical Supports:
1. Supports shall be provided in strict compliance with National Electrical Code.

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- P. Where bends or risers from underground PVC Schedule 40 conduit terminate above grade or floor or in areas where subject to physical damage during or after construction, use rigid steel factory ells. If additional riser or nipple is required, they also shall be rigid steel. The rigid steel ells and risers shall be taped with Slipknot #100 pipe wrapping tape, or equal (no know equal).
- Q. Pull Wires. Provide a 1/8" size polypropylene pull wire in all empty conduits, including those for signal and telephone systems. Pull cords in telephone/data service conduits (4" and larger) shall be 3/16" size. Identify conduits at exposed ends with tags. Tags shall identify location of other end of conduit. The pull wires shall be left with more than 5 feet in length at both ends for future use.
- R. Joints and Connections. Cut conduit squarely and ream ends to remove burrs. Close open ends of conduits, unless in a closed box or cabinet, with approved conduit caps or closures as soon as installed and keep closed until ready to pull in conductors.
- S. Steel conduit must be clear from contact with building reinforcing steel or other conductors in the building. Each conduit should run no more than two 90 degree bends. If more than two 90 degree bends are necessary, insert an accessible pull-box in the run. Terminate underground conduit inside the building, 2" above the floor below a backboard, or flush with the inside of a cabinet. Terminate overhead conduit 2 feet below floor slab, or flush with the inside of a cabinet.
- T. Where conduits pass through exterior concrete or masonry walls below grade, or through floor slab on fill below grade, make entrance watertight. Install pipe sleeves in concrete with 1/2" minimum clearance around conduit and caulk with oakum and mastic, or use gland type conduit entrance seal.
- U. Underground conduits, which terminate inside building below grade, or which slope so that water might flow into building, shall be sealed at termination after installation of conductors. Install plugs or caps on all spare (empty) conduits.
- V. Do not install conduits in any isolated floor slab. Where it is necessary to cross such area, install conduit below isolated slab, in supporting structural slab or below it. Stub-ups to equipment located on isolated slab shall be through openings at least 1/2" larger in diameter than outside diameter of conduit. Fill space between conduit and opening in slab with mastic.
- W. Expansion Joints
1. Where embedded conduits cross building expansion or seismic joints, provide sliding conduit expansion joints with bonding strap and clamps.
 2. Where exposed conduits or conduits in furred spaces cross building expansion or seismic joints, use offset flexible conduit or sliding conduit expansion joint.
- X. Terminate conduits of 1" size and larger with insulated bushings with grounding lugs where required, O.Z. Type Bldg., or equal (no known equal).
- Y. Bends and sweeps for conduits used for telephone systems shall be long radius and factory made with the radius marked on them.
- Z. Flashings. Where conduits extend through roof, provide flashings as required by Division 7.

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- AA. Penetration in Fire Rated Structures: Provide 3M or Dow Corning No. 3-6548, RTV Silicone form for making fire rated seals around penetrations through floors, walls, elevator shafts as minimum or mechanical fire stop fittings with UL listed fire rating or equal to wall or floor ratings, whichever is larger.
- BB. A separate conduit shall be installed for each homerun indicated on the Drawings.
- CC. Encase all nonmetallic feeder conduit installed underground in a 3-inch concrete envelope. Extend concrete envelopes a minimum of 3 inches beyond all external sides of all outermost conduits. Space the external surfaces of all conduit within a bank, a minimum of 3 inches apart, except that all sound, telephone, and data communication circuits contained within nonmetallic conduit shall have a minimum separation of 12 inches from any light or power circuits that parallel them within a bank. All underground conduits and duct banks containing high voltage feeders shall be encased in red concrete. Concrete shall be pre-mixed at the factory. Sprinkling red oxide in field is not acceptable. All underground conduits to be installed a minimum 36" below grade. Use manufactured concrete or plastic spacers to insure required concrete coverage. Concrete shall be minimum 2500 psi.
- DD. Provide a plastic warning tape in the backfill over the ductlines and approximately 12 inches below grade. Tape shall be run continuously along the entire length of the underground utility lines. Tape shall be polyethylene plastic manufactured specifically for warning and identification of all buried utility lines. Tape shall be of the type provided in rolls, 6-inches minimum width, color coded for electric lines (red) and for communication lines (orange), with warning and identification imprinted in bold black letters continuously and repeatedly over entire tape length. Warning and identification shall be "CAUTION - BURIED ELECTRIC (or COMMUNICATION) LINE BELOW", or similar wording. Code and letter coloring shall be permanent, unaffected by moisture and other substances contained in trench backfill material.
- EE. During construction, partially completed duct lines shall be protected from the entrance of debris such as mud, sand and dirt by means of suitable conduit plugs. As each section of a duct line is completed from manhole to vault, a testing mandrel not less than 12 inches long with a diameter 1/4-inch less than the size of the conduit, shall be drawn through each conduit, after which a brush having the diameter of the duct, and have stiff bristles shall be drawn through until the conduit is clear of all particles of earth, sand, gravel and other foreign materials. Conduit plugs shall then be immediately installed.
- FF. Maintain minimum 6-inch clearance between conduit and piping. Maintain 12-inch clearance between conduit and heat sources such as flues, steampipes, hot water pipes, and heating appliances.
- GG. Tag all empty conduits at each accessible end with a permanent tag identifying the purpose of the conduit and the location of the other end. In wet, corrosive outdoor or underground locations, use brass, bronze, or copper 16 gauge tags or lead tags secured to conduit ends with #16 or larger galvanized wire. Inscribe on the tags, with steel punch dies, clear and complete identifying information.
- HH. Provide expansion and deflection fittings where two rigidly supported conduits may move in relation to each other at expansion joint crossings.
- II. From each panel which is flush mounted in a wall, stub from top of the panel, a minimum of 4-3/4-inch conduits to the nearest ceiling space or other accessible location and cap for future use.

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- JJ. Conduits which are installed above dry type suspended ceilings shall not be secured to ceiling support wires. Support such conduit independent of ceiling suspension systems.
- KK. Underground duct-banks shall have continuous slope downward toward manholes and away from buildings with a pitch of not less than 4 inches in 100 feet. Changes in direction of runs exceeding a total of 10 degrees, either vertical or horizontal, shall be accomplished by longsweep bends having a minimum radius of curvature of 25 feet, except that manufactured bends may be used at ends of short runs of 100 feet or less, and then only at or close to the end of run.
- LL. Exposed conduit larger than 1 inch shall be suspended with pipe hangers. Hangers and racks shall be attached to concrete with insets, set at the time the concrete is poured, and to steel members with beam clamps or matching bolts.
- MM. Conduit 1-inch and smaller, in metal and stud partitions, shall be tied to the furring channels with No. 12 gauge galvanized tie wire space not more than 5 feet apart. Conduits above metal channel lath and plaster ceilings for other services and lighting home runs shall be supported independently to the slab.
- NN. Wherever conduits pass through concrete walls, suspended slabs or metal deck floors, furnish and install sleeves of ample size to permit installation of conduit. Sleeves shall be installed prior to pouring of concrete and shall have ends flush with the wall or extend 2 inches above floor surfaces. Verify location with the University's Representative.
- OO. Except as otherwise indicated on the Drawings, bends in conduit 2 inches or larger shall have a radius of curvature of the inner edge, equal to not less than ten (10) times the internal diameter of the conduit. Any deviations from this radius shall be approved by the University's Representative. Wire or cable bends in junction or pull boxes shall be made with a long radius. Bends for 600-volt cable shall have a radius of not less than five (5) times the diameter of the cable. Nesting of conduits shall be made when two or more conduits are run in parallel. High voltage feeder conduit runs (above 600 volts), telephone and closed-circuit television conduit runs shall not have more than two 90-degree long radius bends. All other conduit runs (below 600 volts) shall not have more than three 90-degree long radius bends between pull boxes, junction boxes or terminal cabinets.
- PP. Conduit shall not be run closer than 6 inches on the top of light fixtures and cable trays. Do not install conduit on the sides of the cable tray or within 6 inches below the tray.
- QQ. All control apparatus, outlet boxes, junction and pull boxes, and other similar equipment shall be installed and maintained in accessible positions and locations.
- RR. Conduits in furred spaces shall be routed to clear access openings.
- SS. Where steel conduits enter a concrete floor below a surface mounted panelboard, they shall be encased in a concrete curb of sufficient height to match the height of the finished base file.
- TT. Holes for conduits through existing concrete walls or floors shall be made by the "core-drill" method. Core drilling time shall be coordinated with University's Representative to avoid noise problem.

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- UU. Upon completing the installation of any run of conduit, the runs shall be tested to see that they are free from all obstructions and have a smooth interior. Each end of each conduit run shall be plugged with "pennies" and bushings and left plugged until ready to pull circuit wires.
 - VV. A 6-inch square by 2 foot deep concrete block with an embedded brass nameplate shall be installed over the ends of all spare conduits stubbed out of the Building, indicating the origin of the conduits. Verify location with University's Representative prior to rough-in.
 - WW. Telephone and signal conduits placed in the same trench with power service conduit must be separated by no less than 12" of well packed earth or 3" of concrete.
 - XX. Underground conduits for branch circuits without concrete encasement shall have 6-inch thick envelope of sand all around. Conduit installed in unpaved or planted areas shall have 6 inches of sand below and 2-inch thick cap of lean concrete on top.
 - YY. Avoid installing conduits underneath the building.
 - ZZ. The ends of all underground conduits entering pullboxes, manholes, etc. shall terminate in end bells and shall be capped or sealed with an approved compound, Crouse Hinds "Chico A", or equal (no known equal) after installation of wire. Cap empty conduit stubouts at both ends. In landscaped areas, terminate in a waterproof J-box. Junction boxes located above grade in the landscaped areas shall have factory made gaskets, stainless steel screws and factory painting.
 - AAA. Limit to a minimum the routing of conduits within the planting areas of parking lot dividers. Do not run conduit within the planting area parallel to the long dimension of the divider. Coordinate the routing of service conduits to lighting standards and landscape lighting fixtures to avoid conflict with trees and major shrubs.
 - BBB. Underground conduits containing wiring for irrigation system shall not be permitted inside the high voltage (600V & above) manholes or pullboxes.
 - CCC. Branch circuit conduits from the panelboard to the loads shall be installed on the same floor above the accessible ceiling.
 - DDD. A green ground conductor shall be run in all conduits.
- 3.2 BOXES, OUTLETS AND SUPPORTS: Provide boxes in wiring or raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures. Boxes for metallic raceways shall be cast-metal, hub-type when located in wet locations, when surface mounted on outside of exterior surfaces, when installed exposed up to 7 feet above interior floors, when installed under raised floor or when installed in hazardous areas. Boxes in other areas shall be sheet steel. Each box shall have volume required by NFPA 70 for number of conductors enclosed in the box. Provide gaskets for cast-metal boxes installed in wet locations.
- 3.3 JUNCTION AND PULL BOXES
- A. Wherever possible use outlet boxes for junction and pull boxes.

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- B. Locate interior junction and pull boxes in machine rooms, equipment rooms, storage rooms, electrical rooms and similar utility spaces unless otherwise indicated or approved. Where junction or pull boxes must be used in finished areas, use flush boxes only equipped with prime finished sheet metal plates. Fasten plates to boxes with countersunk flat head screws. Provide plates with 3/4" trim all around.
- C. Do not use sectionalized boxes except where indicated. Do not mix feeder and branch circuit conductors in a common pull or junction box.
- D. Where more than one circuit passes through a common junction or pull box, tag conductors to indicate circuit number and panel designation.

END OF SECTION 260533

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SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 1. Conduit, ducts, and duct accessories for direct-buried and concrete-encased duct banks.
 2. Handholes and boxes.
 3. Manholes.

1.3 DEFINITION

- A. RNC: Rigid nonmetallic conduit.

1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
 1. Duct-bank materials, including separators and miscellaneous components.
 2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
 3. Accessories for manholes, handholes, boxes.
 4. Warning tape.
- B. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Include plans, elevations, sections, details, attachments to other work, and accessories, including the following:
 1. Duct entry provisions, including locations and duct sizes.
 2. Reinforcement details.
 3. Frame and cover design and manhole frame support rings.
 4. Grounding details.
 5. Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
 6. Joint details.
- C. Shop Drawings for Factory-Fabricated Handholes and Boxes Other Than Precast Concrete: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:
 1. Duct entry provisions, including locations and duct sizes.
 2. Cover design.
 3. Grounding details.

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4. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

1.5 INFORMATIONAL SUBMITTALS

- A. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.
 1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
 2. Drawings shall be signed and sealed by a qualified professional engineer.
- B. Product Certificates: For concrete and steel used in precast concrete manholes and handholes, as required by ASTM C 858.
- C. Qualification Data: For professional engineer and testing agency.
- D. Source quality-control test reports.
- E. Field quality-control test reports.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
- B. Comply with ANSI C2.
- C. Comply with NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.
- B. Store precast concrete underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.
- C. Lift and support precast concrete units only at designated lifting or supporting points.

1.8 PROJECT CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
 1. Notify Owner no fewer than 14 days in advance of proposed interruption of electrical service.
 2. Do not proceed with interruption of electrical service without Owner's written permission.

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1.9 COORDINATION

- A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.
- B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.

PART 2 - PRODUCTS

2.1 CONDUIT

- A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.
- B. RNC: NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.2 NONMETALLIC DUCTS AND DUCT ACCESSORIES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - 1. Cantex, Inc.
 - 2. CertainTeed Corp.; Pipe & Plastics Group.
 - 3. Condux International, Inc.
 - 4. ElecSys, Inc.
 - 5. Spiraduct/AFC Cable Systems, Inc.
- D. Duct Accessories:
 - 1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
 - 2. Warning Tape: Underground-line warning tape specified in Section 260553 "Identification for Electrical Systems."

2.3 PRECAST CONCRETE HANDHOLES AND BOXES

- 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:

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1. Oldcastle Precast Group.
 2. Utility Concrete Products, LLC.
 3. Utility Vault Co.
- B. Comply with ASTM C 858 for design and manufacturing processes.
- C. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.
1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
 2. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 3. Cover Legend: Molded lettering, "ELECTRIC."
 4. Configuration: Units shall be designed for flush burial and have closed bottom, unless otherwise indicated.
 5. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
 - a. Extension shall provide increased depth of 12 inches.
 - b. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.
 6. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
 - a. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
 - b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
 - c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.
 7. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
 - a. Type and size shall match fittings to duct or conduit to be terminated.
 - b. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.
 8. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.4 HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

- A. Description: Comply with SCTE 77.
1. Color: Gray.
 2. Configuration: Units shall be designed for flush burial and have closed bottom, unless otherwise indicated.
 3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
 4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 5. Cover Legend: Molded lettering, "ELECTRIC."
 6. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.

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7. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
 8. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.
- B. Fiberglass Handholes and Boxes with Polymer Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.
1. 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:
 2. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - a. Armorcast Products Company.
 - b. Carson Industries LLC.
 - c. Christy Concrete Products.
 - d. Synertech Moulded Products, Inc.; a division of Oldcastle Precast.

2.5 PRECAST MANHOLES

- A. Manufacturers: Subject to compliance with requirements, Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Oldcastle Precast Group.
 2. Utility Concrete Products, LLC.
 3. Utility Vault Co.
- B. Comply with ASTM C 858, with structural design loading as specified in Part 3 "Underground Enclosure Application" Article and with interlocking mating sections, complete with accessories, hardware, and features.
1. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
 - a. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.
 - b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
 - c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.
 2. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
 - a. Type and size shall match fittings to duct or conduit to be terminated.
 - b. Fittings shall align with elevations of approaching ducts and be located near interior corners of manholes to facilitate racking of cable.
- C. Concrete Knockout Panels: 1-1/2 to 2 inches thick, for future conduit entrance and sleeve for ground rod.

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- D. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

2.6 UTILITY STRUCTURE ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Oldcastle Precast Group.
 - 2. Utility Concrete Products, LLC.
 - 3. Utility Vault Co.
- B. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.
 - 1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A 48/A 48M, Class 30B with milled cover-to-frame bearing surfaces; diameter, 26 inches.
 - a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - b. Special Covers: Recess in face of cover designed to accept finish material in paved areas.
 - 2. Cover Legend: Cast in. Selected to suit system.
 - a. Legend: "ELECTRIC-LV" for duct systems with power wires and cables for systems operating at 600 V and less.
 - b. Legend: "ELECTRIC-HV" for duct systems with medium-voltage cables.
 - c. Legend: "SIGNAL" for communications, data, and telephone duct systems.
 - 3. Manhole Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.
 - a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C 270, Type M, except for quantities less than 2.0 cu. ft. where packaged mix complying with ASTM C 387, Type M, may be used.
- C. Manhole Sump Frame and Grate: ASTM A 48/A 48M, Class 30B, gray cast iron.
- D. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch- diameter eye, and 1-by-4-inch bolt.
 - 1. Working Load Embedded in 6-Inch, 4000-psi Concrete: 13,000-lbf minimum tension.
- E. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch ID by 2-3/4 inches deep, flared to 1-1/4 inches minimum at base.
 - 1. Tested Ultimate Pullout Strength: 12,000 lbf minimum.
- F. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch bolt, 5300-lbf rated pullout strength, and minimum 6800-lbf rated shear strength.
- G. Cable Rack Assembly: Steel, hot-rolled galvanized, except insulators.
 - 1. Stanchions: T-section or channel; 2-1/4-inch nominal size; punched with 14 holes on 1-1/2-inch centers for cable-arm attachment.

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2. Arms: 1-1/2 inches wide, lengths ranging from 3 inches with 450-lb minimum capacity to 18 inches with 250-lb minimum capacity. Arms shall have slots along full length for cable ties and be arranged for secure mounting in horizontal position at any vertical location on stanchions.
 3. Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.
- H. Cable Rack Assembly: Nonmetallic. Components fabricated from nonconductive, fiberglass-reinforced polymer.
1. Stanchions: Nominal 36 inches high by 4 inches wide, with minimum of 9 holes for arm attachment.
 2. Arms: Arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. Arms shall be available in lengths ranging from 3 inches with 450-lb minimum capacity to 20 inches with 250-lb minimum capacity. Top of arm shall be nominally 4 inches wide, and arm shall have slots along full length for cable ties.
- I. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F. Capable of withstanding temperature of 300 deg F without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.
- J. Cover Hooks: Heavy duty, designed for lifts 60 lbf and greater. Two required.

2.7 SOURCE QUALITY CONTROL

- A. Test and inspect precast concrete utility structures according to ASTM C 1037.
- B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
1. Tests of materials shall be performed by a independent testing agency.
 2. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
 3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 UNDERGROUND DUCT APPLICATION

- A. Ducts for Electrical Cables Over 600 V: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated.
- B. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank, unless otherwise indicated.

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- C. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank, unless otherwise indicated.
- D. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated.

3.2 UNDERGROUND ENCLOSURE APPLICATION

- A. Handholes and Boxes for 600 V and Less:
 - 1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-20 structural load rating.
 - 2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20 structural load rating.
 - 3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-10 structural load rating.
 - 4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf vertical loading.
- B. Manholes: Precast concrete.
 - 1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.
 - 2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

3.3 EARTHWORK

- A. Excavation and Backfill: Comply with Section 312000 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
- C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 329200 "Turf and Grasses" and Section 329300 "Plants."
- D. Cut and patch existing pavement in the path of underground ducts and utility structures according to Section 017329 "Cutting and Patching."

3.4 DUCT INSTALLATION

- A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.

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- B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations, unless otherwise indicated.
- C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.
- D. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch ducts, and vary proportionately for other duct sizes.
 - 1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line.
 - 2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole.
 - 3. Grout end bells into structure walls from both sides to provide watertight entrances.
- E. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."
- F. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.
- G. Pulling Cord: Install 100-lbf- test nylon cord in ducts, including spares.
- H. Concrete-Encased Ducts: Support ducts on duct separators.
 - 1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
 - 2. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
 - a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
 - b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing rod dowels extending 18 inches into concrete on both sides of joint near corners of envelope.
 - 3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.

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4. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
 5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
 6. Minimum Space between Ducts: 3 inches between ducts and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and signal ducts.
 7. Depth: Install top of duct bank at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 30 inches below finished grade in deliberate traffic paths for vehicles, unless otherwise indicated.
 8. Stub-Ups: Use manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Extend concrete encasement throughout the length of the elbow.
 9. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
 - b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.
 10. Warning Tape: Bury warning tape approximately 12 inches above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches of the centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.
- I. Direct-Buried Duct Banks:
1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
 2. Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches between tiers.
 3. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Section 312000 "Earth Moving" for pipes less than 6 inches in nominal diameter.
 4. Install backfill as specified in Section 312000 "Earth Moving."
 5. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand-place backfill to 4 inches over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."
 6. Install ducts with a minimum of 3 inches between ducts for like services and 6 inches between power and signal ducts.
 7. Depth: Install top of duct bank at least 36 inches below finished grade, unless otherwise indicated.
 8. Set elevation of bottom of duct bank below the frost line.

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9. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.
10. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
 - b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
11. Warning Planks: Bury warning planks approximately 12 inches above direct-buried ducts and duct banks, placing them 24 inches o.c. Align planks along the width and along the centerline of duct bank. Provide an additional plank for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional planks 12 inches apart, horizontally.

3.5 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

- A. Precast Concrete Handhole and Manhole Installation:
 1. Comply with ASTM C 891, unless otherwise indicated.
 2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
 3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- B. Elevations:
 1. Manhole Roof: Install with rooftop at least 15 inches below finished grade.
 2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.
 3. Install handholes with bottom below the frost line
 4. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.
 5. Where indicated, cast handhole cover frame integrally with handhole structure.
- C. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.
- D. Manhole Access: Circular opening in manhole roof; sized to match cover size.
 1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
 2. Install chimney, constructed of precast concrete collars and rings to support frame and cover and to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.
- E. Dampproofing: Apply dampproofing to exterior surfaces of manholes after concrete has cured at least three days. Dampproofing materials and installation are specified in Section 071113 "Bituminous Dampproofing." After ducts have been connected and grouted, and before backfilling, dampproof joints and connections and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.

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- F. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, as required for installation and support of cables and conductors and as indicated.
- G. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches for manholes and 2 inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.
- H. Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each manhole cover.

3.6 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas and traffic ways, set so cover surface will be flush with finished grade. Set covers of other handholes 1 inch above finished grade.
- D. Install handholes and boxes with bottom below the frost line
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.
- F. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
- G. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.
 - 1. Concrete: 3000 psi, 28-day strength, complying with Section 033000 "Cast-in-Place Concrete," with a troweled finish.
 - 2. Dimensions: 10 inches wide by 12 inches deep

3.7 GROUNDING

- A. Ground underground ducts and utility structures according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.8 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
 - 1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
 - 2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
 - 3. Test manhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.9 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
- B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION 260543

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SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
 - 2. Sleeve-seal systems.
 - 3. Sleeve-seal fittings.
 - 4. Grout.
 - 5. Silicone sealants.
- B. Related Requirements:
 - 1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. LEED Submittals:
 - 1. Product Data for Credit EQ 4.1: For sealants, documentation including printed statement of VOC content.
 - 2. Laboratory Test Reports for Credit EQ 4: For sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Wall Sleeves:
 - 1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
 - 2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

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- B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.
- C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.
- E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- F. Sleeves for Rectangular Openings:
 - 1. Material: Galvanized sheet steel.
 - 2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
 - b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
 - 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Advance Products & Systems, Inc.
 - b. CALPICO, Inc.
 - c. Metraflex Company (The).
 - d. Pipeline Seal and Insulator, Inc.
 - e. Proco Products, Inc.
 - 2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 3. Pressure Plates: Carbon steel.
 - 4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.
 - 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Presealed Systems.

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2.4 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
 - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
 - 2. Sealant shall have VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 3. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
 - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
 - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 - 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.

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4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
 5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 260544

SECTION 260548 - VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Isolation pads.
 - 2. Spring isolators.
 - 3. Restrained spring isolators.
 - 4. Channel support systems.
 - 5. Restraint cables.
 - 6. Hanger rod stiffeners.
 - 7. Anchorage bushings and washers.
- B. Related Sections include the following:
 - 1. Section 260529 "Hangers and Supports for Electrical Systems" for commonly used electrical supports and installation requirements.

1.3 DEFINITIONS

- A. The CBC: California Building Code.
- B. ICC-ES: ICC-Evaluation Service.
- C. OSHPD: Office of Statewide Health Planning and Development for the State of California.

1.4 PERFORMANCE REQUIREMENTS

- A. Seismic-Restraint Loading:
 - 1. Site Class as Defined in the CBC: D.
 - 2. Assigned Seismic Use Group or Building Category as Defined in the CBC: III.
 - a. Component Importance Factor: 1.0.
 - b. Component Response Modification Factor: Per ASCE 7-10 Table 13.6-1.
 - c. Component Amplification Factor: Per ASCE 7-10 Table 13.6-1.
 - 3. Design Spectral Response Acceleration at Short Periods (0.2 Second): SDS= 1.00g.
 - 4. Design Spectral Response Acceleration at 1.0-Second Period: S1S=0.60g.

1.5 ACTION SUBMITTALS

- A. Product Data: For the following:
1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
 - a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
 - b. Annotate to indicate application of each product submitted and compliance with requirements.
 3. Restrained-Isolation Devices: Include ratings for horizontal, vertical, and combined loads.
- B. Delegated-Design Submittal: For seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators and seismic restraints.
 - a. Coordinate design calculations with wind-load calculations required for equipment mounted outdoors. Comply with requirements in other electrical Sections for equipment mounted outdoors.
 2. Indicate materials and dimensions and identify hardware, including attachment and anchorage devices.
 3. Field-fabricated supports.
 4. Seismic-Restraint Details:
 - a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
 - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events.
 - c. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of seismic bracing for electrical components with other systems and equipment in the vicinity, including other supports and seismic restraints.
- B. Qualification Data: For testing agency.
- C. Welding certificates.
- D. Field quality-control test reports.

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- E. Catalog cuts and data sheets on specific vibration isolators, mufflers, electrical box pads and other equipment to be utilized showing compliance with the specification.
 - 1. An itemized list showing the items of equipment to be isolated, the isolator type and model number selected, isolator loading and deflection.
 - 2. The Contractor shall obtain written instructions from the vibration isolation manufacturer as to the proper installation and adjustment of vibration isolation devices and seismic restraints.

1.7 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
- B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.
- E. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - 1. Ace Mountings Co., Inc.
 - 2. Amber/Booth Company, Inc.
 - 3. California Dynamics Corporation.
 - 4. Isolation Technology, Inc.
 - 5. Kinetics Noise Control.
 - 6. Mason Industries.
 - 7. Vibration Eliminator Co., Inc.
 - 8. Vibration Isolation.

9. Vibration Mountings & Controls, Inc.
- C. Pads: Arrange in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
1. Resilient Material: Oil- and water-resistant neoprene.
- D. Spring Isolators: Freestanding, laterally stable, open-spring isolators.
1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
 6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
- E. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch- thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
 2. Restraint: Seismic or limit-stop as required for equipment and authorities having jurisdiction.
 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- F. Equipment Isolation Requirements:
1. Floor Mounted Transformers: Isolator Type E. Minimum static deflection 0.15”.
 2. Distribution Panels Connected to Transformers: Isolator Type E. Minimum static deflection 0.1”.
 3. Liquid-filled Transformers: Isolator Type A.
 4. Lighting Inverter and UPS: Isolator Type E. Minimum static deflection 0.15”.
 5. Suspended Raceways Between Liquid-Filled Transformers and Distribution Boards: Isolator Type F. Minimum static deflection 0.2”.
- G. Isolator Type Information:
1. Type E: Neoprene isolator capable of resisting a seismic load of 1.0 G in all directions. The mount shall consist of a captive steel insert embedded into a neoprene element which is enclosed by a steel housing which also includes floor mounting holes. The isolator shall have a minimum rated deflection of 0.15 inches in compression, 0.12 inches in tension and 0.09 inches in shear. Locate at 4 corners of transformer, lighting inverters, and UPS. Bolt to floor. Wall-mounted not permitted.

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2. Type A: Neoprene pad. Waffle, ribbed, or other forms. Typically 1/4 to 5/16 inch thick. Durometers of 40-65. Static deflections from 0.01 to 0.07 inches. Nominal design 40 durometer for 0.05 inches static deflection. Provide steel load distribution plates. Size of pad to be specified by isolator supplier base on load per pot. Mason W and WM, Vibrex R, or equal.
3. Type F: A suspension hanger with a steel box frame and a molded neoprene in shear element. A neoprene grommet shall be provided at the location where the hanger rod passes through the hanger box so that no metal-to-metal contact occurs.

H. Boxes and Conduit:

1. Provide electrical box pads at all junction boxes located within sound insulated drywall partitions. Lowry's Outlet Box Pads, or equal.
2. Provide flexible electrical connections:
 - a. At connections to motors or other vibrating equipment.
 - b. Conduit over 1 inch OD: Make electrical connections to vibrating equipment via flexible expansion/deflection conduit coupling sized as required. Coupling shall have a flexible and watertight outer jacket, an internal grounding strap, plastic inner sleeve to maintain smooth wireway, and end hubs with threads to fit standard threaded metal conduit. XD Expansion Deflection Coupling by Crouse-Hinds, Type DF Expansion and Deflection fitting by Spring City Electrical, or equal.
 - c. For conduit under 1 inch OD: Use flexible conduit with slack at least 3 feet or 15 diameters long, whichever is the longer or provide a flexible coupling as defined above.

I. General Properties:

1. All vibration isolation equipment exposed to moisture or an outdoor environment shall be coated as follows:
 - a. All steel parts shall be hot-dipped galvanized.
 - b. All bolts shall be cadmium plated.
 - c. All springs shall be cadmium plated and neoprene coated.

2.2 SEISMIC-RESTRAINT DEVICES

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 1. Amber/Booth Company, Inc.
 2. California Dynamics Corporation.
 3. Cooper B-Line, Inc.; a division of Cooper Industries.
 4. Hilti Inc.
 5. Loos & Co.; Seismic Earthquake Division.
 6. Unistrut; Tyco International, Ltd.
- C. General Requirements for Restraint Components: Rated strengths, features, and application requirements shall be as defined in reports by an agency acceptable to authorities having jurisdiction.

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1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
- D. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.
- E. Restraint Cables: ASTM A 603 galvanized-steel cables with end connections made of steel assemblies with thimbles, brackets, swivels, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.
- F. Hanger Rod Stiffener: Steel slotted-support-system sleeve with internally bolted connections to hanger rod. Do not weld stiffeners to rods.
- G. Bushings for Floor-Mounted Equipment Anchor: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchors and studs.
- H. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices.
- I. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.
- J. Mechanical Anchor: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchors with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.
- K. Adhesive Anchor: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.3 FACTORY FINISHES

- A. Finish: Manufacturer's standard prime-coat finish ready for field painting.
- B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
 1. Powder coating on springs and housings.
 2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
 3. Baked enamel or powder coat for metal components on isolators for interior use.
 4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
- B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Equipment and Hanger Restraints:
 - 1. Install restrained isolators on electrical equipment.
 - 2. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
 - 3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.
- B. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- C. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- D. Drilled-in Anchors:
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.

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2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- E. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where they terminate with connection to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post connection testing has been approved), and with at least seven days' advance notice.
 3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
 5. Test to 90 percent of rated proof load of device.
 6. Measure isolator restraint clearance.
 7. Measure isolator deflection.
 8. Verify snubber minimum clearances.
 9. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Prepare test and inspection reports.

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3.6 ADJUSTING

- A. Adjust isolators after isolated equipment is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Adjust active height of spring isolators.
- D. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.2 VIBRATION ISOLATION DEVICES

- A. Transmission of perceptible vibration or structure borne noise to occupied areas by equipment installed under this Contract will not be permitted.
- B. Vibration isolators shall be installed per manufacturer's directions.
- C. Use of vibration isolators for lighting inverter and UPS shall be coordinated with lighting inverter supplier.
- D. Flexible electrical connections:
 - 1. Installation of flexible electrical connections to vibration isolated equipment shall in no way impair or restrain the function of the aforementioned vibration isolation.
 - 2. Option 1: Install the flexible conduit in a grossly slack loop form or shallow "U" form. Install the stranded conductors with sufficient slack to accommodate maximum possible movement.
 - 3. Option 2: The flexible coupling shall be free and not in contact with any nearby building construction and shall be installed slack and free of strain in any direction. Install stranded conductors as above.
- E. All vibration isolation devices, including auxiliary steel bases shall be designed and furnished by a single manufacturer or supplier, who will be responsible for adequate coordination of all phases of this work.
- F. The vibration isolation manufacturer, or his representative, shall be responsible for providing such supervision as may be necessary to assure correct installation and adjustment of the isolators. Upon completion of the installation and after the system is put into operation, the manufacturer, or his representative, shall make a final inspection and submit his report to the Architect in writing, certifying the correctness of installation and compliance with approved submittal data.

3.3 OUTLET BOX PADS

- A. All holes in outlet boxes in sound rated walls shall be completely covered with electrical box pads molded and pressed to the back side of the box.

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3.4 COORDINATION

- A. The contractor shall coordinate his work with other trades to avoid rigid contact between isolated equipment and raceways with the building. He shall inform other trades following his work to avoid any contact which would reduce the vibration isolation.

END OF SECTION 260548

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Nameplates and labels.
- B. Wire and cable markers.
- C. Medium voltage cable tags.
- D. Underground warning tape.
- E. Conduit markers.
- F. Warning Signs.

1.2 APPLICABLE PUBLICATIONS:

The following publications form a part of this specification. The publications are referred to in the text by the basic designation only.

- A. American National Standards Institute, Inc. (ANSI) Publications:
 - 1. C2-99 National Electrical Safety Code
 - 2. Z35.1-97 Safety Color Code
 - 3. Z35.2-97 Environmental and Facility Safety Signs
 - 4. Z35.5-97 Accident Prevention Tags (for Temporary Hazards)
- B. State of California Administrative Code:
 - 1. Title 8, Industrial Relations
 - 2. Title 24, Part 3, CCR, California Electrical Code
- C. National Fire Protection Association (NFPA) Publication:
 - 1. 70-2008 National Electrical Code (NEC)

1.3 SUBMITTALS

- A. Submit under provisions of Division 1 and 26 05 00.
- B. Product Data: Provide data for:
 - 1. Nameplates
 - 2. Wire/Cable markers
 - 3. Medium voltage cable tags
 - 4. Underground warning tape
 - 5. Conduit markers

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- C. Field Samples: Provide for:
 - 1. Nameplates: (1) sample
 - 2. Wire/Cable markers: (1) sample
 - 3. Medium voltage cable tags: (1) sample
 - 4. Underground warning tape: (1) sample, 24" long
 - 5. Conduit markers: (1) sample
 - 6. Property ID Labels: see Section 2.7

1.4 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.

PART 2 - PRODUCTS

2.1 NAMEPLATES

- A. Nameplate designations shall clearly state:
 - 1. Manufacturer's nameplate including equipment design rating of current, voltage, kVA, HP, bus bracing rating, or as applicable.
 - 2. Equipment nameplate designating system usage and purpose, system nominal voltage, equipment rating for kVA, amperes, HP and RPM as applicable.
 - 3. Receptacles and lighting switches (wiring devices): Panel designation and circuit number.
- B. Nameplates shall be melamine plastic, 0.125-inch thick, white with black center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering into the black core. Minimum size of nameplates shall be 1.0 inch by 2.5 inches except that wiring device nameplates shall be 0.5 inch by 1.5 inch. Lettering shall be normal block style unless otherwise noted.
- C. Nameplates shall be secured permanently with screws.
- D. Letter Size:
 - 1. Use 0.25 inch letters for identifying individual equipment and loads.
 - 2. Use 0.50 inch for identifying grouped equipment and loads.

2.2 WIRE MARKERS

- A. Description: Heat shrinkable, flame-retarded, crosslinked polyolefin wire marker. Wire tags shall have a dielectric strength of 500 V/mil minimum and a temperature range from -30°C to 105°C. Thermoplastic or wraparound tags are not acceptable. All tags shall be printed using a 9 or 24 pin dot matrix printer. Raychem ShrinkMark™, Brady Permasleeve or approved equal.
- B. Legend:
 - 1. Power and Lighting Circuits: Branch circuit or feeder number per design builder drawings.

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2.3 UNDERGROUND WARNING TAPE:

- A. The tape shall be 6" wide x 0.004" polyethylene plastic with a metallic core detection tape. The tape shall be of a bright color contrast with soil, with identifying printing on one side. The imprint shall read "Caution (type of utility) Line Buried Below". The identifying lettering shall be repeated continuously the full length of the tape. Seton style 6ELE, THOR Enterprises or approved equal.

2.4 CONDUIT MARKERS:

- A. ANSI Z35.1 G.2. Pressure-sensitive, adhesive-backed vinyl markers with fade-proof ultraviolet inhibitors, black characters on orange background. 2.25" x 9" marker with 1.5" high letters. Marker shall read "4160 VOLTS" depending on circuit phase-to-phase voltage. Carlton Industries type EM-1, Seton Code Electrical Markers style AA, Brady B-500 series or approved equal.

2.5 MV CABLE TAGS

- A. Provide as indicated on the plans.

2.6 WARNING SIGNS: ANSI Z35.1, Z35.2 AND Z35.5.

- A. Warning signs shall be minimum 18-gauge steel white porcelain enamel finish with red lettering. Lettering to read "DANGER - HIGH VOLTAGE" with "DANGER" in 1-1/2" letters and "HIGH VOLTAGE" in 1" letters. New warning signs shall be provided on door/gate or immediately above door of all electrical equipment rooms, vaults, closets or outdoor substations containing equipment energized above 150 volts to ground, except where such spaces are accessible from public areas.
- B. Warning designations in 1" red letters shall be painted by stencil or pre-printed adhesive on each new pull box or cabinet stating "DANGER" and giving voltage of enclosed conductors such as "DANGER - 5000 VOLTS", for all systems over 150 volts to ground.
- C. A warning sign showing "ELECTRICAL ROOM – NO STORAGE PERMITTED" shall also be provided at the entrance of each electrical room.

2.7 PROPERTY ID LABELS FOR EQUIPMENT

- A. List of Equipment for Property ID Labels:
 - 1. Submit list of equipment of property ID labels, including location, function, equipment manufacturer's name, and model and serial numbers for verification by Engineer. After acceptance by engineer, submit hard and electronic copies for assignment of bar-coding identification numbers by Campus Facility Services.
 - 2. Samples: Submit two property ID labels.

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3. Closeout submittals: Record actual locations of labeled items; include bar-code numbers, and provide as-built electronic copy of list of equipment with location, function, equipment manufacturer's name, and model and serial numbers.
 4. Convene minimum two weeks prior to commencing work of this section
- B. Labels
1. Material: Anodized Aluminum
 2. Size: 2x0.875 inches
 3. Attachment: Adhesive backed
 4. Message: Printed identification

PART 3 - EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive nameplates and labels.
- B. Coordinate installation of nameplates, markers and warning signs with the sequence of painting. Refer to Section for, "Painting."

3.2 NAMEPLATES

- A. Provide laminated plastic nameplates for all electrical equipment and devices including, but not limited to, the following:
 1. Enclosures for switchgear, medium voltage controllers, transformers, low voltage switchgear, motor control centers, variable frequency drives, panels, panelboards, busway, pull boxes, junction boxes, cabinets and motors.
 2. Enclosures for all separately enclosed devices including but not limited to disconnect switches, circuit breakers, contactors, time switches, control stations and relays.
 3. All receptacles and lighting switches.
 4. Special systems such as but not limited to telephone, warning and signal systems. Identification shall be at each equipment rack, terminal cabinet, control panel, annunciator, and pull box.
 5. Devices mounted within and part of an equipment including circuit breakers, switches, control devices, control transformers, relays, indication devices and instruments.
- B. Mounting: Provide number, location, and letter designation of nameplates as indicated. Install nameplate parallel to equipment lines. Fasten nameplates to enclosures with a minimum of two sheet-metal screws or two rivets. Fasten nameplates to device plates with suitable adhesive. Secure nameplate to inside surface of door on panelboard that is recessed in finished locations.

3.3 WIRE MARKERS:

- A. Provide markers for each conductor at panelboard gutters, pull boxes, junction boxes, outlet boxes, and each load connection.

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3.4 UNDERGROUND WARNING TAPE:

- A. Identifying tapes shall be buried in all utility line trenches. Each trench shall have one tape above the centerline of each duct. In non-paved areas, the tape shall be located approximately 8" below the final finish grade. In areas where paving is to be installed, the tape shall be placed immediately below the paving or its sub-base.

3.5 CONDUIT MARKERS:

- A. Provide markers on all exposed conduit for circuits greater than 600 volts. Provide markers at lengths not greater than 20 feet on center.

3.6 MV CABLE TAGS:

- A. All new cables installed shall be identified at each end and at all accessible points in between (such as manholes, pull boxes, switchgear, etc.). Identify existing cables that are being re-routed or changed with new tags. Modification of existing tags shall not be acceptable.

3.7 WARNING SIGN MOUNTING:

- A. Signs shall be permanently mounted with cadmium plated steel screws or nickel-plated brass bolts.

END OF SECTION 260553

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SECTION 260573 – OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes computer-based, fault-current, overcurrent protective device coordination studies and arc flash study. Protective devices shall be set based on results of the protective device coordination study.
- B. The short circuit study, coordination study and arc flash study shall include all voltage classes of equipment from the Owner's main incoming line, existing protective devices at the medium voltage (12KV) switching station, and down to and including panel boards. The entire electrical system shall be included in the coordination study including emergency/standby power system and feeders. Verify characteristics and settings of existing devices in the field and from the manufacturer.
- C. The arc flash study shall determine the incident energy level and PPE category for applicable equipment enclosure.
- D. Coordination of series rated devices is not permitted unless specifically indicated.

1.3 DEFINITIONS:

- A. IEEE: Institute of Electrical and Electronics Engineers
- B. NETA ATS: InterNational Electrical Testing Association - Acceptance Testing Specifications
- C. PPE: Personal Protective Equipment

1.4 ACTION SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. Submittals may be in digital form if requested by the Owner's Representative.
 - 1. Coordination-study input data, including completed computer program input data sheets.
 - 2. Complete Study and Equipment Evaluation Reports.
 - 3. Coordination-Study Report.

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4. The study shall be signed and stamped by a CA registered professional engineer responsible for the study.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For coordination-study specialist.
- B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.

1.6 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.
- B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
 1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.
 2. The Engineer performing the study shall be located within 50 miles of the project and be available for on-site meeting on short notice.
- C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.
- D. Comply with IEEE 399 for general study procedures.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Available Computer Software Developers: Subject to compliance with requirements, companies offering computer software programs that may be used in the Work include, but are not limited to, the following:
- B. Computer Software Developers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 1. SKM Systems Analysis, Inc.
 2. E-tap

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

- A. Comply with IEEE 399.
- B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.
 - 1. Additional Features:
 - a. Arcing faults.
 - b. Simultaneous faults.
 - c. Explicit negative sequence.
 - d. Mutual coupling in zero sequence.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.
 - 1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 POWER SYSTEM DATA

- A. Gather and tabulate the following input data to support coordination study:
 - 1. Product Data for overcurrent protective devices specified in other electrical Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 - 2. Impedance of utility service entrance. Verify from the serving Utility Company and include a written letter of documentation.
 - 3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
 - a. Circuit-breaker and fuse-current ratings and types including existing devices.
 - b. Relays and associated power and current transformer ratings and ratios.
 - c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
 - d. Generator kilovolt amperes, size, voltage, and source impedance.
 - e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
 - f. Busway ampacity and impedance.

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- g. Motor horsepower and code letter designation according to NEMA MG 1.
4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
 - a. Special load considerations, including starting inrush currents and frequent starting and stopping.
 - b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
 - c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
 - d. Generator thermal-damage curve.
 - e. Ratings, types, and settings of utility company's overcurrent protective devices.
 - f. Special overcurrent protective device settings or types stipulated by utility company.
 - g. Time-current-characteristic curves of devices indicated to be coordinated.
 - h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
 - i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
 - j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.
5. Field verify settings of existing devices.

3.3 FAULT-CURRENT STUDY

- A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:
 1. Switchgear and switchboard bus.
 2. Medium-voltage controller.
 3. Motor-control center.
 4. Distribution panelboard.
 5. Branch circuit panelboard.
- B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.
- C. Calculate momentary and interrupting duties on the basis of maximum available fault current.
- D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 141 and IEEE 242.
 1. Transformers:
 - a. ANSI C57.12.10.
 - b. ANSI C57.12.22.
 - c. ANSI C57.12.40.
 - d. IEEE C57.12.00.
 - e. IEEE C57.96.

2. Medium-Voltage Circuit Breakers: IEEE C37.010.
3. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
4. Low-Voltage Fuses: IEEE C37.46.

E. Study Report:

1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.
2. Show interrupting (5-cycle) and time-delayed currents (6 cycles and above) on medium-voltage breakers as needed to set relays and assess the sensitivity of overcurrent relays.

F. Equipment Evaluation Report:

1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

3.4 COORDINATION STUDY

- A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.
1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
 2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.
 3. Calculate the maximum and minimum ground-fault currents.
- B. Comply with IEEE 141 and IEEE 242 recommendations for fault currents and time intervals.
- C. Transformer Primary Overcurrent Protective Devices:
1. Device shall not operate in response to the following:
 - a. Inrush current when first energized.
 - b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
 - c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
 2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.
- D. Motors served by voltages more than 600 V shall be protected according to IEEE 620.
- E. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

- F. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
 - a. Device tag.
 - b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
 - c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
 - d. Fuse-current rating and type.
 - e. Ground-fault relay-pickup and time-delay settings.
 2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
 - a. Device tag.
 - b. Voltage and current ratio for curves.
 - c. Three-phase and single-phase damage points for each transformer.
 - d. No damage, melting, and clearing curves for fuses.
 - e. Cable damage curves.
 - f. Transformer inrush points.
 - g. Maximum fault-current cutoff point.
- G. Completed data sheets for setting of overcurrent protective devices.

3.5 ARC FLASH HAZARD STUDY

- A. Perform an arc flash hazard study after the short circuit and protective device coordination study has been completed based upon IEEE standard 1584 "IEEE Guide for Performing Arc Flash Hazard Calculation".
- B. The study shall be calculated by means of the SKM PowerTools for Windows computer software package. Pertinent data, rationale employed, and assumptions in developing the calculations shall be incorporated in the introductory remarks of the study.
- C. The study shall be in accordance with applicable NFPA 70E, OSHA 29-CFR, part 1910 Sub part S and IEEE 1584 Standards.
- D. Determine the following:
1. Flash Hazard Protection Boundary in inches.
 2. Limited Approach Boundary.
 3. Restricted Boundary.
 4. Prohibited Boundary.
 5. Incident Energy Level.
 6. Required Personal Protective Equipment Class.
 7. Type of Fire Rating Clothing.
- E. Produce an Arc Flash Warning label based on the results of the incident energy study. Install a warning label (orange ≤ 40 cal/cm²) or danger label (red > 40 cal/cm²) approximately 3"X4" (Brady multi color or equal) for every point in the system as specified in accordance with ANSI Z535.4-2002. The label must be suitable for indoor or outdoor environments for at least 3 years

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and contain listing items 1 - 7 above. Also include the large “Warning” or “Danger” on the top; “Arc Flash and Shock Hazard” appropriate PPE required; equipment/bus name, system operating voltage, and date of issue.

- F. Produce Bus Detail sheets that listed the items D 1 - 7 from above and the following traditional items:
1. Bus Name.
 2. Upstream Protective Device Name, Type and Settings.
 3. Bus Line to Line Voltage.
- G. Produce Arc Flash Evaluation Summary Sheet listing the following additional items:
1. Bus Name.
 2. Upstream Protective Device Name, Type and Settings.
 3. Bus Line to Line Voltage.
 4. Bus Bolted Fault
 5. Protective Device Bolted Fault Current.
 6. Arcing Fault Current.
 7. Protective Device Trip/Delay Time.
 8. Breaker Opening Time.
 9. Solidly Grounded Column.
 10. Equipment Type.
 11. Gap.
 12. Arc Flash Boundary.
 13. Working Distance.
 14. Incident Energy.
 15. Required Protective Fire Rated Clothing Type and Class.
- H. Safety Training: The contractor shall hire the services of a trained engineer to provide to Owner’s maintenance staff an arc flash safety training per requirements referenced in OSHA 1910.269; OSHA 1910 Subpart S and NFPA 70E. This shall include:
1. Proper use of system analysis data.
 2. Interpretation of hazard labels.
 3. Selection and utilization of personal protective equipment (PPE).
 4. Safe work practices.

3.6 OVERCURRENT PROTECTIVE DEVICE SETTING

- A. Manufacturer's Field Service: Engage a factory-authorized service representative, of electrical distribution equipment being set and adjusted to assist in setting of over-current protective devices within equipment.
- B. Testing: Engage qualified independent testing agency to perform the following device setting and to prepare test reports. Refer to section 260126 “Electrical Acceptance Testing” for additional requirements. Perform the following device setting and prepare reports:
- C. Verify that over-current protective devices meet parameters used in studies.
- D. Adjust devices to values listed in study results.

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- E. Adjust devices according to recommendations in Chapter 7, "Inspection and Test Procedures," and Tables 10.7 and 10.8 in latest standard of NETA ATS.

END OF SECTION 260573

SECTION 260913 - ELECTRICAL POWER MONITORING AND CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes the following for monitoring of electrical power system:
 - 1. PC-based workstation(s) and software.
 - 2. Communication network and interface modules for RS-485, Modbus TCP/IP data transmission protocols.

1.3 DEFINITIONS

- A. Ethernet: Local area network based on IEEE 802.3 standards.
- B. Firmware: Software (programs or data) that has been written onto read-only memory (ROM). Firmware is a combination of software and hardware. Storage media with ROMs that have data or programs recorded on them are firmware.
- C. HTML: Hypertext markup language.
- D. I/O: Input/output.
- E. KY Pulse: A term used by the metering industry to describe a method of measuring consumption of electricity that is based on a relay changing status in response to the rotation of the disk in the meter.
- F. LAN: Local area network; sometimes plural as "LANs."
- G. LCD: Liquid crystal display.
- H. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or remote-control, signaling and power-limited circuits.
- I. Modbus TCP/IP: An open protocol for exchange of process data.
- J. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.
- K. PC: Personal computer; sometimes plural as "PCs."

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- L. rms: Root-mean-square value of alternating voltage, which is the square root of the mean value of the square of the voltage values during a complete cycle.
- M. RS-232: A TIA standard for asynchronous serial data communications between terminal devices.
- N. RS-485: A TIA standard for multipoint communications using two twisted-pairs.
- O. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.
- P. THD: Total harmonic distortion.
- Q. UPS: Uninterruptible power supply; used both in singular and plural context.
- R. WAN: Wide area network.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. 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. Shop Drawings: For power monitoring and control equipment. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Outline Drawings: Indicate arrangement of components and clearance and access requirements.
 - 2. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
 - 3. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 4. Wiring Diagrams: For power, signal, and control wiring. Coordinate nomenclature and presentation with a block diagram.
 - 5. UPS sizing calculations for workstation.
 - 6. Surge Suppressors: Data for each device used and where applied.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified manufacturer.
- B. Field quality-control reports.
- C. Other Informational Submittals:
 - 1. Manufacturer's system installation and setup guides, with data forms to plan and record options and setup decisions.

1.6 CLOSEOUT SUBMITTALS

- A. 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 017823 "Operation and Maintenance Data," include the following:
 - 1. Operating and applications software documentation.
 - 2. Software licenses.
 - 3. Software service agreement.
 - 4. PC installation and operating documentation, manuals, and software for the PC and all installed peripherals. Software shall include system restore, emergency boot diskettes, and drivers for all installed hardware. Provide separately for each PC.
 - 5. Hard copies of manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware, and PDF files on CD-ROM of the hard-copy submittal.

- B. Software and Firmware Operational Documentation:
 - 1. 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.
 - 2. Software operating and upgrade manuals.
 - 3. Software Backup: On a magnetic media or compact disc, complete with Owner-selected options.
 - 4. Device address list and the set point of each device and operator option, as set in applications software.
 - 5. Graphic file and printout of graphic screens and related icons, with legend.

- C. Software Upgrade Kit: For Owner to use in modifying software to suit future power system revisions or power monitoring and control revisions.

- D. Software licenses and upgrades required by and installed for operating and programming digital and analog devices.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

- B. Manufacturer Qualifications: A firm experienced in manufacturing power monitoring and control equipment similar to that indicated for this Project and with a record of successful in-service performance.

- 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.

1.8 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.

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- B. Coordinate Work of this Section with those in Sections specifying distribution components that are monitored or controlled by power monitoring and control equipment.

1.9 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning with Substantial Completion, provide software support for two years.
- B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include the operating systems. Upgrade shall include new or revised licenses for use of software.
 - 1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Corporation; Cutler-Hammer products.
 - 2. General Electric Company; GE Consumer & Industrial.
 - 3. Schneider Electric - Power Management Operation.
 - 4. Shark Meters

2.2 FUNCTIONAL DESCRIPTION

- A. Instrumentation and Recording Devices: Monitor and record load profiles and chart energy consumption patterns.
 - 1. Calculate and Record the Following:
 - a. Load factor.
 - b. Peak demand periods.
 - 2. Measure and Record Metering Data for the Following:
 - a. Electricity.
- B. Power Quality Monitoring: Identify power system anomalies and measure, display, and record trends and alarms of the following power quality parameters:
 - 1. Voltage regulation and unbalance.
 - 2. Continuous three-phase rms voltage.
 - 3. Periodic max./min./avg. voltage samples.
 - 4. Harmonics.
 - 5. Voltage excursions.
- C. System: Report equipment status and power system control.

2.3 SYSTEM REQUIREMENTS

- A. BAS Interface: Provide factory-installed hardware and software to enable the BAS to monitor, display, and record data for use in processing reports.
 - 1. Hardwired Monitoring Points: Electrical power demand (kilowatts), electrical power consumption (kilowatt-hours), power factor.
 - 2. Modbus communication utilizing BACnet protocol interface with the BAS shall enable the BAS operator to remotely monitor meter information from a BAS operator workstation. Control features and monitoring points displayed locally at metering panel shall be available through the BAS.

2.4 COMMUNICATION COMPONENTS AND NETWORKS

- A. Network Configuration: High-speed, multi-access, open nonproprietary, industry standard communication protocol; LANs complying with EIA 485, 100 Base-T Ethernet, and Modbus TCP/IP.

2.5 POWER MONITORS

- A. Separately mounted, permanently installed instrument for power monitoring and control, complying with UL 1244.
 - 1. Enclosure: NEMA 250, Type 1.
- B. 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 non-air-conditioned 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.
- C. rms Real-Time Measurements:
 - 1. Current: Each phase, neutral, average of three phases, percent unbalance.
 - 2. Voltage: Line-to-line each phase, line-to-line average of three phases, line-to-neutral each phase, line-to-neutral average of three phases, line-to-neutral percent unbalance.
 - 3. Power: Per phase and three-phase total.
 - 4. Reactive Power: Per phase and three-phase total.
 - 5. Apparent Power: Per phase and three-phase total.
 - 6. Power Factor: Per phase and three-phase total.
 - 7. Displacement Power Factor: Per phase and three-phase total.
 - 8. Frequency.
 - 9. THD: Current and voltage.
 - 10. Accumulated Energy: Real kWh, reactive kVARh, apparent kVAh (signed/absolute).
 - 11. Incremental Energy: Real kWh, reactive kVARh, apparent kVAh (signed/absolute).
 - 12. Conditional Energy: Real kWh, reactive kVARh, apparent kVAh (signed/absolute).
- D. Demand Current Calculations, per Phase, Three-Phase Average and Neutral:
 - 1. Present.
 - 2. Running average.
 - 3. Last completed interval.

4. Peak.
- E. Demand Real Power Calculations, Three-Phase Total:
1. Present.
 2. Running average.
 3. Last completed interval.
 4. Predicted.
 5. Peak.
 6. Coincident with peak kVA demand.
 7. Coincident with kVAR demand.
- F. Power Demand Calculations: According to one of the following calculation methods, selectable by the user:
1. Thermal Demand: Sliding window updated every second for the present demand and at end of the interval for the last interval. Adjustable window that can be set in 1-minute intervals, from 1 to 60 minutes.
 2. Block Interval with Optional Subintervals: Adjustable for 1-minute intervals, from 1 to 60 minutes. User-defined parameters for the following block intervals:
 - a. Sliding block that calculates demand every second, with intervals less than 15 minutes, and every 15 seconds with an interval between 15 and 60 minutes.
 - b. Fixed block that calculates demand at end of the interval.
 - c. Rolling block subinterval that calculates demand at end of each subinterval and displays it at end of the interval.
 3. Demand Calculation Initiated by a Synchronization Signal:
 - a. Signal is a pulse from an external source. Demand period begins with every pulse. Calculation shall be configurable as either a block or rolling block calculation.
 - b. Signal is a communication signal. Calculation shall be configurable as either a block or rolling block calculation.
 - c. Demand can be synchronized with clock in the power meter.
- G. Sampling:
1. Current and voltage shall be digitally sampled at a rate high enough to provide accuracy to 63rd harmonic of 60-Hz fundamental.
 2. Power monitor shall provide continuous sampling at a rate of 128 samples per cycle on all voltage and current channels in the meter.
- H. Minimum and Maximum Values: Record monthly minimum and maximum values, including date and time of record. For three-phase measurements, identify phase of recorded value. Record the following parameters:
1. Line-to-line voltage.
 2. Line-to-neutral voltage.
 3. Current per phase.
 4. Line-to-line voltage unbalance.
 5. Line-to-neutral voltage unbalance.
 6. Power factor.
 7. Displacement power factor.
 8. Total power.
 9. Total reactive power.
 10. Total apparent power.
 11. THD voltage L-L.
 12. THD voltage L-N.

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13. THD current.
 14. Frequency.
- I. Current and Voltage Ratings:
1. Designed for use with current inputs from standard instrument current transformers with 5-A secondary and shall have a metering range of 0-10 A.
 2. Withstand ratings shall not be less than 15 A, continuous; 50 A, lasting over 10 seconds, no more frequently than once per hour; 500 A, lasting 1 second, no more frequently than once per hour.
 3. Designed for use with voltage inputs from standard instrument potential transformers with a 120-V secondary.
- J. Accuracy:
1. Comply with ANSI C12.20, Class 0.5; and IEC 60687, Class 0.5 for revenue meters. Accuracy from Light to Full Rating shall meet the following criteria:
 - a. Power: Accurate to 0.25 percent of reading, plus 0.025 percent of full scale.
 - b. Voltage and Current: Accurate to 0.075 percent of reading, plus 0.025 percent of full scale.
 - c. Power Factor: Plus or minus 0.002, from 0.5 leading to 0.5 lagging.
 - d. Frequency: Plus or minus 0.01 Hz at 45 to 67 Hz.
 2. For meters that are circuit-breaker accessories, metering accuracy at full-scale shall not be less than the following:
 - a. Current: Plus or minus 2.5 percent.
 - b. Voltage: Plus or minus 1.5 percent.
 - c. Energy, Demand, and Power: Plus or minus 4.0 percent.
 - d. Frequency: Plus or minus 1 Hz.
- K. Input: One digital input signal(s).
1. Normal mode for on/off signal.
 2. Demand interval synchronization pulse, accepting a demand synchronization pulse from a utility demand meter.
 3. Conditional energy signal to control conditional energy accumulation.
- L. Outputs:
1. Operated either by user command sent via communication link, or set to operate in response to user-defined alarm or event.
 2. Closed in either a momentary or latched mode as defined by user.
 3. Each output relay used in a momentary contact mode shall have an independent timer that can be set by user.
 4. One digital KY pulse to a user-definable increment of energy measurement. Output ratings shall be up to 120-V ac, 300-V dc, 50 mA, and provide 3500-V rms isolation.
 5. One relay output module(s), providing a load voltage range from 20- to 240-V ac or from 20- to 30-V dc, supporting a load current of 2 A.
 6. Output Relay Control:
 - a. Relay outputs shall operate either by user command sent via communication link or in response to user-defined alarm or event.
 - b. Normally open and normally closed contacts, field configured to operate as follows:
 - 1) Normal contact closure where contacts change state for as long as signal exists.

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- 2) Latched mode when contacts change state on receipts of a pickup signal; changed state is held until a dropout signal is received.
- 3) Timed mode when contacts change state on receipt of a pickup signal; changed state is held for a preprogrammed duration.
- 4) End of power demand interval when relay operates as synchronization pulse for other devices.
- 5) Energy Pulse Output: Relay pulses quantities used for absolute kWh, absolute kVARh, kVAh, kWh In, kVARh In, kWh Out, and kVARh Out.
- 6) Output controlled by multiple alarms using Boolean-type logic.

M. Onboard Data Logging:

1. Store logged data, alarms, events, and waveforms in 80 KB of onboard nonvolatile memory.

N. Alarms.

1. User Options:
 - a. Define pickup, dropout, and delay.
2. Alarm Events:
 - a. Over/undercurrent.
 - b. Over/undervoltage.
 - c. Current imbalance.
 - d. Phase loss, current.
 - e. Phase loss, voltage.
 - f. Voltage imbalance.
 - g. Over kW demand.
 - h. Phase reversal.
 - i. Digital input off/on.
 - j. End of incremental energy interval.
 - k. End of demand interval.

O. Control Power: 90- to 457-V ac or 100- to 300-V dc.

P. Communications:

1. Power monitor shall be permanently connected to communicate via RS-485 Modbus TCP/IP.
2. Local plug-in connections shall be for RS-232 and 100 Base-T Ethernet.

2.6 RS-232 ASCII INTERFACE

A. ASCII interface shall allow RS-232 connections to be made between a meter or circuit monitor operating as the host PC and any equipment that will accept RS-232 ASCII command strings, such as local display panels.

B. Cables:

1. PVC-Jacketed, RS-232 Cable: Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, polypropylene insulation, and individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage; PVC jacket. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
 - a. NFPA 70, Type CM.
 - b. Flame Resistance: UL 1581, Vertical Tray.

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2. Plenum-Type, RS-232 Cable: Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, plastic insulation, and individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage; plastic jacket. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
 - a. NFPA 70, Type CMP.
 - b. Flame Resistance: NFPA 262, Flame Test.

2.7 LAN CABLES

- A. Comply with Section 271500 "Communications Horizontal Cabling."
- B. RS-485 Cable:
 1. PVC-Jacketed, RS-485 Cable: Paired, 2 pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors, PVC insulation, unshielded, PVC jacket, and NFPA 70, Type CMG.
 2. Plenum-Type, RS-485 Cable: Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, fluorinated-ethylene-propylene insulation, unshielded, and fluorinated-ethylene-propylene jacket, and NFPA 70, Type CMP.
- C. Unshielded Twisted Pair Cables: Category 6 as specified for horizontal cable for data service in Section 271500 "Communications Horizontal Cabling."

2.8 LOW-VOLTAGE WIRING

- A. Comply with Section 260519 "Low Voltage Wires"
- 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.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. 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.

3.2 CABLING

- A. Comply with NECA 1.

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- B. Install cables and wiring according to requirements in Section 271500 "Communications Horizontal Cabling."
- C. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces.
- D. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Use NRTL-listed plenum cable in environmental air spaces, including plenum ceilings. Conceal raceway and cables except in unfinished spaces.
- E. Install LAN cables using techniques, practices, and methods that are consistent with specified category rating of components and that ensure specified category performance of completed and linked signal paths, end to end.
- F. Install cables without damaging conductors, shield, or jacket.

3.3 IDENTIFICATION

- A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."
- B. Label each power monitoring and control module with a unique designation.

3.4 GROUNDING

- A. Comply with IEEE 1100, "Recommended Practice for Powering and Grounding Electronic Equipment."

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Tests and Inspections:
 - 1. Electrical Tests: Use caution when testing devices containing solid-state components.
 - 2. Continuity tests of circuits.
 - 3. 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

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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.

- a. Coordinate testing required by this Section with that required by Sections specifying equipment being monitored and controlled.
 - b. Test LANs according to requirements in Section 271500 "Communications Horizontal Cabling."
 - c. 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.
 - d. Verify accuracy of graphic screens and icons.
 - e. Metering Test: Load feeders, measure loads on feeder conductor with an 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.
 - f. Record metered values, control settings, operations, cues, time intervals, and functional observations and submit test reports printed by workstation printer.
- E. Power monitoring and control equipment will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.
- G. Correct deficiencies, make necessary adjustments, and retest. Verify that specified requirements are met.
- H. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.
- I. Reports: Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.
- J. Remove and replace malfunctioning devices and circuits and retest as specified above.

3.6 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain systems. See Section 017900 "Demonstration and Training."
1. Train Owner's management 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 a minimum of 12 hours' training.
 2. Training Aid: Use approved final versions of software and maintenance manuals as training aids.

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3.7 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.

END OF SECTION 260913

SECTION 260923 - DISTRIBUTED DIGITAL LIGHTING CONTROL SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Digital Lighting and Plug Load Controls
2. Relay Panels
3. Emergency Lighting Control

B. Related Sections:

1. Section 262726 - Wiring Devices
2. Section 265100 – Interior Lighting
3. Section 265600 – Exterior Lighting
4. Drawings and general provision of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections apply to this Section
5. Electrical Sections, including wiring devices, apply to the work of this Section.

C. Control Intent – Control Intent includes, but is not limited to:

1. Defaults and initial calibration settings for such items as time delay, sensitivity, fade rates, etc.
2. Initial sensor and switching zones
3. Initial time switch settings
4. Emergency Lighting control (if applicable)

1.2 REFERENCES

- A. American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE) (www.ansi.org and www.ieee.org)
- B. International Electrotechnical Commission (IEC) (www.iec.ch)
- C. International Organization for Standardization (ISO) (www.iso.ch):
- D. National Electrical Manufacturers Association (NEMA) (www.nema.org)
- E. WD1 (R2005) - General Color Requirements for Wiring Devices.
- F. Underwriters Laboratories, Inc. (UL) (www.ul.com):
 1. 20 – Plug Load Controls
 2. 508 – Industrial Controls
 3. 916 – Energy Management Equipment
 4. 924 – Emergency Lighting
- G. Underwriter Laboratories of Canada (ULC) (www.ulc.ca)

1.3 SYSTEM DESCRIPTION & OPERATION

- A. The Lighting Control and Automation system as defined under this section covers the following equipment:
1. Distributed digital lighting control on a local network – Free topology, plug-in wiring system (Cat 5e) for power and data to room devices.
 2. Digital Room Controllers – Self-configuring, digitally addressable one, two or three relay plenum-rated controllers for on/off control. Selected models include 0-10 volt or line voltage forward phase control dimming outputs and integral current monitoring capabilities.
 3. Digital Plug Load Controllers – Self-configuring, digitally addressable, single relay, plenum-rated application-specific controllers. Selected models include integral current monitoring capabilities.
 4. Digital Fixture Controllers – Self-configuring, digitally addressable one relay fixture-integrated controllers for on/off/0-10V dimming control.
 5. Digital Occupancy Sensors – Self-configuring, digitally addressable, calibrated occupancy sensors with LCD display and two-way active infrared (IR) communications.
 6. Digital Switches – Self-configuring, digitally addressable pushbutton on/off, dimming, and scene switches with two-way active infrared (IR) communications.
 7. Handheld remotes for personal control – On/Off, dimming and scene remotes for control using infrared (IR) communications. Remote may be configured in the field to control selected loads or scenes without special tools.
 8. Digital Daylighting Sensors – Single-zone closed loop, multi-zone open loop and single-zone dual-loop daylighting sensors with two-way active infrared (IR) communications for daylight harvesting using switching, bi-level, tri-level or dimming control.
 9. Configuration Tools – Handheld remote for room configuration and relay panel programming provides two way infrared (IR) communications to digital devices and allows complete configuration and reconfiguration of the device / room from up to 30 feet away.
 10. Distributed digital lighting control central network – Linear topology, BACnet MS/TP network (1.5 twisted pair, shielded) to connect multiple local networks for centralized control.
 11. Network Bridge – Provides BACnet MS/TP-compliant digital networked communication between rooms, panels and the Segment Manager or building automation system (BAS) and automatically creates BACnet objects representative of connected devices.
 12. Segment Manager – BACnet MS/TP-based controller with web browser-based user interface for system control, scheduling, power monitoring, room device parameter administration and reporting.
 13. Programming and Configuration Software – Optional PC-native application capable of accessing control parameters within a room, for the local network, via a USB adapter, or globally, for many segment networks simultaneously, via BACnet/IP communication.
 14. Digital Lighting Management Relay Panel and Zone Controller – Provides up to 8, 24, or 48 mechanically latching relays. Relays include a manual override and a single push-on connector for easy installation or removal from the panel. Panel accepts program changes from handheld configuration tool for date and time, location, holidays, event scheduling, button binding and group programming. Provides BACnet MS/TP-compliant digital networked communication between other lighting controls and/or building automation system (BAS). Zero relay Zone Controller primarily supports Digital Fixture Controller applications.

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15. Emergency Lighting Control Unit (ELCU) – Allows a standard lighting control device to control emergency lighting in conjunction with normal lighting in any area within a building

1.4 LIGHTING CONTROL APPLICATIONS

- A. Unless relevant provisions of the applicable local energy codes are more stringent, provide a minimum application of lighting controls as follows:
 1. Space Control Requirements – Provide occupancy/vacancy sensors with Manual- or Partial-ON functionality in all spaces except toilet rooms, storerooms, library stacks, or other applications where hands-free operation is desirable and Automatic-ON occupancy sensors are more appropriate. Provide Manual-ON occupancy/vacancy sensors for any enclosed office, conference room, meeting room, open plan system and training room. For spaces with multiple occupants, or where line-of-sight may be obscured, provide ceiling- or corner-mounted sensors and Manual-ON switches.
 2. Bi-Level Lighting – Provide multi-level controls in all spaces except toilet rooms, storerooms, library stacks, or applications where variable dimming is used.
 3. Task Lighting / Plug Loads – Provide automatic shut off of non essential plug loads and task lighting in all spaces except toilet rooms and storerooms. Provide Automatic-ON of plug loads whenever spaces are occupied. For spaces with multiple occupants a single shut off consistent with the overhead lighting may be used for the area.
 4. Daylit Areas – Provide daylight-responsive automatic control in all spaces (conditioned or unconditioned) where daylight contribution is available as defined by relevant local building energy code:
 - a. All luminaires within code-defined daylight zones shall be controlled separately from luminaires outside of daylit zones.
 - b. Daytime setpoints for total ambient illumination (combined daylight and electric light) levels that initiate dimming shall be programmed in compliance with relevant local building energy codes.
 - c. Multiple-level switched daylight harvesting controls may be utilized for areas marked on drawings.
 - d. Provide smooth and continuous daylight dimming for areas marked on drawings. Daylighting control system may be designed to turn off electric lighting when daylight is at or above required lighting levels, only if system functions to turn lamps back on at dimmed level, rather than turning full-on prior to dimming.
 5. Conference, meeting, training, auditoriums, and multipurpose rooms shall have controls that allow for independent control of each local control zone. Rooms larger than 300 square feet shall instead have at least four preset lighting scenes unless otherwise specified. Occupancy / vacancy sensors shall be provided to turn off all lighting in the space. Spaces with up to four moveable walls shall include controls that can be reconfigured when the room is partitioned.

1.5 SUBMITTALS

- A. Submittals Package: Submit the shop drawings, and the product data specified below at the same time as a package.
- B. Shop Drawings:

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1. Composite wiring and/or schematic diagram of each control circuit as proposed to be installed.
2. Show exact location of all digital devices, including at minimum sensors, load controllers, and switches for each area on reflected ceiling plans. (Contractor must provide AutoCAD format reflected ceiling plans.)
3. Provide room/area details including products and sequence of operation for each room or area. Illustrate typical acceptable room/area connection topologies.
4. Network riser diagram including floor and building level details. Include network cable specification and end-of-line termination details, if required. Illustrate points of connection to integrated systems. Coordinate integration with mechanical and/or other trades.

C. Product Data: Catalog sheets, specifications and installation instructions.

D. Include data for each device which:

1. Indicates where sensor is proposed to be installed.
2. Prove that the sensor is suitable for the proposed application.

1.6 QUALITY ASSURANCE

A. Manufacturer: Minimum 10 years experience in manufacture of lighting controls.

1.7 PROJECT CONDITIONS

A. Do not install equipment until following conditions can be maintained in spaces to receive equipment:

1. Ambient temperature: 0° to 40° C (32° to 104° F).
2. Relative humidity: Maximum 90 percent, non-condensing.

1.8 WARRANTY

A. Provide a five year limited manufacturer's warranty on all room control devices and panels.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer:

1. Basis of design product: WattStopper Digital Lighting Management (DLM) or subject to compliance and prior approval with specified requirements of this section, one of the following:
 - a. nLight Network Control System Acuity Brand
 - b. Encelium
 - c. Or approved equal

2.2 DIGITAL LIGHTING CONTROLS

- A. Furnish the Company's system which accommodates the square-footage coverage requirements for each area controlled, utilizing room controllers, digital occupancy sensors, switches, daylighting sensors and accessories which suit the lighting and electrical system parameters.

2.3 LOCAL NETWORK (Room Network)

- A. The local network is a free topology lighting control physical connection and communication protocol designed to control a small area of a building.
- B. Features of the local network include:
 - 1. Automatic configuration and binding of occupancy sensors, switches and lighting loads to the most energy-efficient sequence of operation based upon the device attached.
 - 2. Simple replacement of any device in the local network with a standard off the shelf unit without requiring significant commissioning, configuration or setup.
 - 3. Configuration to change the automatic configuration, including binding and load parameters without tools, using only the buttons on the digital devices in the local network.
 - 4. Two-way infrared communications for control by handheld remotes, and configuration by a handheld tool including adjusting load parameters, sensor configuration and binding, within a line of sight of up to 30 feet from a sensor, wall switch or IR receiver.
- C. Digital room devices connect to the local network using pre-terminated Cat 5e cables with RJ-45 connectors, which provide both data and power to room devices. Systems that utilize RJ-45 patch cords but do not provide serial communication data from individual end devices are not acceptable.
- D. If manufacturer's pre-terminated Cat5e cables are not used for the installation, the contractor is responsible for testing each cable following installation and supplying manufacturer with test results.
- E. WattStopper Product Number: LMRJ-Series

2.4 DIGITAL LOAD CONTROLLERS (ROOM, PLUG LOAD AND FIXTURE CONTROLLERS)

- A. Digital controllers for lighting and plug loads automatically bind the room loads to the connected devices in the space without commissioning or the use of any tools. Room and plug load controllers shall be provided to match the room lighting and plug load control requirements. The controllers will be simple to install, and will not have dip switches or potentiometers, or require special configuration for standard Plug n' Go applications. The control units will include the following features:
 - 1. Automatic room configuration to the most energy-efficient sequence of operation based upon the devices in the room.
 - 2. Simple replacement – Using the default automatic configuration capabilities, a room controller may be replaced with an off-the-shelf.
 - 3. Multiple room controllers connected together in a local network must automatically arbitrate with each other, without requiring any configuration or setup, so that individual

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load numbers are sequentially assigned using each controller's device ID's from highest to lowest.

4. Quick installation features including:
 - a. Standard junction box mounting
 - b. Quick low voltage connections using standard RJ-45 patch cable
 5. Based on individual configuration, each load shall be capable of the following behavior on power up following the loss of normal power:
 - a. Turn on to 100%
 - b. Turn off
 - c. Turn on to last level
 6. Each load shall at a minimum be configurable to operate in the following sequences based on occupancy:
 - a. Auto-on/Auto-off (Follow on and off)
 - b. Manual-on/Auto-off (Follow off only)
 7. The polarity of each load output shall be reversible, via digital configuration, so that on is off and off is on.
 8. BACnet object information shall be available for the following objects:
 - a. Load status
 - b. Electrical current (when available)
 - c. Total watts per controller
 - d. Schedule state – normal or after-hours
 - e. Demand response enable and disable
 - f. Room occupancy status
 - g. Total room lighting and plug loads watts
 - h. Total room watts/sq ft
 - i. Force on/off all loads
 9. UL 2043 plenum rated
 10. Manual override and LED indication for each load
 11. Dual voltage (120/277 VAC, 60 Hz). Rated for 20A total load, derating to 16A required for some dimmed loads (forward phase dimming); plug load controllers carry application-specific UL 20 rating for receptacle control.
 12. Zero cross circuitry for each load
 13. All digital parameter data programmed into an individual room controller or plug load controller shall be retained in non-volatile FLASH memory within the controller itself. Memory shall have an expected life of no less than 10 years.
- B. On/Off Room Controllers shall include:
1. One or two relay configuration
 2. Efficient 150 mA switching power supply
 3. Three RJ-45 local network ports with integral strain relief and dust cover
 4. WattStopper product numbers: LMRC-101, LMRC-102
- C. On/Off/Dimming enhanced Room Controllers shall include:
1. Real time current monitoring
 2. Multiple relay configurations
 - a. One, two or three relays (LMRC-21x series)
 - b. One or two relays (LMRC-22x series)
 3. Efficient 250 mA switching power supply
 4. Four RJ-45 local network ports with integral strain relief and dust cover
 5. One dimming output per relay

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- a. 0-10V Dimming - Where indicated, one 0-10 volt analog output per relay for control of compatible ballasts and LED drivers. The 0-10 volt output shall automatically open upon loss of power to the Room Controller to assure full light output from the controlled lighting. (LMRC-21x series)
 - b. Line Voltage, Forward Phase Dimming - Where indicated, one forward phase control line voltage dimming output per relay for control of compatible two-wire or three-wire ballasts, LED drivers, MLV, forward phase compatible ELV, neon/cold cathode and incandescent loads. (LMRC-22x series)
 - c. Each dimming output channel shall have an independently configurable minimum and maximum calibration trim level to set the dimming range to match the true dynamic range of the connected ballast or driver.
 - d. The LED level indicators on bound dimming switches shall utilize this new maximum and minimum trim.
 - e. Each dimming output channel shall have an independently configurable minimum and maximum trim level to set the dynamic range of the output within the new 0-100% dimming range defined by the minimum and maximum calibration trim.
 - f. Calibration and trim levels must be set per output channel.
 - g. Devices that set calibration or trim levels per controller are not acceptable.
 - h. All configuration shall be digital. Devices that set calibration or trim levels per output channel via trim pots or dip-switches are not acceptable.
6. Each load shall have an independently configurable preset on level for Normal Hours and After Hours events to allow different dimmed levels to be established at the start of both Normal Hours and After Hours events.
 7. Fade rates for dimming loads shall be specific to bound switch buttons, and the load shall maintain a default value for any bound buttons that do not specify a unique value.
 8. The following dimming attributes may be changed or selected using a wireless configuration tool:
 - a. Establish preset level for each load from 0-100%
 - b. Set high and low trim for each load
 - c. Set lamp burn in time for each load up to 100 hours
 9. Override button for each load provides the following functions:
 10. WattStopper product numbers: LMRC-211, LRMC-212, LRMC-213, LMRC-221, LMRC-222
- D. Plug Load Controllers shall include:
1. One relay configuration with additional connection for unswitched load
 2. Configurable additive time delay to extend plug load time delay beyond occupancy sensor time delay (e.g. a 10 minute additive delay in a space with a 20 minute occupancy sensor delay ensures that plug loads turn off 30 minutes after the space is vacated).
 3. Factory default operation is Auto-on/Auto-off, based on occupancy
 4. Real time current monitoring of both switched and un-switched load (LMPL-201 only)
 5. Efficient switching power supply
 - a. 150mA (LMPL-101)
 - b. 250mA (LMPL-201)
 6. RJ-45 local network ports
 - a. Three RJ-45 ports (LMPL-101)
 - b. Four RJ-45 ports (LMPL-201)
 7. WattStopper product numbers: LMPL-101, LMPL-201.
- E. Fixture Controllers shall include:

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1. A form factor and product ratings to allow various OEM fixture manufacturers to mount the device inside the ballast/driver cavity of standard-sized fluorescent or LED general lighting fixtures.
2. One 3A 120/277V rated mechanically held relay.
3. Programmable behavior on power up following the loss of normal power:
 - a. Turn on to 100%
 - b. Turn off
 - c. Turn on to last level
4. Requirement for 7 mA of 24VDC operating power from the local network.
 - a. The Fixture Controller does not require a connection to a neutral conductor to operate, and unlike other types of Load Controllers it does not contribute power to the local network to drive accessory devices.
 - b. Power to drive the LMFC Fixture Controller electronics can come from any Room or Plug Load Controller, LMPB-100 Power Booster and/or LMZC-301 Zone Controller (described later in the LMCP LIGHTING CONTROL PANELS specification section).
5. 0-10V dimming capability via a single 0-10 volt analog output from the device for control of compatible ballasts and LED drivers. The 0-10 volt output shall automatically open upon loss of power to the Fixture Controller.
6. Terminals to connect an RJ-45 adaptor with 24" leads, mountable in a ½" KO, for connection to the local network.
 - a. The adaptor leads are insulated for use in a fixture cavity, and the lead length allows the OEM fixture manufacturer flexibility to position the Fixture Controller and the RJ45 jack in the best locations on each fixture.
7. A complete set of dimming features described above in the section detailing On/Off/Dimming Enhanced Room Controllers (subsection C.5 onward).
8. WattStopper product numbers: Fixture Controller: LMFC-011, DLM Cable Connector: LMFC-RJ-50-24, Power Booster: LMPB-100

2.5 DIGITAL WALL OR CEILING MOUNTED OCCUPANCY SENSOR

- A. Wall or ceiling mounted (to suit installation) passive infrared (PIR), ultrasonic or dual technology digital (passive infrared and ultrasonic) occupancy sensor.
- B. Digital Occupancy Sensors shall provide graphic LCD display for digital calibration and electronic documentation. Features include the following:
 1. Digital calibration and pushbutton configuration for the following variables:
 - a. Sensitivity – 0-100% in 10% increments
 - b. Time delay – 1-30 minutes in 1 minute increments
 - c. Test mode – Five second time delay
 - d. Detection technology – PIR, Ultrasonic or Dual Technology activation and/or re-activation.
 - e. Walk-through mode
 2. Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the local network.
 3. Programmable control functionality including:
 - a. Each sensor may be programmed to control specific loads within a local network.
 - b. Sensor shall be capable of activating one of 16 user-definable lighting scenes.

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- c. Adjustable retrigger time period for manual-on loads. Load will retrigger (turn on) automatically within a configurable period of time (default 10 seconds) after turning off.
 - d. On dual technology sensors, independently configurable trigger modes are available for both Normal (NH) and After Hours (AH) time periods. The retrigger mode can be programmed to use the following technologies:
 - e. Ultrasonic and Passive Infrared
 - f. Ultrasonic or Passive Infrared
 - g. Ultrasonic only
 - h. Passive Infrared only
 - i. Independently configurable sensitivity settings for passive infrared and ultrasonic technologies (on dual technology sensors) for both Normal (NH) and After Hour (AH) time periods.
 - 4. One or two RJ-45 port(s) for connection to local network.
 - 5. Two-way infrared (IR) transceiver to allow remote programming through handheld commissioning tool and control by remote personal controls.
 - 6. Device Status LEDs, which may be disabled for selected applications, including:
 - a. PIR detection
 - b. Ultrasonic detection
 - c. Configuration mode
 - d. Load binding
 - 7. Assignment of occupancy sensor to a specific load within the room without wiring or special tools.
 - 8. Manual override of controlled loads.
 - 9. All digital parameter data programmed into an individual occupancy sensor shall be retained in non-volatile FLASH memory within the sensor itself. Memory shall have an expected life of no less than 10 years.
- C. BACnet object information shall be available for the following objects:
- 1. Detection state
 - 2. Occupancy sensor time delay
 - 3. Occupancy sensor sensitivity, PIR and Ultrasonic
- D. Units shall not have any dip switches or potentiometers for field settings.
- E. Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology local network. No additional configuration will be required.
- F. WattStopper product numbers: LMPX, LMDX, LMPC, LMUC, LMDC

2.6 DIGITAL WALL SWITCH OCCUPANCY SENSORS

- A. Wallbox mounted passive infrared PIR or dual technology (passive infrared and ultrasonic) digital occupancy sensor with 1 or 2 switch buttons.
- B. Digital Occupancy Sensors shall provide scrolling LCD display for digital calibration and electronic documentation. Features include the following:
 - 1. Digital calibration and pushbutton configuration for the following variables:
 - a. Sensitivity – 0-100% in 10% increments
 - b. Time delay – 1-30 minutes in 1 minute increments

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- c. Test mode – Five second time delay
 - d. Detection technology – PIR, Dual Technology activation and/or re-activation.
 - e. Walk-through mode
 - f. Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the local network.
2. Programmable control functionality including:
 - a. Each sensor may be programmed to control specific loads within a local network.
 - b. Sensor shall be capable of activating one of 16 user-definable lighting scenes.
 - c. Adjustable retrigger time period for manual-on loads. Load will retrigger (turn on) automatically during the configurable period of time (default 10 seconds) after turning off.
 - d. On dual technology sensors, independently configurable trigger modes are available for both Normal (NH) and After Hours (AH) time periods. The retrigger mode can be programmed to use the following technologies:
 - 1) Ultrasonic and Passive Infrared
 - 2) Ultrasonic or Passive Infrared
 - 3) Ultrasonic only
 - 4) Passive Infrared only
 3. Independently configurable sensitivity settings for passive infrared and ultrasonic technologies (on dual technology sensors) for both Normal (NH) and After Hour (AH) time periods.
 4. Two RJ-45 ports for connection to local network.
 5. Two-way infrared (IR) transceiver to allow remote programming through handheld configuration tool and control by remote personal controls.
 6. Device Status LEDs including
 - a. PIR detection
 - b. Ultrasonic detection
 - c. Configuration mode
 - d. Load binding
 7. Assignment of any occupancy sensor to a specific load within the room without wiring or special tools.
 8. Assignment of local buttons to specific loads within the room without wiring or special tools
 9. Manual override of controlled loads
 10. All digital parameter data programmed into an individual wall switch sensor shall be retained in non-volatile FLASH memory within the wall switch sensor itself. Memory shall have an expected life of no less than 10 years.
- C. BACnet object information shall be available for the following objects:
1. Detection state
 2. Occupancy sensor time delay
 3. Occupancy sensor sensitivity, PIR and Ultrasonic
 4. Button state
 5. Switch lock control
 6. Switch lock status
- D. Units shall not have any dip switches or potentiometers for field settings.
- E. Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology local network. No additional configuration will be required.

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- F. Two-button wall switch occupancy sensors, when connected to a single relay dimming room or fixture controller, shall operate in the following sequence as a factory default:
1. Left button
 - a. Press and release - Turn load on
 - b. Press and hold - Raise dimming load
 2. Right button
 - a. Press and release - Turn load off
 - b. Press and hold - Lower dimming load
- G. Low voltage momentary pushbuttons shall include the following features:
1. Load/Scene Status LED on each switch button with the following characteristics:
 - a. Bi-level LED
 - b. Dim locator level indicates power to switch
 - c. Bright status level indicates that load or scene is active
 2. The following button attributes may be changed or selected using a wireless configuration tool:
 - a. Load and Scene button function may be reconfigured for individual buttons (from Load to Scene, and vice versa).
 - b. Individual button function may be configured to Toggle, On only or Off only.
 - c. Individual scenes may be locked to prevent unauthorized change.
 - d. Fade Up and Fade Down times for individual scenes may be adjusted from 0 seconds to 18 hours.
 - e. Ramp rate may be adjusted for each dimmer switch.
 - f. Switch buttons may be bound to any load on any load controller or relay panel and are not load type dependent; each button may be bound to multiple loads.
 - g. WattStopper part numbers: LMPW, LMDW. Available in white, light almond, ivory, grey, red and black; compatible with wall plates with decorator opening

2.7 DIGITAL WALL SWITCHES

- A. Low voltage momentary pushbutton switches in 1, 2, 3, 4, 5 and 8 button configuration. Wall switches shall include the following features:
1. Two-way infrared (IR) transceiver for use with personal and configuration remote controls.
 2. Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.
 3. Configuration LED on each switch that blinks to indicate data transmission.
 4. Load/Scene Status LED on each switch button with the following characteristics:
 - a. Bi-level LED
 - b. Dim locator level indicates power to switch
 - c. Bright status level indicates that load or scene is active
 - d. Dimming switches shall include seven bi-level LEDs to indicate load levels using 14 steps.
 5. Programmable control functionality including:
 - a. Button priority may be configured to any BACnet priority level, from 1-16, corresponding to networked operation allowing local actions to utilize life safety priority
 - b. Scene patterns may be saved to any button other than dimming rockers. Once set, buttons may be digitally locked to prevent overwriting of the preset levels.

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6. All digital parameter data programmed into an individual wall switch shall be retained in non-volatile FLASH memory within the wall switch itself. Memory shall have an expected life of no less than 10 years.
- B. BACnet object information shall be available for the following objects:
 1. Button state
 2. Switch lock control
 3. Switch lock status
- C. Two RJ-45 ports for connection to local network.
- D. Multiple digital wall switches may be installed in a room by simply connecting them to the free topology local network. No additional configuration shall be required to achieve multi-way switching.
- E. The following switch attributes may be changed or selected using a wireless configuration tool:
- F. Load and Scene button function may be reconfigured for individual buttons (from Load to Scene, and vice versa).
 1. Individual button function may be configured to Toggle, On only or Off only.
 2. Individual scenes may be locked to prevent unauthorized change.
 3. Fade Up and Fade Down times for individual scenes may be adjusted from 0 seconds to 18 hours.
 4. Ramp rate may be adjusted for each dimmer switch.
 5. Switch buttons may be bound to any load on any load controller or relay panel and are not load type dependant; each button may be bound to multiple loads.
 6. WattStopper product numbers: LMSW-101, LMSW-102, LMSW-103, LMSW-104, LMSW-105, LMSW-108, LMDM-101. Available in white, light almond, ivory, grey, red and black; compatible with wall plates with decorator opening.

2.8 HANDHELD USER INTERFACE REMOTES

- A. Battery-operated handheld devices in 1, 2 and 5 button configurations for remote switching or dimming control. Remote controls shall include the following features:
 1. Two-way infrared (IR) transceiver for line of sight communication with local network within up to 30 feet.
 2. LED on each button confirms button press.
 3. Load buttons may be bound to any load on a load controller or relay panel and are not load type dependant; each button may be bound to multiple loads.
 4. Inactivity timeout to save battery life.
- B. A wall mount holster and mounting hardware shall be included with each remote control
- C. WattStopper part numbers: LMRH-101, LMRH-102, LMRH-105.

2.9 DIGITAL DAYLIGHTING SENSORS

- A. Digital daylighting sensors shall work with load controllers and relay panels to provide automatic switching, bi-level, or tri-level or dimming daylight harvesting capabilities for any

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load type connected to the controller or panel. Daylighting sensors shall be interchangeable without the need for rewiring.

1. Closed loop sensors measure the ambient light in the space and control a single lighting zone.
2. Open loop sensors measure incoming daylight in the space, and are capable of controlling up to three lighting zones.
3. Dual loop sensors measure both ambient and incoming daylight in the space to insure that proper light levels are maintained as changes to reflective materials are made in a single zone.

B. Digital daylighting sensors shall include the following features:

1. The sensor's internal photodiode shall only measure lightwaves within the visible spectrum. The photodiode's spectral response curve shall closely match the entire photopic curve. The photodiode shall not measure energy in either the ultraviolet or infrared spectrums. The photocell shall have a sensitivity of less than 5% for any wavelengths less than 400 nanometers or greater than 700 nanometers.
2. Sensor light level range shall be from 1-6,553 footcandles (fc).
3. The capability of ON/OFF, bi-level or tri-level switching, or dimming, for each controlled zone, depending on the selection of load controller(s) and load binding to controller(s).
4. For switching daylight harvesting, the photosensor shall provide a field-selectable deadband, or a separation, between the "ON Setpoint" and the "OFF Setpoint" that will prevent the lights from cycling excessively after they turn off.
5. For dimming daylight harvesting, the photosensor shall provide the option, when the daylight contribution is sufficient, of turning lights off or dimming lights to a field-selectable minimum level.
6. Photosensors shall have a digital, independently configurable fade rate for both increasing and decreasing light level in units of percent per second.
7. Photosensors shall provide adjustable cut-off time. Cut-off time is defined by the number of selected minutes the load is at the minimum output before the load turns off. Selectable range between 0-240 minutes including option to never cut-off.
8. Optional wall switch override shall allow occupants to reduce lighting level to increase energy savings or, if permitted by system administrator, raise lighting levels for a selectable period of time or cycle of occupancy.
9. Integral infrared (IR) transceiver for configuration and/or commissioning with a handheld configuration tool, to transmit detected light level to wireless configuration tool, and for communication with personal remote controls.
10. Configuration LED status light on device that blinks to indicate data transmission.
11. Status LED indicates test mode, override mode and load binding.
12. Recessed switch on device to turn controlled load(s) ON and OFF.
13. BACnet object information shall be available for the following daylighting sensor objects, based on the specific photocell's settings:
 - a. Light level
 - b. Day and night setpoints
 - c. Off time delay
 - d. On and off setpoints
 - e. Up to three zone setpoints
 - f. Operating mode – on/off, bi-level, tri-level or dimming
14. One RJ-45 port for connection to local network.
15. A choice of accessories to accommodate multiple mounting methods and building materials. The photosensors may be mounted on a ceiling tile, skylight light well,

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suspended lighting fixture or backbox. Standard tube photosensors accommodate mounting materials from 0-0.62" thickness (LMLS-400, LMLS-500). Extended tube photosensors accommodate mounting materials from 0.62"-1.25" thickness (LMLS-400-L, LMLS-500-L). Mounting brackets are compatible with J boxes (LMLS-MB1) and wall mounting (LMLS-MB2). LMLS-600 photosensor to be mounted on included bracket below skylight well.

16. Any load or group of loads in the room can be assigned to a daylighting zone
 17. Each load within a daylighting zone can be individually enabled or disabled for discrete control (load independence).
 18. All digital parameter data programmed into a photosensor shall be retained in non-volatile FLASH memory within the photosensor itself. Memory shall have an expected life of no less than 10 years.
- C. Closed loop digital photosensors shall include the following additional features:
1. An internal photodiode that measures light in a 100-degree angle, cutting off the unwanted light from bright sources outside of this cone.
 2. Automatic self-calibration, initiated from the photosensor, a wireless configuration tool or a PC with appropriate software.
 3. Automatically establishes application-specific setpoints following self-calibration. For switching operation, an adequate deadband between the ON and OFF setpoints shall prevent the lights from cycling; for dimming operation a sliding setpoint control algorithm with separate Day and Night setpoints shall prevent abrupt ramping of loads.
 4. WattStopper Product Number: LMLS-400, LMLS-400-L.
- D. Open loop digital photosensors shall include the following additional features:
1. An internal photodiode that measures light in a 60-degree angle (cutting off the unwanted light from the interior of the room).
 2. Automatically establishes application-specific setpoints following manual calibration using a wireless configuration tool or a PC with appropriate software. For switching operation, an adequate deadband between the ON and OFF setpoints for each zone shall prevent the lights from cycling; for dimming operation, a proportional control algorithm shall maintain the design lighting level in each zone.
 3. Each of the three discrete daylight zones can include any non overlapping group of loads in the room.
 4. WattStopper Product Number: LMLS-500, LMLS-500-L.
- E. Dual loop digital photosensors shall include the following additional features:
1. Close loop portion of dual loop device must have an internal photodiode that measures light in a 100 degree angle, cutting off the unwanted light from sources outside of this cone
 2. Open loop portion of dual loop device must have an internal photodiode that can measure light in a 60 degree angle, cutting off the unwanted light from the interior of the room.
 3. Automatically establishes application-specific set-points following self-calibration. For switching operation, an adequate deadband between the ON and OFF setpoints shall prevent the lights from cycling; for dimming operation a sliding setpoint control algorithm with separate Day and Night setpoints shall prevent abrupt ramping of load.
 4. Device must reference closed loop photosensor information as a base line reference. The device must be able to analyze the open loop photosensor information to determine if an adjustment in light levels is required.
 5. Device must be able to automatically commission setpoints each night to provide adjustments to electrical lighting based on changes in overall lighting in the space due to

changes in reflectance within the space or changes to daylight contribution based on seasonal changes.

6. Device must include extendable mounting arm to properly position sensor within a skylight well.
7. WattStopper product number LMLS-600

2.10 DIGITAL PARTITION CONTROLS

- A. Partition controls shall enable manual or automatic coordination of lighting controls in flexible spaces with up to four moveable walls by reconfiguring the connected digital switches and occupancy sensors.
- B. Four-button low voltage pushbutton switch for manual control.
 1. Two-way infrared (IR) transceiver for use with configuration remote control.
 2. Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.
 3. Configuration LED on each switch that blinks to indicate data transmission.
 4. Each button represents one wall; Green button LED indicates status.
 5. Two RJ-45 ports for connection to local network.
 6. WattStopper part number: LMPS-104. Available in white, light almond, ivory, grey and black; compatible with wall plates with decorator opening.
- C. Contact closure interface for automatic control via input from limit switches on movable walls (by others).
 1. Operates on Class 2 power supplied by local network.
 2. Includes 24VDC output and four input terminals for maintained third party contract closure inputs.
 3. Input max. sink/source current: 1-5mA
 - a. Logic input signal voltage High: >18VDC
 - b. Logic input signal voltage Low: <2VDC
 4. Four status LEDs under hinged cover indicate if walls are open or closed; supports LMPS-104 as remote status indicator.
 5. Two RJ-45 ports for connection to local network.
 6. WattStopper part number: LMIO-102

2.11 HANDHELD AND COMPUTER CONFIGURATION TOOLS

- A. A wireless configuration tool facilitates optional customization of local networks using two-way infrared communications, while PC software connects to each local network via a USB interface.
- B. Features and functionality of the wireless configuration tool shall include but not be limited to:
 1. Two-way infrared (IR) communication with IR-enabled devices within a range of approximately 30 feet.
 2. High visibility organic LED (OLED) display, pushbutton user interface and menu-driven operation.

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3. Must be able to read and modify parameters for load controllers and relay panels, occupancy sensors, wall switches, daylighting sensors, network bridges, and identify devices by type and serial number.
4. Save up to eight occupancy sensor setting profiles, and apply profiles to selected sensors.
5. Temporarily adjust light level of any load(s) on the local network, and incorporate those levels in scene setting. Set room mode for testing of Normal Hours (NH) and After Hours (AH) parameter settings.
6. Adjust or fine-tune daylighting settings established during auto-configuration, and input light level data to complete configuration of open loop daylighting controls.
7. Set room mode for testing of Normal Hours (NH) and After Hours (AH) parameter settings.
8. Verify status of building level network devices.

C. WattStopper Product Numbers: LMCT-100, LMCI-100/LMCS-100

2.12 SEGMENT NETWORK (Room to Room Network)

- A. The segment network shall be a linear topology, BACnet-based MS/TP subnet to connect local networks (rooms) and LMCP relay panels for centralized control.
1. Each connected local network shall include a single network bridge (LMBC-300), and the network bridge is the only room-based device that is connected to the segment network.
 2. Network bridges, relay panels and segment managers shall include terminal blocks, with provisions for separate “in” and “out” terminations, for segment network connections.
 3. The segment network shall utilize 1.5 twisted pair, shielded, cable supplied by the lighting control manufacturer. The maximum cable run for each segment is 4,000 feet. Conductor-to-conductor capacitance of the twisted pair shall be less than 30 pf/ft and have a characteristic impedance of 120 Ohms.
 4. Network signal integrity requires that each conductor and ground wire be correctly terminated at every connected device.
 5. Substitution of manufacturer-supplied cable must be pre-approved: Manufacturer will not certify network reliability, and reserves the right to void warranty, if non-approved cable is installed, and if terminations are not completed according to manufacturer’s specific requirements.
 6. Segment networks shall be capable of connecting to BACnet-compliant BAS (provided by others) either directly, via MS/TP, or through NB-ROUTERS, via BACnet/IP or BACnet/Ethernet. Systems whose room-connected network infrastructure require gateway devices to provide BACnet data to a BAS are unacceptable.

B. WattStopper Product Number: LM-MSTP, LM-MSTP-DB

2.13 NETWORK BRIDGE

- A. The network bridge module connects a local network to a BACnet-compliant segment network for communication between rooms, relay panels and a segment manager or BAS. Each local network shall include a network bridge component to provide a connection to the local network room devices. The network bridge shall use industry standard BACnet MS/TP network communication and an optically isolated EIA/TIA RS-485 transceiver.

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1. The network bridge shall be provided as a separate module connected on the local network through an available RJ-45 port.
2. Provide Plug n' Go operation to automatically discover room devices connected to the local network and make all device parameters visible to the segment manager via the segment network. No commissioning shall be required for set up of the network bridge on the local network.
3. The network bridge shall automatically create standard BACnet objects for selected devices to allow any BACnet-compliant BAS to include lighting control and power monitoring features as provided by the devices on each local network. BACnet objects will be created for the addition or replacement of any given device for the installed life of the system. Products requiring that an application-specific point database be loaded to create or map BACnet objects are not acceptable. Systems not capable of providing BACnet data for control devices via a dedicated BACnet Device ID and physical MS/TP termination per room are not acceptable. Standard BACnet objects shall be provided as follows:
 - a. Read/write the normal or after hours schedule state for the room
 - b. Read the detection state of each occupancy sensor
 - c. Read the aggregate occupancy state of the room
 - d. Read/write the On/Off state of loads
 - e. Read/write the dimmed light level of loads
 - f. Read the button states of switches
 - g. Read total current in amps, and total power in watts through the load controller
 - h. Read/write occupancy sensor time delay, PIR sensitivity and ultrasonic sensitivity settings
 - i. Activate a preset scene for the room
 - j. Read/write daylight sensor fade time and day and night setpoints
 - k. Read the current light level, in footcandles, from interior and exterior photosensors and photocells
 - l. Set daylight sensor operating mode
 - m. Read/write wall switch lock status
 - n. Read watts per square foot for the entire controlled room
 - o. Write maximum light level per load for demand response mode
 - p. Read/write activation of demand response mode for the room
 - q. Activate/restore demand response mode for the room

B. WattStopper product numbers: LMBC-300

2.14 LMCP LIGHTING CONTROL PANELS AND LMZC ZONE CONTROLLER

- A. **HARDWARE:** Provide LMCP lighting control panels in the locations and capacities as indicated on the plans and schedules. Each panel shall be of modular construction and consist of the following components:
1. Enclosure/Tub shall be NEMA 1, sized to accept an interior with 1 - 8 relays, 1 - 24 relays and 6 four-pole contactors, or 1 - 48 relays and 6 four-pole contactors.
 2. Cover shall be configured for surface or flush wall mounting of the panel as indicated on the plans. LMCP panel cover shall have a hinged and lockable door with restricted access to line voltage section of the panel.
 3. Interior assembly shall be supplied as a factory assembled component specifically designed and listed for field installation. The interior construction shall provide total isolation of high voltage (Class 1) wiring from low voltage (Class 2) wiring within the

assembled panel. The interior assembly shall include intelligence boards, power supply, DIN rails for mounting optional Class 2 control devices, and individually replaceable latching type relays. The panel interiors shall include the following features:

- a. Removable, plug-in terminal blocks with connections for all low voltage terminations.
 - b. Individual terminal block, override pushbutton, and LED status light for each relay.
 - c. Direct wired switch inputs associated with each relay shall support 2-wire momentary switches only.
 - d. Digital inputs (four RJ-45 jacks) shall support 1-, 2-, 3-, 4-, and 8-button digital switches; digital IO modules capable of receiving 0-5V or 0-10V analog photocell inputs; digital IO modules capable of receiving momentary or maintained contact closure inputs or analog sensor inputs; digital daylighting sensors; and digital occupancy sensors. Inputs are divided into two separate digital networks, each capable of supplying 250mA to connected devices.
 - e. True relay state shall be indicated by the on-board LED and shall be available to external control devices and systems via BACnet.
 - f. Automatically sequenced operation of relays to reduce impact on the electrical distribution system when large loads are controlled simultaneously.
 - g. Group and pattern control of relays shall be provided through a simple keypad interface from a handheld IR programmer. Any set of relays can be associated with a group for direct on/off control or pattern (scene) control via a simple programming sequence using the relay override pushbuttons and LED displays for groups 1-8 or a handheld IR programmer for groups 1-99.
 - h. Relay group status for shall be provided through LED indicators for groups 1-8 and via BACnet for groups 1-99. A solid LED indicates that the last group action called for an ON state and relays in the group are on or in a mixed state.
4. Single-pole latching relays with modular plug-in design. Relays shall provide the following ratings and features:
- a. Electrical:
 - 1) 30 amp ballast at 277V
 - 2) 20 amp ballast at 347V
 - 3) 20amp tungsten at 120V
 - 4) 30 amp resistive at 347V
 - 5) 1.5 HP motor at 120V
 - 6) 14,000 amp short circuit current rating (SCCR) at 347V
 - 7) Relays shall be specifically UL 20 listed for control of plug-loads
 - b. Mechanical:
 - 1) Replaceable, ½" KO mounting with removable Class 2 wire harness.
 - 2) Actuator on relay housing provides manual override and visual status indication, accessible from Class 2 section of panel.
 - 3) Dual line and load terminals each support two #14 - #12 solid or stranded conductors.
 - 4) Tested to 300,000 mechanical on/off cycles.
5. Isolated low voltage contacts provide for true relay status feedback and pilot light indication.
6. Power supply shall be a multi-voltage transformer assembly with rated power to supply all electronics, occupancy sensors, switches, pilot lights, and photocells as necessary to meet the project requirements. Power supply to have internal over-current protection with automatic reset and metal oxide varistor protection.

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7. Where indicated, lighting control panels designated for control of emergency lighting shall be provided with factory installed provision for automatic by pass of relays controlling emergency circuits upon loss of normal power. Panels shall be properly listed and labeled for use on emergency lighting circuits and shall meet the requirements of UL924 and NFPA 70 - Article 700.
8. Integral system clock shall provide scheduling capabilities for panel-only projects without segment networks or BAS control.
 - a. Each panel shall include digital clock capability able to issue system wide automation commands to up to (11) eleven other panels for a total of (12) twelve networked lighting control panels. The clock shall provide capability for up to 254 independent schedule events per panel for each of the ninety-nine system wide channel groups.
 - b. The clock capability of each panel shall support the time-based energy saving requirements of applicable local energy codes.
 - c. The clock module shall provide astronomic capabilities, time delays, blink warning, daylight savings, and holiday functions and will include a battery back up for the clock function and program retention in non-volatile FLASH memory. Clocks that require multiple events to meet local code lighting shut off requirements shall not be allowed.
 - d. The clock capability of each panel shall operate on a basis of ON/OFF or Normal Hours/After Hours messages to automation groups that implement pre-configured control scenarios. Scenarios shall include:
 - 1) Scheduled ON / OFF
 - 2) Manual ON / Scheduled OFF
 - 3) Astro ON / OFF (or Photo ON / OFF)
 - 4) Astro and Schedule ON / OFF (or Photo and Schedule ON / OFF)
 - e. The user interface shall be a portable IR handheld remote control capable of programming any panel in the system (LMCT-100)
 - f. The clock capability of each panel shall employ non-volatile memory and shall retain user programming and time for a minimum of 10 years.
 - g. Schedules programmed into the clock of any one panel shall be capable of executing panel local schedule or Dark/Light (photocell or Astro) events for that panel in the event that global network communication is lost. Lighting control panels that are not capable of executing events independently of the global network shall not be acceptable.
9. The lighting control panel can operate as a stand-alone system, or can support schedule, group, and photocell control functions, as configured in a Segment Manager controller, via a segment network connection.
10. The lighting control panel shall support digital communications to facilitate the extension of control to include interoperation with building automation systems and other intelligent field devices. Digital communications shall be RS485 MS/TP-based using the BACnet® protocol.
 - a. The panel shall have provision for an individual BACnet device ID and shall support the full 222 range (0 – 4,193,304). The device ID description property shall be writable via the network to allow unique identification of the lighting control panel on the network.
 - b. The panel shall support MS/TP MAC addresses in the range of 0 – 127 and baud rates of 9600k, 38400k, 76800k, and 115.2k bits per second.

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- c. Lighting control relays shall be controllable as binary output objects in the instance range of 1 – 64. The state of each relay shall be readable and writable by the BAS via the object present value property.
 - d. Lighting control relays shall report their true on/off state as binary input objects in the instance range of 1 – 64.
 - e. The 99 group Normal Hours/After Hours control objects associated with the panel shall be represented by binary value objects in the instance range of 201 – 299. The occupancy state of each channel group shall be readable and writable by the BAS via the object present value property. Commanding 1 to a channel group will put all relays associated with the channel into the normal hours mode. Commanding 0 or NULL shall put the relays into the after hours mode.
 - f. Setup and commissioning of the panel shall not require manufacturer-specific software or a computer. All configuration of the lighting control panel shall be performed using standard BACnet objects or via the handheld IR programming remote. Provide BACnet objects for panel setup and control as follows:
 - 1) Binary output objects in the instance range of 1 – 64 (one per relay) for on/off control of relays.
 - 2) Binary value objects in the instance range of 1 – 99 (one per channel) for normal hours/after hours schedule control.
 - 3) Binary input objects in the instance range of 1 – 64 (one per relay) for reading true on/off state of the relays.
 - 4) Analog value objects in the instance range of 101 – 199 (one per channel group) shall assign a blink warn time value to each channel. A value of 5 shall activate the blink warn feature for the channel and set a 5-minute grace-time period. A value of 250 shall activate the sweep feature for the channel and enable the use of sweep type automatic wall switches.
 - a) The description property for all objects shall be writable via the network and shall be saved in non-volatile memory within the panel.
 - b) The BO and BV 1 – 99 objects shall support BACnet priority array with a relinquish default of off and after hours respectively. Prioritized writes to the channel BV objects shall propagate prioritized control to each member relay in a way analogous to the BACnet Channel object described in addendum aa. (<http://www.bacnet.org/Addenda/Add-135-2010aa.pdf>)
 - c) Panel-aggregate control of relay Force Off at priority 2 shall be available via a single BV5 object. Force On at priority 1 shall be available via a single BV4 object.
 - d) Lockout of all digital switch buttons connected to a given panel shall be command-able via a single BV2 object. The lock status of any connected switch station shall be represented as BV101-196.
11. In addition to the LMCP Relay Panels, an LMZC Zone Controller panel shall be available for zero-relay applications. The panel is designed for applications where LMFC-011 Fixture Controllers or other distributed load controllers are used to switch and/or dim the controlled loads. Key similarities to and differences from the LMCP panel design shall include:
- a. The LMZC shall use the same intelligence board as the LMCP relay panel.
 - b. The LMZC shall not include relay driver boards or relays.
 - c. The LMZC shall have a removable interior section to facilitate installation, and a Tub/Cover. Cover is for surface mounting applications only.

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- d. The LMZC tub shall have two interior KOs to allow installation of LMPB-100 Power Boosters. Each installed Power Booster can provide an additional 150 mA for either of the two available local networks provided by the LMZC.
 - e. All programming and networking (whether Local Network and/or Segment Network) capabilities in the LMZC Zone Controller shall be similar to capabilities for LMCP relay panels, except for functions designed for panel-mounted HDR relays.
12. To aid in project start up, if LMFC Fixture Controllers are connected to an LMZC Zone Controller, Plug n' Go automatic configuration will establish a unique sequence of operation so that all LMFC-controlled fixtures will turn on to 50% output when any digital occupancy sensor detects motion..
 13. WattStopper Product Number: Relay Panels: LMCP8, LMCP24 or LMCP48, Zone Controller: LMZC-301.
- B. USER INTERFACE Each lighting control panel system shall be supplied with at least (1) handheld configuration tool (LMCT-100). As a remote programming interface the configuration tool shall allow setup, configuration, and diagnostics of the panel without the need for software or connection of a computer. The user interface shall have the following panel-specific functions as a minimum:
1. Set network parameters including panel device ID, MS/TP MAC address, baud rate and max master range.
 2. Relay Group creation of up to 99 groups. Group creation shall result in programming of all seven key relay parameters for member relays. The seven parameters are as follows: After-hours Override Time Delay, Normal Hours Override Time Delay, Action on Transition to Normal Hours, Action on Transition to After Hours, Sensor Action During Normal Hours, Sensor Action During After Hours, Blink-Warn Time for After Hours.
 3. Program up to 254 separate scheduled events. Events shall occur on seven day intervals with each day selectable as active or inactive, and shall be configurable as to whether the event is active on holidays. Holidays are also defined through the User Interface.
 4. Program up to 32 separate Dark/Light events. Events shall have a selectable source as either calculated Astro with delay, or a digital IO module with an integral 0-5V or 0-10V analog photocell. Dark/Light events shall occur on seven day intervals with each day selectable as active or inactive, and shall be configurable as to whether the event is active on holidays.
 5. Button binding of digital switches to groups shall be accessible via the handheld IR remote and accomplished from the digital switch station.
 6. Programming of panel location information shall be accomplished by the handheld IR remote and include at a minimum LAT, LON, DST zone, and an approximate city/state location.
 7. WattStopper Product Number: LMCT-100

2.15 SEGMENT MANAGER

- A. For networked applications, the Digital Lighting Management system shall include at least one segment manager to manage network communication. It shall be capable of serving up a graphical user interface via a standard web browser utilizing either unencrypted TCP/IP traffic via a configurable port (default is 80) or 256 bit AES encrypted SSL TCP/IP traffic via a configurable port (default is 443).

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- B. Each segment manager shall have integral support for at least three segment networks. Segment networks may alternately be connected to the segment manger via external BACnet-to-IP interface routers and switches, using standard Ethernet structured wiring. Each router shall accommodate one segment network. Provide the quantity of routers and switches as shown on the plans.
- C. Operational features of the Segment Manager shall include the following:
1. Connection to PC or LAN via standard Ethernet TCP/IP via standard Ethernet TCP/IP with the option to use SSL encrypted connections for all traffic.
 2. Easy to learn and use graphical user interface, compatible with Internet Explorer 8, or equal browser. The Segment Manager shall not require installation of any lighting control software on an end-user PC.
 3. Log in security capable of restricting some users to view-only or other limited operations.
 4. Segment Manager shall provide two main sets of interface screens – those used to initially configure the unit (referred to as the config screens), and a those used to allow users to dynamic monitor the performance of their system, and provide a centralized scheduling interface. Capabilities using the Config Screens shall include:
 - a. Automatic discovery of devices and relay panels on the segment network(s). Commissioning beyond activation of the discovery function shall not be required to provide communication, monitoring or control of all local networks and lighting control panels.
 - b. Allow information for all discovered devices to be imported into the Segment Manager via a single XML based site file from the WattStopper LMCS Software, significantly reducing the time needed to make a system usable by the end user. Importable information can include text descriptions of every component and individual loads, and automatic creation of room location information and overall structure of network. Info entered into LMCS should not have to be re-entered manually via keystrokes into the Segment Manager
 - c. After discovery, all rooms and panels shall be presented in a standard navigation tree format. Selecting a device from the tree will allow the device settings and operational parameters to be viewed and changed by the user.
 - d. Ability to view and modify device operational parameters. It shall be possible to set device parameters independently for normal hours and after hours operation including sensor time delays and sensitivities, and load response to sensor including Manual-On or Auto-On.
 - e. Provide capabilities for integration with a BAS via BACnet protocol. At a minimum, the following points shall be available to the BAS via BACnet IP connection to the segment manager: room occupancy state; room schedule mode; room switch lock control; individual occupancy sensor state; room lighting power; room plug-load power; load ON/OFF state; load dimming level; panel channel schedule state; panel relay state; and Segment Manager Group schedule state control. Any of above items shall be capable of being moved into an “Export Table” that will provide any integrator with only the data they need, and by using the Export Table effectively create a firewall between the integrator’s request for info and the overall system performance.
 5. Capabilities using the Segment Manager’s Dashboard Screens shall include:
 - a. A dynamic “tile” based interface that allows easy viewing of each individual room’s lighting and plug load power consumption, and lighting and plug load power density (power consumption information requires Enhanced Room and Plug Load Controllers with integral current transducers such as LMRC-21x). Tiles will be automatically organized according to location so a single tile for the building

summarizes all information for tiles beneath it on every floor, in every area, in every room. Tiles shall be color coded based on three energy target parameters, allowing an owner to quickly identify rooms that are not performing efficiently. Tiles for rooms with occupancy sensors shall include an icon to indicate whether that room is occupied. Tiles shall be clickable, and when clicked the underlying hierarchical level of tiles shall become visible. The tile interface shall be accessible via mouse, or touch screen devices. Tiles shall be created automatically by the segment manager, based on the information found during the device discovery and/or information included in a file imported in from LMCS (such as tagged descriptions for each room) without any custom programming.

- b. Ability to set up schedules for local networks (rooms) and panels. Schedules shall be capable of controlling individual rooms with either on/off or normal hours/after hours set controlled zones or areas to either a normal hours or after hours mode of operation. Support for annual schedules, holiday schedules and unique date-bound schedules, as well as astro On or astro Off events with offsets. Schedules shall be viable graphically as time bars in a screen set up to automatically show scheduled events by day, week or month.
 - c. Ability to provide a simple time vs. power graph based on information stored in each Segment Manager's memory (typically two to three days' data).
6. If shown in the contract drawings, Segment Managers shall be integrated into a larger control network by the addition of a Network Supervisor package. The Supervisor is a server level computer running a version of the Segment Manager interface software with dedicated communication and networking capability, able to pull information automatically from each individual Segment Manager in the network. By using a Supervisor, information for individual Segment Managers can be accessed and stored on the Supervisor's hard drive, eliminating the risk of data being overwritten after a few days because of Segment Manager memory limits.
 7. The Segment Manager shall allow access and control of the overall system database via Native Niagara AX FOX connectivity. Systems that must utilize a Tridium Niagara controller in addition to the programming, scheduling and configuration server are not acceptable.
- D. Segment Manager shall support multiple rooms as follows:
1. Support up to 120 network bridges and 900 digital in-room devices (LMSM-3E).
 2. Support up to 300 network bridges and 2,200 digital in room devices, connected via network routers and switches (LMSM-6E).
- E. WattStopper Product Numbers: LMSM-3E, LMSM-6E, LM-SUPERVISOR, NB-ROUTER, NB-SWITCH, NB-SWITCH-8, NB-SWITCH-16.

2.16 PROGRAMMING, CONFIGURATION AND DOCUMENTATION SOFTWARE

- A. PC-native application for optional programming of detailed technician-level parameter information for all products, including all parameters not accessible via BACnet and the handled IR configuration tool. Software must be capable of accessing room-level parameter information locally within the room when connected via the optional LMCI-100 USB programming adapter, or globally for many segment networks simultaneously utilizing standard BACnet/IP communication.
- B. Additional parameters exposed through this method include but are not limited to:

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1. Occupancy sensor detection LED disable for performance and other aesthetic spaces where blinking LEDs present a distraction.
 2. Six occupancy sensor action behaviors for each controlled load, separately configurable for normal hours and after hours modes. Modes include: No Action, Follow Off Only, Follow On Only, Follow On and Off, Follow On Only with Override Time Delay, Follow Off Only with Blink Warn Grace Time, Follow On and Off with Blink Warn Grace Time.
 3. Separate fade time adjustments per load for both normal and after hours from 0 - 4 hours.
 4. Configurable occupancy sensor re-trigger grace period from 0 - 4 minutes separate for both normal hours and after hours.
 5. Separate normal hours and after hours per-load button mode with modes including: Do nothing, on only, off only, on and off.
 6. Load control polarity reversal so that on events turn loads off and vice versa.
 7. Per-load DR (demand response) shed level in units of percent.
 8. Load output pulse mode in increments of 1second.
 9. Fade trip point for each load for normal hours and after hours that establishes the dimmer command level at which a switched load closes its relay to allow for staggered On of switched loads in response to a dimmer.
 10. Generation of reports at the whole file, partial file, or room level. Reports include but are not limited to:
 - a. Device list report: All devices in a project listed by type.
 - b. Load binding report: All load controller bindings showing interaction with sensors, switches, and daylighting.
 - c. BACnet points report: Per room Device ID report of the valid BACnet points for a given site's BOM.
 - d. Room summary report: Device manifest for each room, aggregated by common BOM, showing basic sequence of operations.
 - e. Device parameter report: Per-room lists of all configured parameters accessible via hand held IR programmer for use with O&M documentation.
 - f. Scene report: All project scene pattern values not left at defaults (i.e. 1 = all loads 100%, 2 = all loads 75%, 3 = all loads 50%, 4 = all loads 25%, 5-16 = same as scene 1).
 - g. Occupancy sensor report: Basic settings including time delay and sensitivity(ies) for all occupancy sensors.
- C. Network-wide programming of parameter data in a spreadsheet-like programming environment including but not limited to the following operations:
1. Set, copy/paste an entire project site of sensor time delays.
 2. Set, copy/paste an entire project site of sensor sensitivity settings.
 3. Search based on room name and text labels.
 4. Filter by product type (i.e. LMRC-212) to allow parameter set by product.
 5. Filter by parameter value to search for product with specific configurations.
- D. Network-wide firmware upgrading remotely via the BACnet/IP network.
1. Mass firmware update of entire rooms.
 2. Mass firmware update of specifically selected rooms or areas.
 3. Mass firmware upgrade of specific products.
- E. WattStopper Product Number: LMCS-100, LMCI-100

2.17 EMERGENCY LIGHTING CONTROL DEVICES

- A. Emergency Lighting Control Unit – A UL 924 listed device that monitors a switched circuit providing normal lighting to an area. The unit provides normal ON/OFF control of emergency lighting along with the normal lighting. Upon normal power failure the emergency lighting circuit will close, forcing the emergency lighting ON until normal power is restored. Features include:
 - 1. 120/277 volts, 50/60 Hz, 20 amp ballast rating
 - 2. Push to test button
 - 3. Auxiliary contact for remote test or fire alarm system interface
- B. WattStopper Product Numbers: ELCU-100, ELCU-200.

PART 3 - EXECUTION

3.1 CONTRACTOR INSTALLATION AND SERVICES

- A. Contractor to install all devices and wiring in a professional manner. All line voltage connections to be tagged to indicate circuit and switched legs.
- B. Contractor to install all room/area devices using manufacturer's factory-tested Cat 5e cable with pre-terminated RJ-45 connectors. If pre-terminated cable is not used for room/area wiring, the contractor is responsible for testing each field-terminated cable following installation, and shall supply the lighting controls manufacturer with test results. Contractor to install any room to room network devices using manufacturer-supplied LM-MSTP network wire. Network wire substitution is not permitted and may result in loss of product warranty per SEGMENT NETWORK section of specification. Low voltage wiring topology must comply with manufacturer's specifications. Contractor shall route network wiring as shown in submittal drawings as closely as possible, and shall document final wiring location, routing and topology on as built drawings.
- C. Install the work of this Section in accordance with manufacturer's printed instructions unless otherwise indicated. Before start up, contractor shall test all devices to ensure proper communication.
- D. Calibrate all sensor time delays and sensitivity to guarantee proper detection of occupants and energy savings.
 - 1. Adjust time delay so that controlled area remains lighted while occupied.
- E. Provide written or computer-generated documentation on the configuration of the system including room by room description including:
 - 1. Sensor parameters, time delays, sensitivities, and daylighting setpoints.
 - 2. Sequence of operation, (e.g. manual ON, Auto OFF. etc.)
 - 3. Load Parameters (e.g. blink warning, etc.)
- F. Post start-up tuning – After 30 days from occupancy contractor shall adjust sensor time delays and sensitivities to meet the Owner's requirements. Provide a detailed report to the Architect / Owner of post start-up activities

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3.2 FACTORY SERVICES

- A. Upon completion of the installation, the manufacturer's factory authorized representative shall start up and verify a complete fully functional system.
- B. The electrical contractor shall provide both the manufacturer and the electrical engineer with three weeks written notice of the system start up and adjustment date.
- C. Upon completion of the system start up, the factory-authorized technician shall provide the proper training to the owner's personnel on the adjustment and maintenance of the system.

3.3 ACCEPTANCE TESTING SUPPORT SERVICES

- A. On all California projects, a certified lighting controls acceptance test technician (CLCATT) must verify the installation of the lighting control system. Manufacturer should include an extra day of factory technician's time to assist the CLCATT review the functionality and settings of the lighting control hardware per the requirements in the California State forms. It will be the CLCATT's responsibility to create and complete any forms required for the commissioning process, although the manufacturer or contractor may offer spreadsheets and/or printouts to assist the CLCATT with this task.

END OF SECTION 260923

SECTION 261200 - MEDIUM-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following types of transformers with medium-voltage primaries:
 - 1. Pad-mounted, liquid-filled transformers.

1.3 DEFINITIONS

- A. NETA ATS: Acceptance Testing Specification.

1.4 ACTION SUBMITTALS

- A. Product Data: Manufacturer's technical data indicating rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices, fuses and features, location of each field connection, and performance for each type and size of transformer indicated.
- B. Shop Drawings: Diagram for power, signal and control wiring.
- C. Type and size of fuses shall be verified by the coordination study.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans, drawn to scale (1/4"=1'-0") on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Underground primary and secondary conduit stub-up location.
 - 2. Dimensioned concrete base, outline of transformer, and required clearances.
 - 3. Ground rod and grounding cable locations.
- B. Manufacturer Seismic Qualification Certification: Submit certification that transformer assembly and components will withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems." Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

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- 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
 - C. Qualification Data: For testing agency.
 - D. Source quality-control test reports. Certified written reports signed by factory testing engineer or technician including their name and review comments from the testing engineer. Each report shall include date, location of tests and actual test data. Submit within two (2) weeks of factory tests prior to shipment of the unit.
 - E. Field quality-control test reports. Submit within two (2) weeks of completion of field tests.
 - F. Follow-up service reports.
- 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For transformer and accessories to include in emergency, operation, and maintenance manuals.
- 1.7 QUALITY ASSURANCE

- A. American made products have been acceptable to the Owner. If non-domestic products are submitted, notice is hereby given that extensive testing shall be required to insure quality and conformance to the Specifications. Testing shall be done by a recognized lab acceptable to the Owner and all tests shall be witnessed by Owner's personnel. All testing procedures and test results shall be satisfactory to the Owner. Contractor shall be responsible for arranging the tests, for transportation, food and lodging for minimum of one Owner's representative to witness the test at the testing lab. Include all costs for the above in the bid.
- B. Contractor shall ensure that the manufacturer has a minimum of 15 years experience in the production of medium voltage transformers similar to the type and size specified in this project.
- C. Manufacturer shall have ISO 9001 and 9002 Certification.
- D. Manufacturer shall have ability to readily provide replacement parts for a minimum period of ten years, from the date of completion of the project. Provide a letter from the manufacturer confirming the above statement.
- E. Transformer shall be manufactured within 12 months of installation and shall be provided with a manufacturer's warranty of no less than 3 years.
- F. Electrical Components, Devices, Accessories including complete assembly: UL Listed and labeled as defined in NFPA 70, Article 100.
- G. Transformer shall comply with:
 - 1. Institute of Electrical and Electronic Engineers, IEEE C2, IEEE C57.12.10, IEEE C57.12.70, and IEEE C57.12.80.
 - 2. American National Standard Institute, ANSI C57.12.28.
 - 3. National Fire Protection Association (NFPA).

4. State of California Code of Regulations (CCR).

H. Testing Agency Qualifications:

1. Testing agency shall be an independent company with the experience and capability to conduct field testing indicated; shall have been a member of International Testing Association (NETA) for a minimum of last ten (10) years.
2. The company shall have permanent in-house testing engineers and technicians on its staff
3. Testing company shall be located within 50 miles radius of the project.
4. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing to supervise on-site testing specified in Part 3.
5. Filed testing technician and supervisor shall have minimum ten (10) years experience in field testing of medium voltage transformers similar to the type and rating specified on this project.

- I. Product Options: Drawings indicate size, profiles, and dimensional requirements of transformers and are based on the specific system indicated. Refer to Section 016000 "Product Requirements."

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store transformers protected from weather and dust so condensation will not form on or in units. Provide temporary heating according to manufacturer's written instructions.

1.9 PROJECT CONDITIONS

- A. Service Conditions: IEEE C37.121, usual service

1.10 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
- B. Coordinate installation of louvers, doors, spill retention areas, and sumps. Coordinate installation so no piping or conduits are installed in space allocated for medium-voltage transformers except those directly associated with transformers.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Square D; Schneider Electric
 2. Cooper Industries; Cooper Power Systems Division.
 3. Eaton-Cutler-Hammer.
 4. GE Electrical Distribution & Control.

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5. Siemens Energy & Automation, Inc.
6. Or approved equal

2.2 PAD-MOUNTED, LIQUID-FILLED TRANSFORMERS

- A. Description: ANSI C57.12.13, pad-mounted, 2-winding transformers. Stainless-steel tank base and cabinet.
- B. Insulating Liquid: Less flammable, edible-seed-oil based, and UL listed as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall be biodegradable and nontoxic.
- C. Insulation Temperature Rise: 55 deg C when operated at rated kVA output in a 40 deg C ambient temperature. Transformer shall be rated to operate at rated kilovolt ampere in an average ambient temperature of 30 deg C over 24 hours with a maximum ambient temperature of 40 deg C without loss of service life expectancy.
- D. Basic Impulse Level: -95 kV.
- E. Full-Capacity Voltage Taps: Four 2.5 percent taps, 2 above and 2 below rated high voltage; with externally operable tap changer for de-energized use and with position indicator and padlock hasp.
- F. High-Voltage Switch: 200 A, make-and-latch rating of 10-kA RMS, symmetrical, arranged for radial feed with 3-phase, 2-position, gang-operated, load-break switch that is oil immersed in transformer tank with hook-stick operating handle in primary compartment.
- G. Primary Fuses: 150-kV fuse assembly with fuses complying with IEEE C37.47. Rating of current-limiting fuses shall be 50-kA RMS at specified system voltage.
 1. Current-limiting type in dry-fuse holder wells, mechanically interlocked with liquid-immersed switch in transformer tank to prevent disconnect under load.
 2. Internal liquid-immersed cartridge fuses.
 3. Bay-O-Net liquid-immersed fuses in series with liquid-immersed current-limiting fuses. Bay-O-Net fuses shall be externally replaceable without opening transformer tank.
- H. Surge Arresters: Distribution class, one for each primary phase; complying with IEEE C62.11 and NEMA LA 1; support from tank wall within high-voltage compartment. Transformers shall have three arresters for radial-feed circuits.
- I. High-Voltage Terminations and Equipment: Dead front with universal-type bushing wells for dead-front bushing-well inserts, complying with IEEE 386 and including the following:
 1. Bushing-Well Inserts: One for each high-voltage bushing well.
 2. Surge Arresters: Dead-front, elbow-type, metal-oxide-varistor units. Provide separate bushing for each arrester.
 3. Parking Stands: One for each high-voltage bushing well.
 4. Portable Insulated Bushings: Arranged for parking insulated, high-voltage, load-break cable terminators; one for each primary feeder conductor terminating at transformer.
- J. Low Voltage Terminations and Equipment: Molded epoxy, with blade type spade terminals with NEMA standard hole spacing arranged for vertical take off. Low-voltage neutral shall be

an insulated bushing, grounded to tank by a removable ground strap. Location as shown on Drawings. Size of phase and neutral terminations shall be based on the load side conductors shown on the drawings.

1. Drain Valve: 1 inch, with sampling device.
2. Dial-type thermometer.
3. Liquid-level gage.
4. Pressure-vacuum gage.
5. Pressure Relief Device: Self-sealing with an indicator.
6. Mounting provisions for low-voltage current transformers.
7. Mounting provisions for low-voltage potential transformers.
8. Busway terminal connection at low-voltage compartment.
9. Alarm contacts for gages and thermometer listed above.

- K. Enclosure: Enclosure shall be made of stainless steel with front accessible double doors padlockable. It shall have separate compartments for high voltage and low voltage terminations. Enclosure exterior finish shall be factory applied powder coated standard munsel green finish over a rust inhibiting primer on treated metal surface. Furnish a minimum of three (3) years manufacturer warranty against corrosion.1.

2.3 IDENTIFICATION DEVICES

- A. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems." Provide a separate name plate on the inside door indicating fuse size and type.

2.4 SOURCE QUALITY CONTROL

- A. Factory Tests: Perform design and routine tests according to standards specified for components. Conduct transformer tests according to ANSI C57.12.50, ANSI C57.12.51 IEEE C57.12.90, IEEE C57.12.91.
- B. Factory Tests: Perform the following factory-certified tests on each transformer:
1. Resistance measurements of all windings on rated-voltage connection and on tap extreme connections.
 2. Ratios on rated-voltage connection and on tap extreme connections.
 3. Polarity and phase relation on rated-voltage connection.
 4. No-load loss at rated voltage on rated-voltage connection.
 5. Excitation current at rated voltage on rated-voltage connection.
 6. Impedance and load loss at rated current on rated-voltage connection and on tap extreme connections.
 7. Applied potential.
 8. Induced potential.
 9. Temperature Test: If transformer is supplied with auxiliary cooling equipment to provide more than one rating, test at lowest kilovolt-ampere Class OA or Class AA rating and highest kilovolt-ampere Class OA/FA or Class AA/FA rating.
 - a. Temperature test is not required if record of temperature test on an essentially duplicate unit is available.

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10. Owner will witness all required factory tests. Notify Architect at least 30 days before date of tests and indicate their approximate duration.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for medium-voltage transformers.
- B. Examine roughing-in of conduits and grounding systems to verify the following:
 1. Wiring entries comply with layout requirements.
 2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and that requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install transformers on concrete bases.
 1. Anchor transformers to concrete bases according to manufacturer's written instructions, seismic codes at Project, and requirements in Section 260529 "Hangers and Supports for Electrical Systems."
 2. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit and 4 inches high.
 3. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Section 033000 "Cast-in-Place Concrete."
 4. Install dowel rods to connect concrete bases to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
 5. Install epoxy-coated anchor bolts, for supported equipment, that extend through concrete base and anchor into structural concrete floor.
 6. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
- B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

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3.3 IDENTIFICATION

- A. Identify field-installed wiring and components and provide warning signs as specified in Section 260553 "Identification for Electrical Systems."

3.4 CONNECTIONS

- A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- 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.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage an independent qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports. Refer to section 260126 for additional information on testing.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. After installing transformers but before primary is energized, verify that grounding system at substation is tested at specified value or less.
 - 2. After installing transformers and after electrical circuitry has been energized, test for compliance with requirements.
 - 3. Perform visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Test Reports: Prepare written reports 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 actions taken to achieve compliance with requirements.

3.6 FOLLOW-UP SERVICE

- A. Voltage Monitoring and Adjusting: If requested by Owner, perform the following voltage monitoring after Substantial Completion but not more than six months after Final Acceptance:
 - 1. During a period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at secondary terminals of each transformer. Use voltmeters with calibration traceable to National Institute of Science and Technology standards and

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with a chart speed of not less than 1 inch per hour. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from nominal value by more than plus or minus 5 percent during test period, is unacceptable.

2. Corrective Actions: If test results are unacceptable, perform the following corrective actions, as appropriate:
 - a. Adjust transformer taps.
 - b. Prepare written request for voltage adjustment by electric utility.
3. Retests: After corrective actions have been performed, repeat monitoring until satisfactory results are obtained.
4. Report: Prepare written report covering monitoring and corrective actions performed.

END OF SECTION 261200

SECTION 262200 - LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:
 - 1. Distribution transformers.

1.3 ACTION SUBMITTALS

- A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Manufacturer Seismic Qualification Certification: Submit certification that transformers, accessories, and components will withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems." Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Qualification Data: For testing agency.
- C. Source quality-control test reports.
- D. Field quality-control test reports.

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1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.
- C. Source Limitations: Obtain each transformer type through one source from a single manufacturer.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."
- F. Electrical Components, Devices, and Accessories shall be provided with the manufacturer's warranty.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.8 COORDINATION

- A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
- B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Eaton Electrical Inc.; Cutler-Hammer Products.
 2. General Electric Company.
 3. Myers Power Products, Inc.
 4. Siemens Energy & Automation, Inc.
 5. Square D; Schneider Electric.
 6. Or approved equal

2.2 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- B. Cores: Grain-oriented, non-aging silicon steel.
- C. Coils: Continuous windings without splices except for taps.
1. Internal Coil Connections: Brazed or pressure type.
 2. Coil Material: Copper.

2.3 DISTRIBUTION TRANSFORMERS

- A. Comply with NEMA ST 20, and list and label as complying with UL 1561.
- B. Provide transformers that are constructed to withstand seismic forces specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- C. Cores: One leg per phase.
- D. Enclosure: Ventilated NEMA 250, Type 2.
1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
- E. Enclosure: Ventilated NEMA 250, Type 3R.
1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
- F. Transformer Enclosure Finish: Comply with NEMA 250.
1. Finish Color: Gray.
- G. Taps for Transformers Smaller Than 3 kVA: One 5 percent tap above normal full capacity.
- H. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.
- I. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

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- J. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 150 deg C rise above 40 deg C ambient temperature.
- K. Energy Efficiency for Transformers Rated 15 kVA and Larger:
 - 1. Energy-Efficient Transformers Rated 15 kVA and Larger: Transformers shall comply with DOE 10 CFR Part 431 Appendix A of Subpart K 2016 efficiency levels. Energy efficiency under DOE 2016 requirements is to be Energy Verified by UL .
- L. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.
 - 1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
 - 2. Indicate value of K-factor on transformer nameplate.
- M. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
 - 1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
 - 2. Include special terminal for grounding the shield.
 - 3. Shield Effectiveness:
 - a. Capacitance between Primary and Secondary Windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.
 - b. Common-Mode Noise Attenuation: Minimum of minus 120 dBA at 0.5 to 1.5 kHz; minimum of minus 65 dBA at 1.5 to 100 kHz.
 - c. Normal-Mode Noise Attenuation: Minimum of minus 52 dBA at 1.5 to 10 kHz.
- N. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

2.4 IDENTIFICATION DEVICES

- A. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."

2.5 SOURCE QUALITY CONTROL

- A. Test and inspect transformers according to IEEE C57.12.91.
- B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.
 - 1. Brace wall-mounting transformers as specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- B. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions, seismic codes applicable to Project, and requirements in Section 260529 "Hangers and Supports for Electrical Systems."

3.3 CONNECTIONS

- A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.
- B. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

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- C. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- D. Remove and replace units that do not pass tests or inspections and retest as specified above.
- E. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
- B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 262200

SECTION 262413 - SWITCHBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Service and distribution switchboards rated 600 V and less and 800A and above.
2. Transient voltage suppression devices (TVSS).
3. Disconnecting and overcurrent protective devices.
4. Instrumentation.
5. Control power.
6. Accessory components and features.
7. Identification.
8. Mimic Bus.

- B. Switchboard shall be front aligned and front accessible.

C. Related Sections include the following:

1. Section 260526 "Grounding and Bonding for Electrical Systems".
2. Section 260553 "Identification for Electrical Systems".
3. Section 260573 "Overcurrent Protective Device Coordination Study" for short-circuit rating of devices and for setting of overcurrent protective devices.

1.3 DEFINITIONS

- A. NETA ATS: InterNational Electrical Testing Association - Acceptance Testing Specification.
- B. EMI: Electromagnetic interference.
- C. GFCI: Ground-fault circuit interrupter.
- D. RFI: Radio-frequency interference.
- E. RMS: Root mean square.
- F. SPDT: Single pole, double throw.
- G. AIC: Interrupting capacity (RMS symmetrical) in amperes.

1.4 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Switchboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
- B. Shop Drawings: For each switchboard and related equipment.
1. Include dimensioned plans, elevations, sections, and details, including required horizontal and vertical clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
 2. Detail enclosure types for types other than NEMA 250, Type 1.
 3. Detail bus configuration, current, and voltage ratings.
 4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
 5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
 6. Detail utility company's metering provisions with indication of approval by utility company.
 7. Include evidence of UL listing for series rating of installed devices. Series rated devices shall not be provided unless specifically indicated on the drawings.
 8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 9. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.
 10. Include diagram and details of proposed mimic bus.
 11. Include schematic and wiring diagrams for power, signal, and control wiring.
- C. Samples: Representative portion of mimic bus with specified material and finish, for color selection.

1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Ceiling and floor plans, drawn to scale (1/4"=1'-0"), on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
1. Show structural members e.g columns, beams, doors etc. within the area where switchboards are located.
- B. Qualification Data: For qualified testing and inspection agency.

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- C. Seismic Qualification Certificates: Submit certification that switchboards, overcurrent protective devices, accessories, and components will withstand seismic forces. Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

- D. Field Quality-Control Reports:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
 - 4. Submit within two (2) weeks of completion of tests.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - 1. Routine maintenance requirements for switchboards and all installed components.
 - 2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - 3. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Potential Transformer Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
 - 2. Control-Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two sets of each size and type.
 - 3. Fuses and Fusible Devices for Fused Circuit Breakers: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 - 4. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 - 5. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 - 6. Indicating Lights: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.

1.9 QUALITY ASSURANCE

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- A. American made products have been acceptable to the Owner. If non-domestic products are submitted, notice is hereby given that extensive testing shall be required to insure quality and conformance to the Specifications. Testing shall be done by a recognized lab acceptable to the Owner and all tests shall be witnessed by Owner's personnel. Testing procedures and test results shall be satisfactory to the Owner. Contractor shall be responsible for arranging the tests, for transportation, food and lodging for minimum of one Owner's representative to witness the test at the testing lab. Include all costs for the above in the bid.
- B. Contractor shall ensure that the manufacturer has a minimum of 15 years experience in the production of Switchboards similar to the type and size specified in this project.
- C. Manufacturer shall have ISO 9001 or 9002 Certification.
- D. Manufacturer shall have ability to readily provide replacement parts for a minimum period of ten (10) years, from the date of completion of the project. Furnish a letter from the manufacturer confirming the availability.
- E. Switchboards shall be assembled at the manufacturer's own manufacturing facility using its own major devices (e.g., circuit breakers) for the assembly. These devices shall be normally carried by the manufacturer as standard catalog items.
- F. Switchboard shall comply with seismic zone applicable to the project. Provide certified test reports of shake table test done by manufacturer on similar units.
- G. Materials and equipment shall be new, modern in design and shall not have been in prior service except as required by factory tests. Major components (e.g., primary switch, transformer, and switchboard) shall be manufactured within six months of installation.
- H. Source Limitations: Obtain switchboards, overcurrent protective devices and accessories through one source from a single manufacturer through a local distributor unless otherwise indicated. All power distribution equipment shall be of the same manufacturer as the substation.
- I. Comply with NEMA PB 2.
- J. Comply with NFPA 70.
- K. Comply with UL 891.
- L. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.
- M. Product Options: Drawings indicate size, profiles, and dimensional requirements of switchboards and are based on the specific system indicated. Refer to Part 2 "Product Requirements."
- N. Electrical Components, Devices, and Accessories: UL Listed and labeled as defined in NFPA 70, Article 100 and marked for intended location and application.
- O. Testing Agency Qualifications: Member of NETA;
 - 1. Testing agency shall be an independent company; shall have been a member of NETA for a minimum of ten (10) years and has permanent in-house testing engineers and

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technicians involved with testing of switchboards and OCPDs similar to those specified on this project.

2. Testing company shall be located with 50 miles radius of the project.
 3. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing to supervise on-site testing specified in Part 3.
 4. Field Testing technician and supervisor shall have minimum ten (10) years experience in field testing of switchboards similar to the type and rating specified on this project.
- P. 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.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products in accordance with manufacturer's recommended practices and as listed in Installation and Maintenance Manual.
- B. Each switchboard section shall be shipped in individual shipping splits for ease of handling. They shall be mounted on shipping skids and individually wrapped.
- C. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path at site.
- D. Inspect and report damage to carrier within their required time period.
- E. Store indoors in clean dry space with uniform temperature to prevent condensation. Protect from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- F. If stored in areas subjected to weather, cover switchboards to provide protection from weather, dirt, dust, corrosive substances, and physical damage.
- G. Remove loose packing and flammable materials from inside switchboards and install temporary electric heating (250 W per section) to prevent condensation.
- H. Handle and prepare switchboards for installation according to NECA 400.

1.11 PROJECT CONDITIONS

- A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.
- B. Environmental Limitations:
 1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated
 - a. Ambient Temperature: Not exceeding 104 deg F.

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- b. Altitude: Not exceeding 6600 feet.
- C. Service Conditions: NEMA PB 2, usual service conditions, as follows:
 - 1. Ambient temperatures within limits specified.
 - 2. Altitude not exceeding 6600 feet.
- D. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Architect and Owner no fewer than fourteen (14) days in advance of proposed interruption of electric service.
 - 2. Do not proceed with interruption of electric service without Owner's Representative and Owner's written permission.
 - 3. Comply with NFPA 70E.
 - 4. Provide temporary standby power through a standby diesel quiet type back-up generator complete with fuel and 7/24 monitoring if the existing service interruption exceeds 2 hours. Coordinate additional requirements with owner minimum fourteen days in advance. Indicate method of providing temporary electric service.

1.12 COORDINATION

- A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
- C. Make sure switchboards shall fit in the available space shown.

1.13 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 (5) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Square D; a brand of Schneider Electric

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2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 3. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 4. Siemens
 5. Or approved equal
- B. Front-Connected, Front-Accessible Switchboards:
1. Main Devices: Fixed, individually mounted unless otherwise indicated.
 2. Branch Devices: Panel mounted for sizes up to 400A. Individually mounted for sizes above 400A.
 3. Sections front and rear aligned.
- C. Nominal System Voltage: 480Y/277 V-
- D. Main-Bus Continuous: 2500 A.
- E. Seismic Requirements: Fabricate and test switchboards according to IEEE 344 to withstand seismic forces.
- F. Indoor Enclosures: Steel, NEMA 250, Type 1.
- G. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.
- H. Barriers: Between adjacent switchboard sections.
- I. Insulation and isolation for main bus of main section and main and vertical buses of feeder sections.
- J. Customer Metering Compartment: A separate customer metering compartment and section with front hinged door, for indicated metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks. For switchboards with space heaters, provide CTs ahead of the main so that power used by the space heaters is recorded by the meter too.
- K. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.
- L. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
- M. Pull Box on Top of Switchboard:
1. Provide a proper size (per NEC) pull box on the top of the switchboard.
 2. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.
 3. Set back from front to clear circuit-breaker removal mechanism.
 4. Removable covers shall form top, front, and sides. Top covers at front/sides shall be easily removable for drilling and cutting.
 5. Bottom shall be insulating, fire-resistive material with separate holes for cable drops into switchboard.
 6. Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.

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- N. Buses and Connections: Three phase, four wire unless otherwise indicated.
 - 1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity, silver-plated, copper feeder circuit-breaker line connections.
 - 2. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with mechanical connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.
 - 3. Ground Bus: 1/4-by-2-inch- hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
 - 4. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
 - 5. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
 - 6. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.
 - O. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.
 - P. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Minimum insulation temperature rating of 105 deg C.
- 2.2 SURGE PROTECTION DEVICES (SPDs): UL listed and labeled and complying with UL 1449.
- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Square D; a brand of Schneider Electric.
 - 2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 3. Or equal.
 - B. SPDs with the following features and accessories:
 - 1. Integral disconnect switch.
 - 2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
 - 3. Indicator light display for 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 protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system. Audible alarm activated on failure of any surge diversion mode.
 - 5. Surge counter. Six digit transient counter set to total transient surge that deviate from the sine-wave envelope by more than 125V.
 - C. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase

shall not be less than 200 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

- D. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V or 208Y/120 V (as indicated on drawings), three-phase, four-wire circuits shall not exceed the following:
1. Line to Neutral: 1200 V for 480Y/277 V; 1200 V for 208Y/120 V.
 2. Line to Ground: 1200 V for 480Y/277 V; 1200 V for 208Y/120 V.
 3. Line to Line: 2000V for 480/277V.

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents. Series ratings are not acceptable. Refer to drawings for additional information.
1. Thermal-Magnetic Circuit Breakers for below 400A frame size: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 3. Electronic trip circuit breakers with rms sensing for circuit breakers 400A frame and above; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long and short time adjustments.
 - d. Ground-fault pickup level, time delay, and I²t response.
 4. MCCB Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles as indicated on drawings. Provide shunt trip on circuit breakers indicated on single line diagram.
 - b. Lugs: Mechanical style, suitable for number, size, trip ratings and conductor material.
 - c. Application Listing: Appropriate for application; type SWD for switching fluorescent lighting loads, type HID for feeding fluorescent and high intensity discharge (HID) lighting circuits.
 - d. Ground Fault Protection: Comply with UL 1053. Integrally mounted relay with internal memory, and three phase current transformer/sensor. and trip with field adjustable pick-up and time delay settings, push to test feature and ground fault indicator. No trip relay test permits ground fault simulation test without tripping.
 - e. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
 - f. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage. Verify setting with Protective Device Coordination Study.
 - g. Under-voltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
 - h. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
 - i. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key

shall be removable only when circuit breaker is in off position.

2.4 INSTRUMENTATION

- A. Instrument Transformers: IEEE C57.13, NEMA EI 21.1, and the following:
1. Potential Transformers: IEEE C57.13; 120 V, 60 Hz, tapped secondary; disconnecting type with integral fuse mountings. Burden and accuracy shall be consistent with connected metering and relay devices.
 2. 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.
 3. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.
 4. 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.
- B. 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. Megawatts: Plus or minus 2 percent.
 - e. Megavars: Plus or minus 2 percent.
 - f. Power Factor: Plus or minus 2 percent.
 - g. Frequency: Plus or minus 0.5 percent.
 - h. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent; accumulated values unaffected by power outages up to 72 hours.
 - i. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from five to 60 minutes.
 - j. Contact devices to operate remote impulse-totalizing demand meter.
 2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.
 3. Digital Meter shall be manufactured by the one following manufacturers: Square D; Eaton-Cutler Hammer, or Shark.

2.5 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- B. Portable Test Set: For testing functions of solid-state trip devices without removing from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

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2.6 IDENTIFICATION

- A. Service Equipment Label: UL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receive, inspect, handle, and store switchboards according to NECA 400.
- B. Examine switchboards before installation to verify compliance with approved shop drawings. Reject switchboards that are moisture damaged or physically damaged.
- C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected to the satisfaction of the owner.

3.2 INSTALLATION

- A. Install switchboards and accessories according to NECA 400.
- B. Equipment Mounting: Install switchboards on concrete base, 4-inch nominal thickness. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to switchboards.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.
- D. Comply with mounting and anchoring requirements.
- E. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.
- F. Install filler plates in unused spaces of panel-mounted sections.
- G. Install overcurrent protective devices, transient voltage suppression devices, and

instrumentation.

1. Set field-adjustable switches and circuit-breaker trip ranges in accordance with the recommendations of the Overcurrent Protective Device Short Circuit, Coordination and Arc Flash Study.

H. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, start-up and to assist in testing.
- C. Acceptance Testing Preparation:
 1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
 2. Test continuity of each circuit.
- D. Tests and Inspections:
 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 2. All tests shall be witnessed by owner's representative. Provide minimum fourteen (14) days advance notice.
 3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 4. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front and rear panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of

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each switchboard 11 months after date of Substantial Completion.

- c. Instruments and Equipment:
 - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- 5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Switchboard will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Overcurrent Protective Device Coordination Study."

3.6 PROTECTION

- A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

3.7 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories.

END OF SECTION 262413

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SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Distribution panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.

1.3 DEFINITIONS

- A. SVR: Suppressed voltage rating.
- B. TVSS: Transient voltage surge suppressor.

1.4 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Detail enclosure types and details for types other than NEMA 250, Type 1.
 - 3. Detail bus configuration, current, and voltage ratings.
 - 4. Short-circuit current rating of panelboards and overcurrent protective devices.
 - 5. Include evidence of NRTL listing for series rating of installed devices.
 - 6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

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1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Seismic Qualification Certificates: Submit certification that panelboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems." Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Field Quality-Control Reports:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- D. Panelboard Schedules: For installation in panelboards.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Keys: Two spares for each type of panelboard cabinet lock.

1.9 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA.
 - 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. All power distribution equipment shall be from the same manufacturer.

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- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- D. 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.
- E. Comply with NEMA PB 1.
- F. Comply with NFPA 70.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards.
- B. Handle and prepare panelboards for installation according to NECA 407.

1.11 PROJECT CONDITIONS

- A. Environmental Limitations:
 - 1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
 - 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding minus 22 deg F to plus 104 deg F.
 - b. Altitude: Not exceeding 6600 feet.
- B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
 - 1. Ambient temperatures within limits specified.
 - 2. Altitude not exceeding 6600 feet.
- C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Architect and Owner no fewer than fourteen days in advance of proposed interruption of electric service.
 - 2. Do not proceed with interruption of electric service without Architect's and Owner's written permission.
 - 3. Comply with NFPA 70E.

1.12 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces.

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Maintain required workspace clearances and required clearances for equipment access doors and panels.

- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.13 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- B. Enclosures: Flush- and surface-mounted cabinets.
 - 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1
 - b. Outdoor Locations: NEMA 250, Type 3R
 - c. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 - d. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 5.
 - 2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
 - 3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
 - 4. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
 - 5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
 - 6. Finishes:
 - a. Panels and Trim: Steel factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Galvanized steel.
 - 7. Directory Card: Inside panelboard door, mounted in transparent card holder.
- C. Incoming Mains Location: Top and bottom.
- D. Phase, Neutral, and Ground Buses:
 - 1. Material: Tin-plated aluminum.

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2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
- E. Conductor Connectors: Suitable for use with conductor material and sizes.
 1. Material: Tin-plated aluminum.
 2. Main and Neutral Lugs: Mechanical type.
 3. Ground Lugs and Bus-Configured Terminators: Mechanical type.
 4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
- F. 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.
- G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- H. Panelboard Short-Circuit Current Rating: UL Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an UL. Include size and type of allowable upstream and branch devices, listed and labeled for series-connected short-circuit rating by an UL.
- I. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 DISTRIBUTION PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 3. Siemens Energy & Automation, Inc.
 4. Square D; a brand of Schneider Electric.
 5. Or approved equal
- B. Panelboards: NEMA PB 1, power and feeder distribution type.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
 1. For doors more than 36 inches high, provide two latches, keyed alike.
- D. Mains: Circuit breaker or Main Lug Only based on Drawings.
- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
- F. 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.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Mains: Circuit breaker or Main Lug Only based on Drawings.
- D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.
- F. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, 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 250 A and larger.
 - 2. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
 - 3. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
 - 4. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

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- e. Shunt Trip: Trip coil energized from separate circuit, set to trip at 55 percent of rated voltage. Coil voltage shall be coordinated with equipment providing the trip signal.
 - f. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.
 - g. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in off position. Provide lock-on devices on circuit breaker serving life safety equipment.
- C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
- 1. Fuses, and Spare-Fuse Cabinet: Comply with requirements specified in Section 262813 "Fuses."
 - 2. Fused Switch Features and Accessories: Standard ampere ratings and number of poles.
 - 3. Auxiliary Contacts: One normally open and normally closed contact(s) that operate with switch handle operation.

2.5 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receive, inspect, handle, and store panelboards according to NECA 407.
- B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
- C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install panelboards and accessories according to NECA 407.
- B. Equipment Mounting: Install panelboards on concrete bases, 4-inch nominal thickness. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch 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.

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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.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- D. Comply with mounting and anchoring requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- E. Mount top of trim 90 inches above finished floor unless otherwise indicated. Maximum mounting height for circuit breaker operating handle shall be 6'-6" AFF except where code requires lower height. Include housekeeping pad.
- F. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- G. Install overcurrent protective devices and controllers not already factory installed.
 1. Set field-adjustable, circuit-breaker trip ranges.
- H. Install filler plates in unused spaces.
- I. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.
- J. Arrange conductors in gutters into groups and bundle and wrap with wire ties.
- K. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 260553 "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- E. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- F. Panelboards will be considered defective if they do not pass tests and inspections.
- G. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

- A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable 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 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

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3.6 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 262416

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
 - 2. Twist-locking receptacles.
 - 3. Weather-resistant receptacles.
 - 4. Wall-switch and exterior occupancy sensors.
 - 5. Floor service outlets, poke-through assemblies, service poles, and multioutlet assemblies.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- D. RFI: Radio-frequency interference.
- E. TVSS: Transient voltage surge suppressor.
- F. UTP: Unshielded twisted pair.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Receptacles for Owner-Furnished Equipment: Match plug configurations.
 - 2. Cord and Plug Sets: Match equipment requirements.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

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- C. Samples: One for each type of device and wall plate specified, in each color specified.

1.6 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
 1. Cooper Wiring Devices; Division of Cooper Industries, Inc. (Cooper).
 2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
 3. Leviton Mfg. Company Inc. (Leviton).
 4. Pass & Seymour/Legrand (Pass & Seymour).
 5. Or approved equal
- B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
 1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
 2. Devices shall comply with the requirements in this Section.

2.3 STRAIGHT-BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
 1. Products: Subject to compliance with requirements, provide the following:
 - a. Cooper; 5351 (single), CR5362 (duplex).
 - b. Hubbell; HBL5351 (single), HBL5352 (duplex).
 - c. Leviton; 5891 (single), 5352 (duplex).

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- d. Pass & Seymour; 5361 (single), 5362 (duplex).
 - 2. Description: Grounded, industrial extra heavy duty specification grade, back and side wired, single-piece grounding brass strap with integral ground, impact resistant thermoplastic nylon cover and body, smooth face with separate grounding screw and NEMA 5-20R plug configurations.
- B. Controlled Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
- 1. Products: Subject to compliance with requirements, provide the following:
 - a. Hubbell; HBL5361 (single), HBL5362 (duplex).
 - b. Leviton; 5361 (single), 5362 (duplex).
 - c. Pass & Seymour; 5361 (single), 5362 (duplex).
 - 2. Description: Color per Architect. Grounded, industrial extra heavy duty specification grade, back and side wired, single-piece grounding brass strap with integral ground, impact resistant thermoplastic nylon cover and body, smooth face with separate grounding screw and NEMA 5-20R plug configurations.

2.4 GFCI RECEPTACLES

- A. General Description:
- 1. Straight blade, non-feed-through type.
 - 2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
 - 3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.
- B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
- 1. Products: Subject to compliance with requirements, provide the following:
 - a. Cooper; VGF20.
 - b. Hubbell; GFR5352L.
 - c. Pass & Seymour; 2095.
 - d. Leviton; 7590.
 - e. Or approved equal

2.5 TWIST-LOCKING RECEPTACLES

- A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration L5-20R, and UL 498.
- 1. Products: Subject to compliance with requirements, provide the following:
 - a. Cooper; CWL520R.
 - b. Hubbell; HBL2310.
 - c. Leviton; 2310.
 - d. Pass & Seymour; L520-R.
 - e. Or approved equal

2.6 TOGGLE SWITCHES

- A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

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- B. Switches, 120/277 V, 20 A:
 - 1. Products: Subject to compliance with requirements, provide the following: Catalog numbers in lists below are for 20-A devices; revise catalog numbers to require other configurations and ratings.
 - a. Single Pole:
 - 1) Cooper; AH1221.
 - 2) Hubbell; HBL1221.
 - 3) Leviton; 1221-2.
 - 4) Pass & Seymour; CSB20AC1.
 - 5) Or approved equal

2.7 WALL PLATES

- A. Single and combination types shall match corresponding wiring devices.
 - 1. Plate-Securing Screws: Metal with head color to match plate finish.
 - 2. Material for Finished Spaces: Smooth, high-impact thermoplastic .
 - 3. Material for Unfinished Spaces: Galvanized steel.
 - 4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

2.8 FINISHES

- A. Device Color:
 - 1. Wiring Devices Connected to Normal Power System: As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.
- B. Wall Plate Color: For plastic covers, match device color.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
- B. Coordination with Other Trades:
 - 1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
 - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 - 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.

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4. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
 3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
 4. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtailling existing conductors is permitted, provided the outlet box is large enough.
- D. Device Installation:
1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
 2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
 3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
 4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
 5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
 6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
 7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
 8. Tighten unused terminal screws on the device.
 9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.
- E. Receptacle Orientation:
1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.
 2. Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade at the top.
- F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.
- G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.
- H. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

- A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.3 IDENTIFICATION

- A. Comply with Section 260553 "Identification for Electrical Systems."
- B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. In healthcare facilities, prepare reports that comply with recommendations in NFPA 99.
 - 2. Test Instruments: Use instruments that comply with UL 1436.
 - 3. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- B. Tests for Convenience Receptacles:
 - 1. Line Voltage: Acceptable range is 105 to 132 V.
 - 2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
 - 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 - 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 - 5. Using the test plug, verify that the device and its outlet box are securely mounted.
 - 6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
- C. Wiring device will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION 262726

SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Cartridge fuses rated 600-V ac and less for use in enclosed switches.
 - 2. Plug-fuse adapters for use in Edison-base, plug-fuse sockets.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
 - 1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
 - a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
 - b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
 - 2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - 1. Ambient temperature adjustment information.
 - 2. Current-limitation curves for fuses with current-limiting characteristics.
 - 3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

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- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70.
- E. Comply with UL 248-11 for plug fuses.

1.6 PROJECT CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.7 COORDINATION

- A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper Bussmann, Inc.
 - 2. Edison Fuse, Inc.
 - 3. Ferraz Shawmut, Inc.
 - 4. Littelfuse, Inc.
 - 5. Or approved equal

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

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- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

- A. Cartridge Fuses:
 - 1. Service Entrance: Class L, fast acting.
 - 2. Feeders: Class L, fast acting
 - 3. Motor Branch Circuits: Class RK1 time delay.
 - 4. Other Branch Circuits: Class RK1, time delay
 - 5. Control Circuits: Class CC, fast acting

3.3 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- B. Install plug-fuse adapters in Edison-base fuseholders and sockets. Ensure that adapters are irremovable once installed.
- C. Install spare-fuse cabinet(s).

3.4 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 262813

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SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Fusible switches.
 - 2. Nonfusible switches.
 - 3. Receptacle switches.
 - 4. Shunt trip switches.
 - 5. Molded-case circuit breakers (MCCBs).
 - 6. Molded-case switches.
 - 7. Enclosures.

1.3 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.4 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
 - 1. Enclosure types and details for types other than NEMA 250, Type 1.
 - 2. Current and voltage ratings.
 - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
 - 4. Include evidence of NRTL listing for series rating of installed devices.

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5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
 6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.
- B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
1. Wiring Diagrams: For power, signal, and control wiring.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Seismic Qualification Certificates: For enclosed switches and circuit breakers, accessories, and components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Field quality-control reports.
1. Test procedures used.
 2. Test results that comply with requirements.
 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- D. Manufacturer's field service report.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
 2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

2. Fuse Pullers: Two for each size and type.

1.9 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 enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.
- C. 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.
- D. 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.
- E. Comply with NFPA 70.

1.10 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
 2. Altitude: Not exceeding 6600 feet.
- B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 1. Notify Owner no fewer than 14 days in advance of proposed interruption of electric service.
 2. Indicate method of providing temporary electric service.
 3. Do not proceed with interruption of electric service without Owner's written permission.
 4. Comply with NFPA 70E.

1.11 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
 - 5. Or approved equal

- B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

- C. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 - 4. Lugs: Mechanical type, suitable for number, size, and conductor material.
 - 5. Service-Rated Switches: Labeled for use as service equipment.

2.2 NONFUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
 - 5. Or approved equal

- B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

- C. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

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2.3 SHUNT TRIP SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper Bussmann, Inc.
 - 2. Ferraz Shawmut, Inc.
 - 3. Littelfuse, Inc.
 - 4. Or approved equal
- B. General Requirements: Comply with ASME A17.1, UL 50, and UL 98, with 200-kA interrupting and short-circuit current rating when fitted with Class J fuses.
- C. Switches: Three-pole, horsepower rated, with integral shunt trip mechanism and Class J fuse block; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.
- D. Control Circuit: 120-V ac; obtained from integral control power transformer, with primary and secondary fuses, with a control power source of enough capacity to operate shunt trip, connected pilot, and indicating and control devices.

2.4 MOLDED-CASE CIRCUIT BREAKERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
 - 5. Or approved equal
- B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- D. Features and Accessories:
 - 1. Standard frame sizes, trip ratings, and number of poles.
 - 2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
 - 3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.

2.5 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
 - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.

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2. Outdoor Locations: NEMA 250, Type 3R.
3. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Comply with mounting and anchoring requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. Install fuses in fusible devices.
- E. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

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- D. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.

- E. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 3. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
 - 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.
 - 4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

- F. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

- G. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

- B. Set field-adjustable circuit-breaker trip ranges

END OF SECTION 262816

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SECTION 263323 - CENTRAL BATTERY EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnishing, installing and connecting emergency system to lighting fixtures, signal systems, and electrical loads as indicated on Drawings.

1.2 DEFINITIONS

- A. CIS: Central Inverter System.
- B. UPS: Uninterruptible Power Supply.

1.3 DESIGN REQUIREMENTS

- A. Emergency systems shall be supplied from storage batteries with charging unit with a minimum of 90 minutes back-up capacity for lighting systems by the furnishing of an CIS, and a minimum of 30 minute back-up for Data Systems by furnishing of an UPS. These 2 systems shall be separate and independent of each other. Systems shall be installed in accordance with requirements of all codes and regulations.

1.4 QUALITY ASSURANCE

- A. The manufacturer shall have been producing inverter system equipment for at least 5 consecutive years.
- B. Systems shall undergo full load burn in testing at the factory.
- C. Systems shall be listed by UL, or another Nationally Recognized Testing Laboratory (NRTL).
- D. A manufacturer's technical representative shall be available for system start-up, warranty work, and service calls.

1.5 WARRANTY

- A. Manufacturer shall provide a 2 year material warranty and a 10 year material warranty for battery cells.
- B. Installer shall provide a 2 year labor warranty.

PART 2 - PRODUCTS

2.1 COMPONENTS

A. CIS and UPS:

1. General: Each system shall be furnished with following features:
 - a. System shall automatically protect itself against damage from overloads and short circuits while powered from either utility AC or during emergency inverter operations. System shall automatically disconnect load when battery voltage drops below approximately 85 percent of nominal battery voltage.
 - b. Batteries of system shall be maintenance-free type with lead calcium grids and shall be provided with a 10-year manufacturer's warranty. Batteries shall have sufficient capacity to power inverter at full rated load for a minimum of 90 minutes for lighting loads and PABX and PA systems, without battery voltage dropping below 85 percent of nominal battery voltage. Battery manufacturer's data sheets shall be provided indicating recommended charge rates, operating conditions and warranty years. Batteries shall be connected and installed in accordance with recommendations of battery manufacturer, and shall be individually labeled with make and model identification. Secure batteries to withstand seismic vibrations. Batteries shall be replaceable in field.
 - c. System shall be enclosed in a heavy gage, commercial grade steel cabinet, including hinged and lockable doors. Locks shall be keyed to Corbin No. 60 keys. Provide input and output manual disconnects for UPS System. Provide complete operating service and parts manuals including, but not limited to, electrical diagrams and factory test data.
2. CIS shall be furnished with following additional features:
 - a. A microprocessor shall oversee inverter, and provide programmable functional self-test according to NFPA 101 to ensure optimal system and sub-system performance. If abnormal conditions or failure occur, warning messages shall be issued and alarms shall be sounded so that timely action maybe taken to alleviate problem or repair system. If inverter becomes inoperable, microprocessor shall be capable of shutting down components to prevent further damage.
 - b. The unit shall include a self-diagnostic facsimile modem that sends a detailed unit status report when:
 - 1) A self-test is performed.
 - 2) An alarm condition exists.
 - 3) The status report shall be sent to 6 user defined locations. These locations can be preprogrammed at factory, programmed on site by customer, or remotely programmed by factory once system is installed.
 - 4) The self/diagnostic facsimile shall allow for remote monitoring and troubleshooting of any abnormal conditions. The facsimile shall be provided with a dedicated telephone line off of PBX system.
 - c. System shall be self contained, UL924 listed, designed to provide no-break power to operate specified lighting load for 90 minutes upon power loss or brown out of utility voltage.
 - d. The system's operation is to be fully automatic. It shall use a linear transformer, with boost tap and surge protection devices. Inverter shall be of Pulse Width Modulated (PWM) design, and shall provide true "no-break" power to load at all times. During normal operation, charger maintains battery bank at full capacity. The three on-board microprocessors continuously monitor charger settings and

- system's overall readiness. System consists of circuitry including an automatic, multi-rate, software controlled charger; continuous self-diagnostics monitoring 265 various parameters, and programmable system testing capabilities. System shall incorporate 30 individual alarms and 9 systems logs. All Logs and Alarms are to be automatically recorded and readily displayed through microprocessor controlled User Interface Display (UID). System shall also include a RS232 Serial port for remote communications.
- e. The system's automatic overload and short circuit protection in normal and emergency operations shall consist of 150% momentary surge capability, 120% overload for 5 minutes, and 110% overload for 10 minutes. System protection shall also include a low battery voltage disconnect, AC input circuit breaker, a DC input fuse and switch, and an AC output fuse. System shall supply a digitally generated sinusoidal output waveform (PWM) with less than 5% total harmonic distortion at rated linear load. A boost tap transfer protection circuit shall maintain desired output voltage during low voltage "brownout" situations, without continuously switching to batteries; thereby preserving battery capacity.
 - f. Start Up and Maintenance: Microprocessor shall contain commission data including unit size, serial number, order number, and battery configuration. Software shall be furnished to assist in installation of equipment, brownout selection, and functional self-test.
 - g. Unit shall be furnished with 5 normally on output circuit breakers with alarm, and 5 normally off circuit breakers with alarm. Provide a descriptive circuit designation schedule.
 - h. IPS shall be Spectron LSN by Dual-Lite, Illuminator by Myers Power Products, or District approved equal.
3. UPS shall have following additional features:
- a. System shall be a self-contained, hard-wired (input and output), UL listed system designed to provide continuous AC power; it shall be fully compatible with connected loads and shall provide a sinusoidal output waveform with 6 percent or less of maximum total harmonic distortion. System input and output ratings shall be as indicated on Drawings. System shall have a throughput efficiency (with utility power on) of at least 90 percent, excluding charger and shall include, but not be limited to, AC sensing equipment, automatic transfer switch, battery charger, batteries, DC to AC inverter, ferro-resonant transformer, and rectifier.
 - b. Sensing and transfer equipment shall operate as follows:
 - 1) Under normal operating conditions, load shall be powered by normal AC line supply that has been filtered through ferro-resonant transformer. When AC line power is present, inverter shall be off; battery charger shall be off if batteries are fully charged.
 - 2) When AC line power fails, inverter shall supply AC power to transformer from batteries. There shall be no interruption or reduction in output of system during transfer from normal AC line supply to inverter battery supply, or back to line.
 - c. Battery charger shall be furnished with solid-state circuitry and shall provide a high charge rate, capable of restoring batteries to full rated capacity within 12 hours. High charge and float charge characteristics shall comply with Specifications and recommendations of battery manufacturer. Battery charger shall operate properly throughout an input voltage range of 5 percent above and below nominal line voltage. Battery charger shall operate at 85 percent minimum efficiency.

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- d. Battery shall be sealed, maintenance free, gas recombinant, self venting, with a suspended electrolyte. Batteries must be factory tested and approved for use with specific inverter.
- e. Solid-state DC to AC inverter shall be capable of driving full rated load at a power factor of 0.85 leading to 0.85 lagging, and shall maintain a frequency between 59 and 61 cycles per second at rated output voltage, throughout all operating conditions. U.P.S. shall be furnished with at least 4 - 20 amp outlets and a power cord of at least 5 foot in length.
- f. Ferro-resonant transformer shall provide filtered AC power to load and protect it against following abnormal conditions such as spikes, sags, surges, noise, lightning, and brownouts.
- g. System shall be provided with a standard RS232 port to allow interface with computer or remote monitoring station. Additionally, system shall be furnished with a front panel keyboard and LCD display furnished with following metering and control capabilities:
 - 1) Meter functions: AC volts out, AC volts in, battery voltage, AC current in, AC current out, VA load, DC current, frequency, heat sink temperature, ambient temperature, time, number of power outages, log of power outages, projected run time available, system hours, inverter hours, number of overloads.
 - 2) Alarm messages for: high AC out, low AC out, near low battery, low battery voltage, high battery voltage, ambient over temperature, heat sink over temperature, inverter on, overload, DC disconnect, charger on to long, charger off too long.
 - 3) Set points for: high AC voltage, low AC voltage, high battery voltage, low battery voltage, near low battery, high heat sink temperature, high ambient temperature, frequency tolerance, baud rate (2400 or 4800 BPS), battery capacity, battery charge voltage, charger equalize hours, equalize cycle.
- h. Integrated maintenance bypass.
- i. Subfeed breaker.
- j. UPS shall be Eaton Corporation to match campus standard.

PART 3 - EXECUTION

3.1 INSTALLATION, SYSTEM SHIPPING, START-UP AND TESTING

- A. Shipping: System shall be shipped separately from batteries. Batteries shall be shipped to Project site directly from battery supplier and shall remain in their sealed cartons until opened and examined in presence of IOR. Batteries shall be shipped to Project site not more than 30 days before system start-up.
- B. Start-Up: System start-up shall be performed by a technical representative of manufacturer, in presence of Architect, with loads connected, and shall include necessary testing and adjusting to assure proper operation of system functions. System start-up shall include follow-up visits as required. Following start-up, maintain system on a normally OFF input circuit until Substantial Completion.
- C. Testing: Before Substantial Completion, conduct in presence of Architect, a complete performance testing of system. Testing shall include operating system in emergency mode for at

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least 90 minutes for CIS, and for at least 30 minutes for UPS, with loads connected, while monitoring battery voltage, output voltage and output frequency. Power factor of load shall be measured to ascertain compatibility with system. Furnish and operate necessary test equipment.

- D. Equipment shall be anchored in accordance with California Zone 4 seismic requirements

3.2 BATTERIES

- A. Batteries shall be complete with necessary connectors and accessories, fully charged, and ready for service.
- B. Documentation for 10 year manufacturer's warranty for all batteries shall be delivered to Architect.

3.3 SERVICE MANUALS

- A. Service Manuals: Submit service manuals to OAR including following:
 1. A detailed explanation of operation of system
 2. Instructions for routine maintenance.
 3. Detailed instructions for repair of major components of system.
 4. Pictorial parts list and parts numbers.
 5. Pictorial and schematic electrical drawings of wiring systems, including operating and safety devices, and major components.
 6. Programming Instructions.
 7. Program listing.
 8. Final test report.
 9. Installation Instructions: Submit manufacturer's written installation instructions.

3.4 TRAINING

- A. Before Substantial Completion, provide the services of a manufacturer's representative on the Project site to instruct persons designated by the Owner in the operation and maintenance of the system. Instruction time shall not be less than 4 hours. Provide training video and training materials to designated owner's personnel.

END OF SECTION 263323

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SECTION 265100 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior lighting fixtures, lamps, and drivers.
2. Emergency lighting units.
3. Exit signs.
4. Lighting fixture supports.

B. Related Sections:

1. Section 260923 "Distributed Digital Lighting Control System" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.2 REFERENCES

- A. ANSI/NFPA 70, National Electrical Code
- B. IESNA LM-79, Electrical and Photometric Measurements of Solid-State Lighting Products
- C. IESNA LM-80, Approved Method for Measuring Lumen Maintenance of LED Light Sources
- D. IESNA TM-21, Luminaire Classification System for Indoor Luminaires
- E. UL1598, Standard for Safety of Luminaires

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, and finishes.
- B. Shop Drawings: Show details of nonstandard or custom lighting fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories. Product Certificates: For each type of driver for dimmer-controlled fixtures, from manufacturer.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

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1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Luminaires shall be fully assembled and individually electrically tested prior to shipment.
- D. Manufacturers of LED luminaires shall demonstrate a suitable testing program to ensure system reliability and to substantiate lifetime claims.
- E. The sole use of IESNA LM-80 data to predict luminaire lifetime is not acceptable.
- F. At time of manufacture, electrical and light technical properties shall be recorded for each luminaire. At a minimum, this should include lumen output, CCT, and CRI. Each luminaire shall utilize a unique serial numbering scheme. Technical properties must be made available for a minimum of 5 years after the date of manufacture.
- G. Luminaires shall be provided with a minimum 5 year warranty covering, LEDs, drivers and paint finish.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, product(s) indicated on Drawings.

2.2 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

- A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
- B. Metal Parts: Free of burrs and sharp corners and edges.
- C. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.
- D. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- E. Diffusers and Globes:
 - 1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - a. Lens Thickness: At least [0.125 inch (3.175 mm)] minimum unless otherwise indicated.
 - b. UV stabilized.

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2. Glass: Annealed crystal glass unless otherwise indicated.

2.3 DRIVERS FOR LED FIXTURES

- A. Electronic Driver for LED Fixtures: Comply with UL 1310 Class 2 requirements for dry and damp locations. Include the following features unless otherwise indicated:
 1. Rated for 50,000 hours of life, unless otherwise noted.
 2. Sound Rating: Class A.
 3. Total Harmonic Distortion Rating: 15 percent or less.
 4. Current Crest Factor: 1.5 or less.
 5. 0-10V Dimming Standard (Step Dimming does not qualify)

2.4 EXIT SIGNS

- A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
 1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.

2.5 LED FIXTURES

- A. Except as otherwise indicated, provide LED luminaires, of types and sizes indicated on fixture schedules.
- B. Include the following features unless otherwise indicated:
 1. Each Luminaire shall consist of an assembly that utilizes LEDs as the light source. In addition, a complete luminaire shall consist of a housing, LED array, and electronic driver (power supply).
 2. Each luminaire shall be rated for a minimum operational life of 50,000 hours utilizing a minimum ambient temperature of (25°C).
 3. Light Emitting Diodes tested under LM-80 Standards for a minimum of 12,000 hours.
 4. Color Rendering Index (CRI) of 82 at a minimum.
 5. Color temperature 4000K, unless otherwise indicated.
 6. Rated lumen maintenance at 70% lumen output for 50,000 hours, unless otherwise indicated.
 7. Fixture efficacy of 60 Lumens/Watt, minimum.
 8. 5 year luminaire warranty, minimum.
 9. Photometry must comply with IESNA LM-79.
 10. The individual LEDs shall be constructed such that a catastrophic loss of the failure of one LED will not result in the loss of the entire luminaire.
 11. Luminaire shall be constructed such that LED modules may be replaced or repaired without the replacement of the whole fixture.
- C. Technical Requirements
 1. Luminaire shall have a minimum efficacy of 60 lumens per watt. The luminaire shall not consume power in the off state.

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2. Operation Voltage: The luminaire shall operate from a 50 HZ to 60 HZ AC line over a voltage ranging from 120 VAC to 277 VAC. The fluctuations of line voltage shall have no visible effect on the luminous output.
3. Power Factor: The luminaire shall have a power factor of 0.9 or greater.
4. THD: Total harmonic distortion (current and voltage) induced into an AC power line by a luminaire shall not exceed 15 percent.
5. Operational Performance: The LED circuitry shall prevent visible flicker to the unaided eye over the voltage range specified above.

D. Thermal Management

1. The thermal management (of the heat generated by the LEDs) shall be of sufficient capacity to assure proper operation of the luminaire over the expected useful life.
2. The LED manufacturer's maximum thermal pad temperature for the expected life shall not be exceeded.
3. Thermal management shall be passive by design. The use of fans or other mechanical devices shall not be allowed.
4. The luminaire shall have a minimum heat sink surface such that LED manufacturer's maximum junction temperature is not exceeded at maximum rated ambient temperature.

2.6 LIGHTING FIXTURE SUPPORT COMPONENTS

- A. Comply with Section 260529 "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports. See Architectural and Electrical drawings for light fixture anchorage.
- B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
- C. Twin-Stem Hangers: Two, 1/2-inch (13-mm) steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
- D. Rod Hangers: 3/16-inch (5-mm) 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.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.
- B. Comply with NFPA 70 for minimum fixture supports.
- C. Suspended Lighting Fixture Support:
 1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
 2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.

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3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end. See Architectural drawings for anchorage and sway bracing.
- D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.2 FIELD QUALITY CONTROL

- A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.
- B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 265100

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SECTION 265600 - EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Exterior luminaires with lamps and drivers.
 - 2. Luminaire-mounted photoelectric relays.
 - 3. Poles and accessories.
 - 4. Luminaire lowering devices.
- B. Related Sections:
 - 1. Section 265100 "Interior Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.
 - 2. Section 260519 "Low Voltage Electrical Power Conductors and Cables".

1.3 DEFINITIONS

- A. AASHTO: American Association of State Highway and Transportation Officials
- B. CCT: Correlated color temperature.
- C. CRI: Color-rendering index.
- D. HID: High-intensity discharge.
- E. IESNA: Illuminating Engineering Society of North America
- F. LER: Luminaire efficacy rating.
- G. Luminaire: Complete lighting fixture, including ballast housing if provided.
- H. Pole: Luminaire support structure, including tower used for large area illumination.
- I. Standard: Same definition as "Pole" above.

1.4 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

- A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4-M.

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- B. Live Load: Single load of 500 lbf, distributed as stated in AASHTO LTS-4-M.
- C. Ice Load: Load of 3 lbf/sq. ft., applied as stated in AASHTO LTS-4-M Ice Load Map.
- D. Wind Load: Pressure of wind on pole and luminaire and banners and banner arms, calculated and applied as stated in AASHTO LTS-4-M.
 - 1. Basic wind speed for calculating wind load for poles 50 feet high or less is 100 mph
 - a. Wind Importance Factor: 1.0
 - b. Minimum Design Life: 25 years
 - c. Velocity Conversion Factors: 1.0.

1.5 ACTION SUBMITTALS

- A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation indicated on Contract Documents. Include data on features, accessories, finishes, and the following:
 - 1. Manufacturer's dimensioned scale drawings showing in complete detail the fabrication of all lighting fixtures including overall dimensions, finishes, metal thickness, glass thickness, type, fabrication methods, support method, ballasts, transformers, sockets, type of shielding, reflectors, trims, hinges, gaskets, provisions for relamping and all other information to show compliance with contract documents.
 - 2. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
 - 3. Details of attaching luminaires and accessories.
 - 4. Details of installation and construction.
 - 5. Luminaire materials.
 - 6. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories. Photometric data shall be developed according to methods of IESNA.
 - a. Testing Agency Certified Data: For indicated luminaires, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
 - b. Manufacturer Certified Data: Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
 - 7. Ballasts, including energy-efficiency data.
 - 8. Lamps, including life, output, CCT, CRI, lumens, and energy-efficiency data.
 - 9. Materials, dimensions, and finishes of poles.
 - 10. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
 - 11. Anchor bolts for poles.
 - 12. Manufactured pole foundations.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
 - 3. Design calculations, certified by a qualified professional engineer, indicating strength of screw foundations and soil conditions on which they are based.

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4. Wiring Diagrams: For power, signal, and control wiring.
 5. For outdoor pathway, parking and roadway luminaires submit photometric calculations with point by point summary layout plan. isocandela charts, coefficients of utilization and IES roadway distribution classification.
 6. Maintenance and operating instructions including tools required, types of cleaners to be used, replacement parts and final as-built shop drawings and name of the project, Architect and Lighting Consultant.
- C. Fixtures under the contract shall be identical with the approved sample fixture. No fixture used as a sample shall be allowed to be installed on the project.
- D. In the event the submission are disapproved, the fixtures shall be returned to the contractor to immediately make a new submission of the fixture in compliance with the contract documents at no additional cost to the owner.
- E. All charges for these shipments shall be prepaid by the contractor.

1.6 INFORMATIONAL SUBMITTALS

- A. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4-M and that load imposed by luminaire and attachments has been included in design. The certification shall be based on design calculations by a professional engineer.
- B. Qualification Data: For qualified agencies providing photometric data for lighting fixtures.
- C. Field quality-control reports.
- D. Warranty: Sample of special warranty.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and poles to include in emergency, operation, and maintenance manuals.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Glass and Plastic Lenses, Covers, and Other Optical Parts: One for every 100 of each type and rating installed. Furnish at least two (2) of each type.
 2. Drivers: One for every 100 of each type and rating installed. Furnish at least two (2) of each type.

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1.9 QUALITY ASSURANCE

- A. Materials and appurtenances as well as workmanship provided under this section shall conform to highest commercial standards, and as specified and as indicated on drawings. Fixture parts and components not specifically identified or indicates shall be made of materials most appropriate to their use or function and as such resistant to corrosion and thermal and mechanical stresses encountered in the normal application and function of the fixtures.
- B. All fixtures shall be manufactured to a consistent level of quality. Size, color and component shall be identical for all fixtures of same types.
- C. All fixtures and components shall be made in accordance with applicable codes and standards such as NEC, CEC and bear the label of independent laboratories such as Underwriters Laboratories (UL) or Factory Mutual (FM).
- D. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- E. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.
- F. Electrical Components, Devices, and Accessories: UL Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- G. Comply with IEEE C2, "National Electrical Safety Code."
- H. Comply with NFPA 70.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Package aluminum poles for shipping according to ASTM B 660.
- B. Store poles on decay-resistant-treated skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
- C. Retain factory-applied pole wrappings on fiberglass and laminated wood poles until right before pole installation. Handle poles with web fabric straps.
- D. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.11 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty

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period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.

1. Warranty Period for Luminaires: Five years from date of Substantial Completion.
2. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide product indicated on Drawings and/or specifications.

2.2 GENERAL REQUIREMENTS FOR LUMINAIRES

- A. Luminaires shall comply with UL 1598 and be UL listed and labeled for installation in wet locations.
- B. Lateral Light Distribution Patterns: Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.
- C. Metal Parts: Free of burrs and sharp corners and edges.
- D. Sheet Metal Components: Corrosion-resistant aluminum unless otherwise indicated. Form and support to prevent warping and sagging.
- E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
- F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.
- G. Exposed Hardware Material: Stainless steel.
- H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
- I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.
- J. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
 1. White Surfaces: 85 percent.
 2. Specular Surfaces: 83 percent.
 3. Diffusing Specular Surfaces: 75 percent.

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- K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- L. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.
- M. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
 2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
 - a. Color: As selected from manufacturer's standard catalog of colors.
 - b. Color: Match Architect's sample of custom color.
 - c. Color: As selected by Architect from manufacturer's full range.
- N. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
 2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
 3. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
 4. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.
 - a. Color: Custom color.
- O. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
1. Label shall include the following lamp and ballast characteristics:
 - a. "USES ONLY" and include specific lamp type.
 - b. Lamp diameter code (T-4, T-5, T-8, T-12), tube configuration (twin, quad, triple), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
 - c. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
 - d. Start type (preheat, rapid start, instant start) for fluorescent and compact fluorescent luminaires.
 - e. ANSI ballast type (M98, M57, etc.) for HID luminaires.
 - f. CCT and CRI for all luminaires.

2.3 DRIVERS FOR LED FIXTURES

- A. Electronic Driver for LED Fixtures: Comply with UL 1310 Class 2 requirements for dry and damp locations. Include the following features unless otherwise indicated:
1. Rated for 50,000 hours of life, unless otherwise noted.
 2. Sound Rating: Class A.
 3. Total Harmonic Distortion Rating: 15 percent or less.
 4. Current Crest Factor: 1.5 or less.
 5. 0-10V Dimming Standard (Step Dimming does not qualify)

2.4 LED FIXTURES

- A. Except as otherwise indicated, provide LED luminaires, of types and sizes indicated on fixture schedules.
- B. Include the following features unless otherwise indicated:
1. Each Luminaire shall consist of an assembly that utilizes LEDs as the light source. In addition, a complete luminaire shall consist of a housing, LED array, and electronic driver (power supply).
 2. Each luminaire shall be rated for a minimum operational life of 50,000 hours utilizing a minimum ambient temperature of (25°C).
 3. Light Emitting Diodes tested under LM-80 Standards for a minimum of 12,000 hours.
 4. Color Rendering Index (CRI) of 82 at a minimum.
 5. Color temperature 4000K, unless otherwise indicated.
 6. Rated lumen maintenance at 70% lumen output for 50,000 hours, unless otherwise indicated.
 7. Fixture efficacy of 60 Lumens/Watt, minimum.
 8. 5 year luminaire warranty, minimum.
 9. Photometry must comply with IESNA LM-79.
 10. The individual LEDs shall be constructed such that a catastrophic loss of the failure of one LED will not result in the loss of the entire luminaire.
 11. Luminaire shall be constructed such that LED modules may be replaced or repaired without the replacement of the whole fixture.
- C. Technical Requirements
1. Luminaire shall have a minimum efficacy of 60 lumens per watt. The luminaire shall not consume power in the off state.
 2. Operation Voltage: The luminaire shall operate from a 50 HZ to 60 HZ AC line over a voltage ranging from 120 VAC to 277 VAC. The fluctuations of line voltage shall have no visible effect on the luminous output.
 3. Power Factor: The luminaire shall have a power factor of 0.9 or greater.
 4. THD: Total harmonic distortion (current and voltage) induced into an AC power line by a luminaire shall not exceed 15 percent.
 5. Operational Performance: The LED circuitry shall prevent visible flicker to the unaided eye over the voltage range specified above.
- D. Thermal Management
1. The thermal management (of the heat generated by the LEDs) shall be of sufficient capacity to assure proper operation of the luminaire over the expected useful life.
 2. The LED manufacturer's maximum thermal pad temperature for the expected life shall not be exceeded.

3. Thermal management shall be passive by design. The use of fans or other mechanical devices shall not be allowed.
4. The luminaire shall have a minimum heat sink surface such that LED manufacturer's maximum junction temperature is not exceeded at maximum rated ambient temperature.

2.5 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS

- A. Structural Characteristics: Comply with AASHTO LTS-4-M.
 1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in "Structural Analysis Criteria for Pole Selection" Article.
 2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.
- B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.
- C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
 1. Materials: Shall not cause galvanic action at contact points.
 2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
 3. Anchor-Bolt Template: Plywood or steel.
- D. Handhole: Oval-shaped, with minimum clear opening of 2-1/2 by 5 inches, with gasketed cover secured by stainless-steel captive screws.
- E. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."
- F. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123M; and with top-plate and mounting bolts to match pole base flange and strength required to support pole, luminaire, and accessories.
- G. Breakaway Supports: Frangible breakaway supports, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-4-M.

2.6 STEEL POLES

- A. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig; one-piece construction up to 40 feet in height with access handhole in pole wall.
 1. Shape: Square, straight.
 2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

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- B. Steel Mast Arms: Single-arm type, continuously welded to pole attachment plate. Material and finish same as pole.
- C. Brackets for Luminaires: Detachable, cantilever, without underbrace.
 - 1. Adapter fitting welded to pole, allowing the bracket to be bolted to the pole mounted adapter, then bolted together with galvanized-steel bolts.
 - 2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire.
 - 3. Match pole material and finish.
- D. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.
- E. Steps: Fixed steel, with nonslip treads, positioned for 15-inch vertical spacing, alternating on opposite sides of pole; first step at elevation 10 feet above finished grade.
- F. Intermediate Handhole and Cable Support: Weathertight, 3-by-5-inch handhole located at midpoint of pole with cover for access to internal welded attachment lug for electric cable support grip.
- G. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Section 260526 "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.
- H. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 safety factor.
- I. Platform for Lamp and Ballast Servicing: Factory fabricated of steel with finish matching that of pole.
- J. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.
- K. Galvanized Finish: After fabrication, hot-dip galvanize complying with ASTM A 123/A 123M.
- L. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or with SSPC-SP 8, "Pickling."
 - 2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.
 - 3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
 - a. Color: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 POLE INSTALLATION

- A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.
- B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on Drawings:
 - 1. Fire Hydrants and Storm Drainage Piping: 60 inches.
 - 2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet
 - 3. Trees: Per landscape architect direction.
- C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Section 033000 "Cast-in-Place Concrete."
- D. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
 - 1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
 - 2. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
 - 3. Install base covers unless otherwise indicated.
 - 4. Use a short piece of 1/2-inch- diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.
- E. Embedded Poles with Tamped Earth Backfill: Set poles to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.
 - 1. Dig holes large enough to permit use of tampers in the full depth of hole.
 - 2. Backfill in 6-inch layers and thoroughly tamp each layer so compaction of backfill is equal to or greater than that of undisturbed earth.
- F. Embedded Poles with Concrete Backfill: Set poles in augered holes to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.
 - 1. Footing diameter as indicated on drawings.
 - 2. Fill augered hole around pole with air-entrained concrete having a minimum compressive strength of 3000 psi at 28 days, and finish in a dome above finished grade.
 - 3. Use a short piece of 1/2-inch- diameter pipe to make a drain hole through concrete dome. Arrange to drain condensation from interior of pole.
 - 4. Cure concrete a minimum of 72 hours before performing work on pole.
- G. Poles and Pole Foundations Set in Concrete Paved Areas: Install poles with minimum of 6-inch- wide, unpaved gap between the pole or pole foundation and the edge of adjacent concrete slab. Fill unpaved ring with pea gravel to a level 1 inch below top of concrete slab.
- H. Raise and set poles using web fabric slings (not chain or cable).

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3.2 BOLLARD LUMINAIRE INSTALLATION

- A. Align units for optimum directional alignment of light distribution.
- B. Install on concrete base with top 4 inches above finished grade or surface at bollard location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."

3.3 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRES

- A. Install on concrete base with top 4 inches above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."

3.4 CORROSION PREVENTION

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
- B. Steel Conduits: Comply with Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.5 GROUNDING

- A. Ground metal poles and support structures according to Section 260526 "Grounding and Bonding for Electrical Systems."
 - 1. Install grounding electrode for each pole unless otherwise indicated.
 - 2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.
- B. Ground nonmetallic poles and support structures according to Section 260526 "Grounding and Bonding for Electrical Systems."
 - 1. Install grounding electrode for each pole.
 - 2. Install grounding conductor and conductor protector.
 - 3. Ground metallic components of pole accessories and foundations.

3.6 FIELD QUALITY CONTROL

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.
 - 1. Verify operation of photoelectric controls.
- C. Illumination Tests:

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1. Measure light intensities at night. Tests shall be witnessed by Architect and/or Owner's representative. Provide two (2) weeks advance notice. Use photometers with calibration referenced to NIST standards. Comply with the following IESNA testing guide(s):
 - a. IESNA LM-72, "Directional Positioning of Photometric Data."
- D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.7 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain luminaire lowering devices.

END OF SECTION 265600

SECTION 271000
STRUCTURED TELECOMMUNICATIONS CABLING AND PATHWAY SYSTEM

PART 1 – GENERAL

1.1 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. CALIFORNIA BUILDING STANDARDS COMMISSION
 2. California Electrical Code Title 24, Part 3
 3. ELECTRONIC INDUSTRIES ASSOCIATION (EIA)
 4. EIA/TIA TSB-75 Additional Horizontal Cabling Practices for Open Offices
 5. EIA/TIA-455-21 FOTP-21 Mating Durability of Fiber Optic Interconnecting Devices
 6. EIA/TIA-526-14 OFSTP-14 Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
 7. TIA/EIA-568-B.1, B.2 Commercial Building Telecommunications Wiring Standard
 8. TIA/EIA-568-B.2-1 Transmission Performance Specifications for 4-Pair 100 Ohm Category 6 Cabling
 9. TIA/EIA-568-B.2-2 Commercial Building Telecommunications Cabling Standard - Part 2: Balanced Twisted-Pair Cabling Components
 10. TIA/EIA-568-B.2-3 Commercial Building Telecommunications Cabling Standard - Part 2: Balanced Twisted-Pair Cabling - Addendum 3 - Additional Considerations for Insertion Loss and Return Loss Pass/Fail Determination
 11. TIA/EIA-568-B.2-5 Commercial Building Telecommunications Cabling Standard - Part 2: Balanced Twisted-Pair Cabling Components - Addendum 5 - Corrections to TIA/EIA-568-B.2-5
 12. TIA/EIA-568B.2-6 Commercial Building Telecommunications Cabling Standard - Part 2: Balanced Twisted-Pair Cabling Components - Addendum 6 – Category 6 Related Component Test Procedures
 13. TIA/EIA-568-B.3 Optical Fiber Cabling Components Standard
 14. TIA/EIA-568-B.3-1 Optical Fiber Cabling Components Standard Addendum 1 – Additional Transmission Performance Specifications for 50/125 μ m Optical Fibers
 15. TIA/EIA-569-A Commercial Building Standard for Telecommunications Pathways and Spaces (ANSI/TIA/EIA-569-A-98)

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16. TIA/EIA-569-A-2 Commercial Building Standard for Telecommunications Pathways and Spaces, Addendum. This addendum defines the furniture pathways and spaces contained in work areas.
17. TIA/EIA-570-A Residential and Light Commercial Telecommunications Wiring Standard
18. TIA/EIA-606-A Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
19. TIA/EIA-607-A Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
20. FEDERAL COMMUNICATIONS COMMISSION (FCC)
21. FCC Part 68.5 Establishment of Telephone Premises Wiring Attestation List
22. INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)
23. ANSI/ICEA S-80-576 Communication Wire and Cable for Wiring of Premises
24. NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)
25. NEMA WC 63.1 NEMA Performance Standard for Twisted Pair Premise Voice and Data Communications Cables
26. NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)
27. NFPA 70 National Electrical Code – latest edition
28. RURAL ELECTRIFICATION ADMINISTRATION (REA)
29. REA TECM 823 Electrical Protection by Use of Gas Tube Arrestors
30. UNDERWRITERS LABORATORIES INC. (UL)
31. UL 444 Communications Cables
32. UL 467 Grounding and Bonding Equipment
33. UL 497 Safety Protector for Paired Conductor Communication Circuit
34. UL 514C Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
35. UL 910 Flame-Propagation and Smoke-Density Values for Electrical and Optical-Fiber Cables Used in Spaces Transporting Environmental Air
36. UL 969 Marking and Labeling Systems
37. UL 1286 Office Furnishings
38. UL 1581 Electrical Wires, Cables, and Flexible Cords
39. UL 1666 Flame Propagation Height of Electrical and Optical-Fiber Cables Installed in Vertical Shafts
40. UL 1863 Communication Circuit Accessories
41. Public Works Standards, Inc.

- 42. GREENBOOK; Green Book Standard Specifications for Public Works Construction – latest edition.
- 43. All publications referred to in this document shall be the latest publicized edition.
- B. Federal, state, local codes, rules, regulations, ordinances governing the work, as well as RSCCD Structured Telecommunications Cable and Pathway Standards, guidelines and practices may apply and shall be incorporated as part of these specifications.
- C. In reviewing the various Contract Documents, the Structured Telecommunications Cable Contractor shall be responsible for noting conflicts between proposed design/concepts and the applicable standards, guidelines and practices. A written Request for Information (RFI) shall be developed by the Structured Telecommunications Cable Contractor and submitted to RSCCD prior to commencing any work impacted by such conflicts. Such RFIs shall describe the conflict/violation and, if appropriate, recommend alternative solutions with associated costs. RSCCD warrants that they will diligently strive to address such RFIs in order to minimize negative impact on each SCCS installation completion schedule.
- D. Where the requirements of the Contract Documents are more stringent than applicable codes, rules, regulations, ordinances, standards, guidelines and practices, the Contract Documents shall apply. In all other instances, the most current standards, guidelines and practices shall apply.

1.2 SYSTEM DESCRIPTION

- A. The structured telecommunications cable and pathway distribution and wiring system shall include permanently installed backbone and horizontal cabling, horizontal and backbone pathways, workstation pathways, telecommunications outlet assemblies, conduit, raceway, and hardware for terminating, and interconnecting.
- B. The horizontal system includes the cabling and pathway between the BDF and/or IDFs and the work area telecommunications outlet.
- C. The backbone cabling and pathway system includes the interconnecting cabling, pathway, and terminal hardware to provide connectivity between the BDF's, and IDF's.
- D. The backbone system shall be wired in a star topology with the BDF at the center or hub of the star.
- E. Hardware and terminating equipment shall consist of UL approved; Category 6 (for new campuses and any modernization) patch panels, jacks, and fiber optic terminating equipment.
- F. Backbone cable shall consist of indoor/outdoor (plenum rated when necessary) 12 strand, Single Mode fiber optic cable. All indoor/outdoor rated fiber optic cable shall be U.L. listed.
- G. Inter-building backbone pathways shall consist of new 4" minimum inside diameter conduits, existing conduits or a combination of both, as per the drawings and other construction documents.

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- H. Horizontal pathways shall consist of new 4” minimum inside diameter conduit, as per drawings and other construction documents.
- I. Structured Telecommunications Cabling and Pathways Systems shall be installed in a “neat and workmanlike manner” as specified by ANSI/NECA/BICSI 568-2001, 569-A and National Electrical Code, Sections 110-12 and 800-6.

1.3 SUBMITTALS

A. MANUFACTURER'S CATALOG DATA

- 1. Telecommunications cabling (backbone and horizontal)
- 2. Fiber optic type LC Duplex connectors
- 3. Telecommunications outlet/connector assemblies RJ-45 jack
- 4. Equipment racks
- 5. Equipment cabinets
- 6. Patch Panels (Copper and Fiber optic)
- 7. Power Strips
- 8. Cable Hangers
- 9. Floor outlet boxes or modules
- 10. Firestop material
- 11. Cable tray
- 12. Conduits
- 13. Outlet boxes
- 14. Pull boxes
- 15. Underground pull boxes
- 16. NEMA rated junction boxes
- 17. Face Plates
- 18. Patch Cords (fiber & copper)

B. SHOP DRAWINGS

- 1. Telecommunications Drawings
- 2. Distribution Frame Elevations

C. TELECOMMUNICATIONS SHOP DRAWINGS AND AS-BUILT DRAWINGS

- 1. Provide BICSI Registered Communications Distribution Designer (RCDD) approved drawings complete with wiring diagrams and details required to prove that the distribution system shall properly support connectivity from the BDF to the IDF to the telecommunications work area outlets.

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2. Show the layout of all cabling and pathway runs, BDF, IDF and ground system.
3. Drawings shall depict all final telecommunications cabling configurations, including locations, gauge, pair assignments and patch panels after completed telecommunications cable installation.
4. Electronic copies of campus as-built drawings shall be provided to the Structured Telecommunications Cable Contractor, if they exist. If no drawings exist, the Structured Telecommunications Cable Contractor shall create original AutoCAD or Revit drawings for that campus.
5. Work added to an existing campus shall be included on as-built drawings. Added work shall be clouded on the drawing and appropriate notes shall be added to the legend and title block, indicating scope of work, contractor name and date of completion.
6. Provide one (1) plastic laminated schematic of telecommunications cable system showing cabling, IDF's, BDF's, and equipment rooms keyed to floor plans by room number.
7. Provide electronic copies of As-Builts to RSCCD.

D. DISTRIBUTION FRAMES

1. Provide shop drawing showing layout of applicable equipment including BDF and/or IDF racks, patch panels and LAN equipment.
2. Provide written documentation that details cabinet wall mounting and anchoring methods anticipated for each installation.

E. STATEMENTS

1. Installer qualifications
2. Test plan
3. Professional References
4. Factory Test Reports
5. Field Test Reports
6. Operations and Maintenance Manuals
7. Schedules
8. Labeling Scheme

F. INSTALLER QUALIFICATIONS

1. Prior to installation, submit data of installer's experience and qualifications, which shall include 3 years on projects of similar complexity. Include names and locations of two projects successfully completed using fiber optic and copper communications cabling systems in similar environments.
2. Installers shall be Manufacturer certified to provide minimum 20-year product performance warranty.

3. Installer shall include BICSI Cabling Installer certifications for all cabling being installed.
4. Include specific experience in installing and testing structured telecommunications distribution systems using fiber optic and Category 6 or higher, cabling systems.
5. Provide a list of at least five professional references for similar projects include Company names, Contacts, phone numbers and a description of project, including scope and dollar amount.

G. TEST PLAN

1. Provide a complete and detailed test plan for the telecommunications cabling system including a complete list of test equipment for the UTP and OFN components and accessories. Include procedures for certification, validation, and testing.
2. Cabling shall be fully terminated from end to end (installed in faceplates and installed into patch panels, wall j-boxes and or raceway).
3. Provide certification of staff to utilize listed testing equipment.
4. Furnish factory test results for patch cords.

H. FACTORY TEST REPORTS

1. Factory reel tests
 - a. Furnish factory reel tests for fiber optic cables.
 - b. Furnish factory tests for fiber and copper patch cords.

I. FIELD TEST REPORTS

1. Telecommunications cabling testing

1.4 LABELING

- A. Labeling scheme must comply with TIA/EIA 606 standards.
- B. Contractor must coordinate with the District Representative and RSCCD ITS prior to installing any permanent labels.
- C. Labeling of patch panels and classroom data outlets must show final occupied room and port numbers not architectural numbering.

1.5 SYSTEM CERTIFICATION AND/OR WARRANTY

- A. The installation must be certified to meet the latest manufacturer system warranty program requirements for an extended warranty of twenty (20) years minimum duration. At minimum such warranty shall, at no additional cost to RSCCD, provide a system warranty covering the installed Structured Telecommunications Cable against defects in workmanship, components and performance. At minimum, the Contractor's qualifications for manufacturer's certification shall include:

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1. Contractor shall be certified by the Manufacturer for a minimum of twelve (12) months prior to bid submittal date.
 2. Contractor shall have valid Manufacturer Certification for the entire project duration of the installation agreement. In addition, Contractor shall have no known pending action or intent by Manufacturer and/or SCCS Contractor to terminate or limit the Contractor status as a Manufacturer Certified installer.
 3. Contractor shall attach to bid response a copy of their current Manufacturer Certification certificate demonstrating valid certification in the Southern California region. The attached certificate is to specifically cite the name of proposing Contractor.
- B. Contractor installation warranty extending to the Structured Telecommunications Cable protecting RSCCD against defects in workmanship for a minimum period of two (2) years from the date of system acceptance. Such warranty shall provide all labor and materials necessary to correct a failed portion of the system and to demonstrate performance within original specifications after the repairs are accomplished.
- C. A system component and performance warranty extended by Manufacturer for a period of not less than twenty (20) years from date of system acceptance. The performance warranty shall warrant the installed horizontal and backbone copper portion of the system and, as applicable, the installed horizontal and backbone fiber optic portions of the system. All such links and segments shall be warranted in accordance with the latest applicable requirements as defined by TIA/EIA.
- D. As outlined herein, RSCCD intends that the resulting Structured Telecommunications Cable System be warranted under the extended warranty provisions extended by the cabling Manufacturer. The warranty shall extend to the fiber optic, Category 6 UTP portions of the installation to the fullest extent allowed by the manufacturers.

1.6 COORDINATION AND SUPPORT

- A. Schedule a pre-installation meeting with Architect, District Project Manager, District ITS Representative, and Contractor in attendance.
- B. Coordinate layout and installation of voice, data, and video communication cabling with other contractors and equipment suppliers.
- C. Meet jointly with other contractors and equipment suppliers in order to exchange information and agree on details of equipment arrangements and installation interfaces.
- D. Record agreements reached in meetings and distribute to other participants in a timely manner.
- E. Adjust arrangements and locations of distribution frames, cross-connect and patch panels in equipment rooms and/or telecommunications rooms to accommodate and/or optimize the arrangement and space requirements of voice and LAN equipment.

1.7 DELIVERY AND STORAGE

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- A. Provide protection from weather, moisture, dirt, dust and other contaminants for telecommunications cabling and pathway equipment placed in storage.

PART 2 - PRODUCTS

2.1 COMPONENTS

- A. UL or third party certified. Provide a complete system of telecommunications cabling and pathway components using star topology and support structures, pathways, and spaces complete with conduits, pull wires, raceways, pull boxes, outlets, cables, ground boxes, as per the drawings. Fixed cables and pathway systems for telecommunications systems shall be UL listed or third party independent testing laboratory certified, and shall comply with NFPA 70. Horizontal cable and termination equipment shall be of a manufacture, installed and certified so as to provide a minimum 20-year warranty.

2.2 PATHWAYS (BACKBONE AND HORIZONTAL)

- A. TIA/EIA-569-A. Pathway shall be conduit raceway installations. Provide grounding and bonding as required by ANSI/J-STD-607-A.
- B. Pathways shall be installed in accordance with NEC Article 314 and Article 800.51 (J), (K), or (L), as applicable, and installed in accordance with Articles 362.24 through 362.56, where the requirements applicable to electrical nonmetallic tubing apply.

2.3 TELECOMMUNICATIONS CABLING

- A. Cabling shall be UL listed for the application and shall comply with TIA/EIA-568-B.1, B.2 and NFPA 70. Cabling shall consist of Category 6 UTP; and indoor/outdoor rated Single Mode 12 strand fiber optic cabling. Plenum rated cables where necessary shall comply with UL 910. Provide a labeling system for cabling as required by TIA/EIA-606-A and UL 969. Cabling manufactured more than 12 months prior to date of installation shall not be used.

2.4 FIBER OPTIC CABLING

- A. Manufacturer: Corning or District approved equal.
- B. Backbone cabling (building to building) shall be 12 strand OS2 Single Mode.
- C. Intra building cabling shall be 12 OM4 strand multimode.

2.5 HORIZONTAL CABLING

- A. Shall consist of Category 6 UTP cabling
 - a. Manufacturer: Belden 3613, or District approved equal.
- B. Comply with NFPA 70, NEMA WC 63, ANSI/ICEA S-80-576 and performance characteristics in TIA/EIA-568-B.1 and B.2 UTP, four-pair 100 ohm.
- C. Category 6 cable shall provide four individually twisted pairs, 23 AWG or 22 AWG conductors.
- D. Individual pairs shall be constructed to contain minimum two twists per foot per each pair.

- E. Ultimate breaking strength shall be minimum 90 pounds.
- F. Four pair cable shall withstand a bend radius of one-inch minimum at a temperature of minus 20 degrees C maximum without jacket or insulation cracking.
- G. Conductors shall be color coded and polarized in accordance with TIA/EIA-568-B.1 and B.2.
- H. Category 6 UTP and OSP rated cable for local area networks shall exceed TIA/EIA-568-B.1 and B.2 standards.
- I. Conductor shall be 24, 23, or 22 AWG solid annealed copper.
- J. Plenum rated cable shall comply with NFPA 70, UL 444, and UL 910.
- K. Cable jacket – verify color with District Project Manager.

2.6 CATEGORY 6 PATCH CABLES

- A. UTP Patch Cables. Patch cables for unshielded twisted pair cable shall be Category 6 rated and shall be equipped with factory-attached connectors to interconnect equipment mounted on the racks of the distribution frame and to connect computer stations to outlet locations.
- B. Contractor shall provide:
 - 1. BDF/IDF Patch Cords – 6-inches in length, Category 6 and colored according to the following:
 - a. Green for instructional network;
 - b. Blue for non-instructional network; and
 - c. White for wireless and CCTV.
 - d. Number of each color to be confirmed with RSCCD ITS and District Representative.
 - 2. Workstations – 10 feet in length, Category 6, black in color.
 - 3. Quantity required for 100% port population at both ends with 10% spare.

2.7 FIBER OPTIC PATCH CABLES.

- A. Fiber Optic Patch Cables shall be Multimode or Single Mode patch cords pre-made to connect fiber optic equipment with fiber optic cross connects, interconnects and outlets.
- B. The patch cords (jumpers) shall be impact-resistant, duplex fiber cables with LC connectors, of the same performance characteristics as the Single Mode fiber backbone being connected.
- C. These fiber optic patch panel connections shall provide 0.4 dB or less insertion loss and provide connection between the Active LAN devices and the Fiber Optic patch panel. Quantities for 100% fiber strand population at both ends plus 10% Spares.
- D. Contractor shall provide:
 - a. IDF Patch Cords – 1 Meter in length, LC connectorized, Single Mode, duplex, fiber optic patch cord.

- b. BDF Patch Cords – 3 Meter in length, LC connectorized, Single Mode duplex, fiber optic patch cord.

2.8 DISTRIBUTION FRAMES

A. BDF/IDF Equipment Cabinets/Free Standing

1. The unit shall be designed to provide a secure, managed environment for computer and networking equipment.
2. The unit shall conform to EIA-310 Standard for Racks, Panels and Associated Equipment and accommodate industry standard 19" rack mount equipment.
3. BDF: Units shall be designed with four (4) vertical posts to allow rack mount equipment installation utilizing four (4) vertical mounting rails.
 - a. Units shall provide 42U of equipment vertical mounting space (1U=1.75" or 44.45mm).
4. Unit shall have base dimension of 84 inches in height by 31.50 inches in width by 41.33 inches in depth.
5. IDF: Units shall be designed with two (2) vertical posts to allow rack mount equipment installation utilizing two (2) vertical mounting rails.
 - a. Units shall provide 45U of equipment vertical mounting space (1U=1.75" or 44.45mm).
6. The vertical mounting rails shall be adjustable to allow different mounting depths.
7. Units shall include at least 60 sets of screwed in mounting screws, caged nuts, bolts and cup washers, and caged nut installation tool for the mounting of equipment inside the unit. Screw sets, caged nuts, bolts, and cup washers shall be installed (physically screwed) in the rack.
8. All weight bearing components shall be constructed from steel no less than 0.9mm (20 gauge).
9. All metal parts shall be painted using a powder coat paint process.
10. Plastic materials shall comply with Underwriters Laboratory Specification 94 with V-1 rating (UL94 V-1) or better.
11. Provisions shall be provided for all enclosure panels and rack-mounted equipment to be earthed or grounded directly to the frame.
12. Unit shall include a grounding kit containing terminated green/yellow jumper wires and associated hardware.
13. Units shall be equipped with vertical wire management.
14. Baying brackets shall be provided where mounting multiple cabinets are to be mounted together.
15. Units shall be black in color.
16. Cabinets shall be seismic/earthquake braced and anchored to floor.

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17. Manufacture: CPI or District approved equal.

2.9 BDF/IDF EQUIPMENT CABINET POWER DISTRIBUTION STRIP (PDU)

- A. Each equipment cabinet shall come equipped with two (2) networkable, SNMP manageable, and metered power distribution strips with minimum of ten (10) 20 amp (NEMA 5-20R) receptacles.
 - 1. Provide vertical mountable PDUs for four post racks.
 - 2. Provide rack mountable PDUs for two post racks.

2.10 BDF/IDF CABLE RUNWAY

- A. Cable runway shall be installed in BDF and IDF Rooms. Size: 18-inch-wide, plus side channel, as needed.
- B. Classified by Underwriters Laboratories (UL) as suitable for equipment grounding.
- C. Cable runway shall be used for voice and, or data and video communications cabling only. No electrical wiring shall be placed in cable runway with voice and data cabling.
- D. Wall angle supports shall be steel angles. Ends to be smooth without hooks or projections. Brackets shall be able to support an end load of 600 lb. with a safety factor of 1.65.
- E. Elbows, Tee's, 90-degree bends and crosses: All horizontal and vertical 90-degree elbows, tees, 90-degree bends and crosses shall be made with right angle couplings, which clamp to the runway without the need for drilling or cutting.
- F. At all horizontal 90-degree bends, tees, and crosses, provide adjustable junction splice kits for large radius cable bends.
- G. Seismically supported by end wall supports, angular wall supports and communications equipment racks.
- H. Black baked enamel finish.
- I. Manufacturer: Chatsworth Products (18") or District approved equal.

2.11 COPPER PATCH PANELS

- A. Manufacture: Belden, or District approved equal.
- B. UTP patch panels shall be rack mounted, rated to exceed EIA/TIA Category 6 modular patch panels each wired to terminate modular jacks per the EIA/TIA T568B standard.
- C. Quantities of jacks are based on the number of UTP cables originating at wall outlets and terminating at the patch panel.
- D. All patch panels shall be grounded.

2.12 CABLE MANAGEMENT

- A. All equipment cabinets shall be equipped with horizontal cable management organizers for each fiber optic and UTP patch panel.
- B. Horizontal cables managers shall be constructed of metal with black finish and be 1 rack unit in height. Horizontal cable managers shall have evenly spaced "fingers" designed to

maintain and allow the entry and exit of jumper, patch, or cross-connect cables and/or wires in place.

- C. Horizontal cable managers shall be designed to extend past the frame to allow placement of equipment in any position within the rack. When mounted between equipment rack frame rails, they shall be securely mounted to equipment rack frame rails.

2.13 FIBER OPTIC PATCH PANELS

- A. Manufacture: Corning, or District approved equal.
- B. Provide panel for maintenance and cross connecting of fiber optic cables.
- C. Panel shall be constructed of 0.125-inch minimum aluminum and shall have connectors which interface the inside plant fiber optic jumper cable with the outside plant fiber optic cable.
- D. Panels shall be equipped with engraved laminated plastic nameplates above each connector.
- E. Rack-mounted fiber patch panels shall be equipped to terminate or splice the incoming inter-building fiber and any required backbone or interconnect cables.
- F. Each cable must be properly dressed.
- G. These units will terminate the fiber optic cables, provide a place for jumper cables and will provide room to terminate additional optics.
- H. Panel shall provide capacity for minimum of 12 fiber optic strands. Larger capacity patch panels shall be determined at site walk.
- I. Panel shall be 100% populated with type LC couplers and adapter plates.
- J. All connectors and couplers shall be type LC.
- K. The fiber optic patch panel connections shall provide 0.4 dB or less insertion loss.
- L. All patch panels shall be grounded.

2.14 TELECOMMUNICATIONS OUTLET/CONNECTOR ASSEMBLIES

- A. Jacks and faceplate manufacturer: Belden REVConnect Cat 6 jack, or District approved equal.
- B. Jacks shall comply with FCC Part 68.5, and TIA/EIA-568-B.1 and B.2.
- C. UTP jacks shall be RJ-45 designation T568B type, UL 1863 listed, eight position, constructed of high impact rated thermoplastic housing rated for Category 6 service.
- D. UTP jacks for data shall be Category 6 hardware and shall comply with the attenuation requirements contained in TIA/EIA-568-B.1 and B.2.
- E. Jacks color – verify with District Project Manager.
- F. Telecommunications face plates shall comply with UL 514C, and TIA/EIA-568-B.1 and B.2; flush design constructed of high impact thermoplastic material.
- G. Telecommunications faceplate colors shall be coordinated with District Project Manager or as noted on drawings.

- H. Telecommunications faceplates shall be available in 2-port, 4-port and 6-port single-gang configurations and as designated by RSCCD at site survey or as noted on drawings.
- I. All unused faceplate openings shall have blanks installed.
- J. Stenciled lettering for voice and data circuits shall be provided using thermal ink transfer process.
- K. Jacks shall be orientated on the patch panel starting at the top left and proceeding in a left to right top to bottom order.

2.15 NON-CONTINUOUS CABLE SUPPORT

- A. Material
 - 1. Contractor shall provide and install all non-continuous cable supporting hardware.
 - 2. Non-continuous cable supporting hardware consists of J-hooks, multi-function clips, beam clamps, etc. Bridle rings or zip ties are not permitted.
 - 3. Non-continuous cable supports shall provide a load bearing surface of sufficient width to comply with required bend radii of high-performance cables; UL Listed. Bridle rings are not permitted.
 - 4. Non-continuous cable supports shall have flared edges to prevent damage while installing cables.
 - 5. Non-continuous cable supports sized 1 5/16" and larger shall have a cable retainer strap to provide containment of cables within the hanger. The cable retainer strap shall be removable and reusable and be suitable for use in air handling spaces.
 - 6. Non-continuous cable supports shall have an electro-galvanized or G60 finish and shall be rated for indoor use in non-corrosive environments.
 - 7. Multi-tiered non-continuous cable support assemblies shall be used where separate cabling compartments are required. Assemblies may be factory assembled or assembled from pre-packaged kits. Assemblies shall consist of a steel angled hanger bracket holding up to six non-continuous cable supports, rated for indoor use in non-corrosive environments; UL Listed.
 - 8. If required, the multi-tier support bracket may be assembled to manufacturer recommended specialty fasteners including beam clamps, flange clips, C and Z purlin clips, etc.
 - 9. Tee-bar support bracket with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments; UL Listed.
 - 10. Fastener to wire/rod with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments; UL Listed.
 - 11. Fastener to beam or flange with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments; UL Listed.
 - 12. Fastener to C or Z purlin with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments, UL Listed.

13. Fastener to wall, concrete, or joist with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments, UL Listed.
 14. Fastener to threaded rod with one non-continuous cable support, factory or jobsite assembled, rated for indoor use in non-corrosive environments, UL Listed.
 15. The multi-tiered support bracket shall have a static load limit of 300 lbs.
 16. U-hooks and double J-hooks shall attach directly to threaded rod using standard nuts.
- B. Manufacturer: Cooper B-Line, or District approved equal.

2.16 BACKBOARDS

- A. Provide fire rated plywood 3/4-inch-thick 36"H x 24"W for mounting of equipment.
- B. Fill and sand all voids in plywood to provide a smooth surface prior to painting.
- C. Backboards shall be painted with a light color, nonconductive fire-resistant overcoat.
- D. Contractor shall be responsible for determining correct backboard mounting and anchoring methods that will safely support the combined weight of the backboard, data network components that will occupy the backboard.
- E. Backboard mounting and anchoring methods shall comply with RSCCD and State building and safety codes.
- F. Contractor shall be responsible for ensuring that mounting and anchoring methods comply with Part 3- Execution 3.1.3.
- G. Drywall screws shall not be used to mount plywood backboards.

2.17 GROUNDING AND BONDING PRODUCTS

- A. Comply with UL 467, ANSI/J-STD--607-A-2002, and NFPA 70. Components shall be identified as required by TIA/EIA-606-A.
- B. All data cabinets and components, cable runways, patch panels, and any parts installed in data cabinets shall be bonded together and bonded to the Telecommunications Grounding Bus-bar.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Telecommunications cabling and pathway systems, including the horizontal and backbone cable, pathway systems, telecommunications outlet/connector assemblies, and associated hardware shall be installed in accordance with TIA/EIA-568-B.1, B.2, B.3, TIA/EIA-569-A, NFPA 70, and UL standards as applicable.
- B. Cabling shall be connected in a star topology network.
- C. Contractor shall provide all necessary tools and materials not specified, (tie wraps, "d" rings, screws, consumables, hardware, etc.) and equipment, (ladders, hydraulic lifts, storage containers, etc.) necessary to provide a complete and operating system.

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- D. Installation methodologies shall adhere to manufacturer installation procedures so as to not violate certifications (i.e. UL).
- E. All work shall be performed in a good workmanship-like manner leaving each location in the same or better condition as at the start of each project.
- F. The designated District Project Manager shall be provided progress reports.
- G. Periodic on-site inspections will be completed during the course of installation.
- H. The District reserves the right of "local jurisdiction" for final approval.

3.2 GENERAL CABLING

- A. Install rated Category 6 and Indoor/Outdoor rated Category 6 UTP and Indoor/Outdoor Rated Single Mode, Multi-Mode fiber optic telecommunications cabling and pathway system in accordance with TIA/EIA-568-B.1, B.2, B.3 and the drawings.
- B. Screw terminals shall not be used except where specifically indicated on plans.
- C. Do not untwist Category 6 UTP cables more than 1/4 inch from the point of termination to maintain cable geometry.
- D. Do not exceed manufacturers' cable pull tensions for copper and fiber optic cables. Provide a device to monitor cable pull tensions. Do not exceed 25 pounds pull tension for four pair copper cables.
- E. Do not chafe or damage outer jacket materials.
- F. Use only lubricants approved by cable manufacturer.
- G. Do not over cinch cables, or crush cables with staples.
- H. For UTP cable, bend radii shall not be less than four times the cable diameter.

3.3 OPEN CABLE

- A. Use only where specifically indicated on plans or determined during site surveys.
- B. When encounter hard lid ceiling run cable in concealed conduit; non-continuous cable support above suspended ceilings.
- C. Comply with TIA/EIA-568-B.1 and B.2.
- D. Install cabling above suspended ceilings 6 to 12 inches above ceiling T-bar using non-continuous cable support spaced on 24 to 48 inch centers and securely attached to structural ceiling.
- E. Do not exceed cable pull tensions recommended by the manufacturer.
 - 1. Plenum cable shall be used in spaces where required by code. Plenum cables shall comply with flammability plenum requirements of NFPA 70 and shall comply with UL 910.
 - 2. Avoid routing copper cable in areas where there may be high levels of electromagnetic interference (EMI). EMI is caused by AC power lines, broadcast signals, X-ray equipment, motors, generators, and fluorescent lights. UTP cables shall be routed at least 5 inches away from fluorescent lighting fixtures.

3. Cables shall be placed in the non-continuous cable support located every 2 to 4 feet, as long as they are separately bundled and tie-wrapped using Velcro ties.
4. Cabling shall be organized and identified so as to facilitate locating and handling individual sheaths for maintenance functions.
5. Each bundle shall be neatly tied without over cinching or stressing cable.
6. Bundles shall be clearly marked identifying the IDF and room to which routed, the station numbers served by the bundle, and any other information that may assist in administration.
7. Great care shall be taken to protect all cabling from physical damage.
8. A 10-foot service loop shall be installed above ceiling on each cable installation where possible.

3.4 BACKBONE CABLE

- A. Fiber Optic Backbone Cable. Install Indoor/Outdoor rated fiber optic backbone in pathways.
- B. Do not exceed manufacturer's recommended bending radii and pull tension.
- C. Prepare cable for pulling by cutting outer jacket 10 inches leaving strength members exposed for approximately 10 inches. Twist strength members together and attach to pulling eye.
- D. Terminate individual strands into fiber optic type LC connectors.

3.5 HORIZONTAL CABLING

- A. Install horizontal cabling and pathway as shown on drawings or as determined at site survey, between BDF, IDF and telecommunications outlet assemblies at workstations, in accordance with TIA/EIA-568-B.1, B.2 and 569-A.

3.6 WORK AREA OUTLETS

- A. Terminate UTP cable in accordance with TIA/EIA-568-B.1, B.2 and wiring configuration T568B.

3.7 BACKBOARD AND EQUIPMENT SUPPORT

- A. Contractor shall coordinate with RSCCD the BDF/IDF backboard and equipment support mounting locations and mounting methods.
- B. Free standing BDF and IDF equipment cabinets shall be seismically anchored to the floor and to the overhead cable runway.
- C. Contractor shall provide and install fasteners and anchors that are designed and rated for determined mounting surface and building construction type.
- D. Contractor shall not use dry wall screws as fasteners for backboard and equipment.
- E. Mounting and anchoring methods shall comply with RSCCD and State building and safety codes.

- F. Contractor shall be responsible for costs of all repairs if equipment installation methods are determined to be inadequate by RSCCD or if contractor provided and installed fasteners and/or anchors fail, resulting with the equipment pulling away from wall or completely falling off of wall.

3.8 TESTING

- A. Telecommunications Cable Testing:
 - a. Perform telecommunications cabling inspection, verification, and performance tests in accordance with TIA/EIA-568-B.1 and B.2.
 - b. All testing personnel shall be trained on testing equipment tools to assure that complete and accurate testing results are obtained / provided.
- B. Inspection:
 - a. Visually inspect cabling jacket materials for UL or third party certification markings.
 - b. Visually inspect Category 6 UTP and Single Mode fiber optic cabling jacket materials for UL or third party certification markings.
 - c. Inspect cabling terminations in telecommunications rooms and at workstations to confirm color code for tip and ring pin assignments, and inspect cabling connections to confirm compliance with TIA/EIA-568-B.1 and B.2.
 - d. Visually confirm Category 6 marking of outlets, cover plates, jacks, and patch panels.
- C. Verification Tests:
 - a. Perform 400 MHz near end cross talk (NEXT) and attenuation tests for Category 6 systems installations.
 - b. Perform fiber optic end-to-end attenuation tests using a power meter light source and manufacturer's recommended test procedures. Perform tests in accordance with EIA/TIA-526-7, EIA/TIA 455-A-1991, EIA/TIA FOTP-171 Methods A3 or D3, or FOTP-34 Method B for horizontal, Single Mode fiber. Perform verification acceptance tests and factory reel tests.
- D. Performance Tests:
 - a. Category 6 Links. Perform UTP link tests in accordance with TIA/EIA-568 B.1, B.2 and manufactures guidelines.
 - b. Tests shall include wire map, length, attenuation, NEXT, PSNEXT, ELFEXT, PSELFEXT, RL and propagation delay.
 - c. Fiber Optic Links. Perform OFN end-to-end attenuation tests and reel tests at job site.
- E. Final Verification Tests
 - a. Perform verification tests for UTP and OFN systems after the complete telecommunications cabling and workstation jacks are installed.
 - b. Provide District Project Manager with written final tests verification within one (1) week of completion of installation.

- c. Final test results shall include summary pages for each IDF/BDF as required.
- d. Test results shall be provided in both hard and electronic copy.

3.9 PATHWAY INSTALLATIONS

A. General Requirements:

- a. Comply with TIA/EIA-569-A, NEC and CEC.
- b. Shall be installed in accordance with NEC Article 314 and Article 800.51 (J), (K), or (L), as applicable, and installed in accordance with Articles 362.24 through 362.56, where the requirements applicable to electrical nonmetallic tubing apply.
- c. Conceal interior conduit under floor slabs and within finished walls, ceilings, and floors where possible.
- d. Keep conduit minimum 6 inches away from parallel runs of electrical power equipment, flues, steam, and hot water pipes.
- e. Install conduit parallel with or at right angles to ceilings, walls, and structural members where located above accessible ceilings and where conduit is visible after completion of project.
- f. Run conduits in crawl spaces and under floor slabs as if cable is exposed.
- g. Install no more than two 90-degree bends for a single horizontal cable run.
- h. Run conduits raceway as determined by site survey or as noted on drawings.
- i. Provide Pullboxes with "Sealtight" flex conduit only where flexible connections are required. District Project Manager approval required prior to all "Sealtight" flex conduit installations.
- j. Provide all coring, patching and painting as needed for Intra-Building and Inter-Building pathways. Caulking is not an acceptable patching method for conduit penetrations into exterior walls. Coordinate with District Project Manager for acceptable patching methods.
- k. Innerduct, where specified, corrugated or splined (inside) flexible orange innerduct, 1 inch in diameter, riser rated, shall be placed for fiber optic cable protection.
- l. Innerduct, where specified, 3" 3-cell fabric innerduct (outside), shall be placed for fiber optical cable protection.
- m. Conduit shall have a factory formed bell on one end for interconnecting segments.
- n. Spacers: High impact spacers shall be used in all multi-duct systems, for solely owned or joint telecommunications/power construction. They shall conform to NEMA TC-2, TC-6, TC-8, and ASTM F 512 dimensions.
- o. All fittings shall be designed specifically for use with the type of conduit placed.
- p. All conduits shall be equipped with seal plugs in all ground boxes and expansion rubber seal plugs within all buildings.

B. Underground Conduits:

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- a. A horizontal and vertical separation of 1 inch between the ducts shall be maintained by installing high impact spacers with horizontal and vertical locking intervals of ten feet.
 - b. All communications conduits shall be placed in a uniform manner between ground boxes and pull boxes. Conduit in position #1 at one ground box or pull box shall maintain its position within the duct run and terminate in the #1 position at the next box. The position of all conduits between ground boxes and pull boxes shall be maintained.
 - c. Long radius bends (over 30 feet) shall be used whenever possible to make changes in direction. If it is found to be necessary to place a 90-degree bend in the conduit run, a factory-made sweep of no less than 60-inch radius shall be used.
 - d. No conduit run shall exceed a total of 180 degrees of bend between any two points (such as manholes or buildings) considering both vertical and horizontal sweeps.
 - e. Cold-formed trench bends shall have a radius of not less than 60 inches and shall pass mandrel integrity. Bend radius criterion is 2" or less 6 times the diameter of the conduit and any conduit larger than 2" is 10 times the diameter of the conduit.
 - f. The length and destination of all conduits shall be identified in each ground box, pull box and building. Embossed metal or heavy plastic tags strapped to each conduit shall be used.
 - g. After installation of communications conduits, the contractor shall prove all conduits by pulling a mandrel with a diameter $\frac{1}{4}$ inch smaller than the conduit and 6 inches long through each conduit end-to-end. An inspector designated by the contractor and RSCCD shall be notified 24 hours before this procedure. Each conduit shall be cleaned with a bristle brush to remove any debris.
 - h. Detectable utility marking tape shall be buried 12 inches below the surface directly above the conduit.
 - i. Where communications and power conduits occupy the same trench, all conduit structures shall be built with the telecommunications conduits placed above the power conduits and separated by a minimum of 12" of compact earth or 3" of concrete encasement, unless otherwise called out on the construction drawings and approved by RSCCD. If this type of construction is required, it shall receive the prior approval of the contractor and RSCCD.
 - j. Contractor shall install new $\frac{1}{4}$ " pull rope in all conduits placed.
- C. Overhead Conduit:
- a. Where overhead conduit is required, Contractor shall utilize EMT conduit with an inside diameter of 2", unless otherwise specified.
 - b. All fittings shall be compression type connectors and couplers designed specifically for use with the type of conduit placed. Set screw connectors shall not be allowed.

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- c. All fittings shall be watertight. Fitting types shall be pre-approved by the designated District representative. Unless pre-approved by the designated District Project Manager, all conduits shall be installed by a qualified electrical contractor who has at least five years experience in similar installations within the Southern California area.
- d. Contractor shall install conduit at roof locations utilizing the current District approved methodology and process. All conduit pathways and locations must be approved by RSCCD prior to installation.
- e. All roof penetrations must be approved by RSCCD prior to installation.
- f. Contractor shall install new ¼" pull rope in all conduits placed.

D. Communications Entrance Conduit

- a. To prevent shear, all inter-building conduit (either underground or aerial) shall transition from PVC or metal to Sealtite flex conduit when attaching to a permanent structure. The contractor and RSCCD shall determine the placement of all entrance conduit. All applicable standards shall be adhered to, i.e., RSCCD, NEC, BICSI or G.O. 128.
- b. Sealtight flex conduit lengths shall not exceed 24", unless approved by RSCCD.
- c. Contractor shall install new ¼" pull rope in all conduits placed.

E. Vertical Conduit

- a. Where vertical conduit is required between pull boxes or within buildings, Contractor shall utilize EMT conduit with an inside diameter of 2", unless otherwise specified.
- b. Where vertical conduit is exposed and subject to damage, contractor shall utilize IMC or Rigid conduit.

F. Duct-Bank Locating Cable (Electronically Detectable Warning Tape)

- a. Warning tape shall be a minimum of 3" wide, orange in color, and shall have a nondegradable imprint as follows:
 - 1. "Caution fiber optic cable buried below"
 - 2. The tape shall be electronically detectable.

G. Pull Rope

- a. Pull rope shall be new ¼" polypropylene over polyester rope with a minimum 1700 lb. Tensile strength.
- b. Pull rope shall be new material that is free of knots, kinks, and abrasions and shall be placed as a single continuous length in every new conduit.
- c. Pull rope shall be secured at each end.

3.10 BONDING AND GROUNDING

A. BDF

- a. Install Telecommunications Grounding Busbar (TGB) in BDF. The TGB shall be installed in accordance with ANSI/J-STD-607-A-2002.

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1. Each BDF Rack shall be bonded to the TGB with a #6 AWG insulated copper conductor.
2. All cable runway sections shall be bonded to each other using the listed bonding kit. Cable runway shall bond to the TMGB or TGB with a #6 GREEN insulated copper conductor.
3. The TGB shall be grounded to the nearest access to the building ground with a #6 AWG insulated conductor.
4. Building ground is identified as main building electrical ground, building structural steel, or ground rod. Water pipes, gas pipes and electrical conduits are not acceptable ground attachment points.
5. Ground conductors are not to exceed 40'. If building ground connection is beyond 40', contractor is to install a new ground round at the nearest outside location. Ground rod location shall be approved by RSCCD prior to installation.
6. Provide ohms testing for ground. Ground connections shall not exceed 5 ohms.

b. Materials shall consist of:

- a. Telecommunications Grounding Busbar, 12" long X 4" high, ¼" thick copper bar with grounding assembly hardware kit; Cooper B-Line part number SBTMGB12K, or District approved equal.
- b. Bonding Conductor, #6 AWG copper wire insulated conductor with #6 compression ring terminals at both ends with ¼" diameter holes. Cooper B-Line part #SBUBC614K for 14", #SBUBC618K for 18", SBUBC632K for 32", or District approved equal.
- c. Two-hole mechanical lug, copper alloy with silicon bronze hardware. Cooper B-Line part #SB47802, or District approved equal.

B. IDF

- a. Install Telecommunications Grounding Busbar (TGB) in each IDF. The TGB shall be installed in accordance with ANSI/J-STD-607-A-2002. The TGB shall be grounded to the nearest building ground with a #6 AWG insulated conductor.
- b. Each IDF Rack shall be bonded to the TGB with a #6 AWG insulated copper conductor. Each IDF shall have a Telecommunications grounding busbar (TGB).
 1. All cable runway sections shall be bonded to each other using the listed bonding kit. Cable runway shall bond to the TMGB or TGB with a #6 GREEN insulated copper conductor.
 2. The TGB shall be grounded to the nearest access to the building ground with a #6 AWG insulated conductor.
 3. Building ground is identified as main building electrical ground, building structural steel, or ground rod. Water pipes, gas pipes and electrical conduits are not acceptable ground attachment points.

4. Ground conductors are not to exceed 40'. If building ground connection is beyond 40', contractor is to install a new ground round at the nearest outside location. Ground rod location shall be approved by RSCCD prior to installation.
 5. Provide ohms testing for ground. Ground connections shall not exceed 5 ohms.
- c. Materials shall consist of:
1. Telecommunications Grounding Busbar, 12" long X 4" high, ¼" thick copper bar with grounding assembly hardware kit; Cooper B-Line part number SBTMGB12K, or District approved equal.
 2. Bonding Conductor, #6 AWG copper wire insulated conductor with #6 compression ring terminals at both ends with ¼" diameter holes. Cooper B-Line part #SBUBC614K for 14", #SBUBC618K for 18", SBUBC632K for 32", or District approved equal.
 3. Two-hole mechanical lug, copper alloy with silicon bronze hardware. Cooper B-Line part #SB47802, or District approved equal.

3.11 FIRESTOPPING MATERIAL

- A. Contractor shall provide all necessary fire stopping of openings through which cable is installed under this specification, in accordance with NFPA 70 and all local codes. This includes installation in conduits, raceways, or bare penetrations. Provide and install UL 1479 approved (Fire Barrier Caulk) firestop material.

3.12 DATA SYSTEMS LABELING PROCEDURES

- A. The labeling shall be in accordance with the TIA/EIA-606-A standards for data.
- B. The labeling shall be computer software generated and printed with readable fonts and black ink.
- C. The ink and label shall be water and smear-proof for both indoor and outdoor use.
- D. Samples of each type of media showing label type, labeling format, font size and ink shall be submitted for RSCCD approval.

3.13 DATA SYSTEMS LABELING

- A. The data systems labeling shall include all related equipment, cables, racks and RJ-45 outlets.
- B. Label all cables at each end of the cable designating the rack and room number.
- C. The labeling shall be delineated on any riser diagrams, floor plans and test reports.
- D. Labeling shall be printed, not handwritten, using a label maker device.
- E. Patch Panels:

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- a. Patch Panels shall be provided with a factory lettering located above the ports with port number and factory installed field labels installed below the ports.
 - b. The field labels shall identify the room location.
 - c. Every 48-port panel shall be labeled with a letter designation from top to bottom “A” to “Z”.
- F. Wall Jacks:
- a. Wall jacks shall be provided with the following labeling standard:
 - i. <Building Letter><IDF/BDF Room Number><Patch Panel ID><1- or 2-digit Patch Panel port>
 - 1. Building Letter: The building designation letter. For example, “A” or “SC”. If the building does not have a letter assignment, this would be left blank.
 - 2. IDF/BDF Room Number: The room number designation for the IDF/BDF where the cable terminates. For example, for an IDF located in A110, “110” would be used to avoid overlap with the building letter required above.
 - 3. Patch Panel ID: Every 48-port patch panel shall be labeled with a letter designation from top to bottom from “A” to “Z”. This shall be the “patch panel ID”, and shall be captured on the data wall jack label.
 - 4. 1 or 2 digit Patch panel port. The actual port number on the patch panel (from 1 to 48).

END OF SECTION 271000

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SECTION 272000 - DATA COMMUNICATIONS ACTIVE INFRASTRUCTURE

PART 1 – GENERAL

1.1 SUMMARY

- A. This section describes the data communications network infrastructure including electronics and software needed to support Local Area Networks and network management.
- B. Products Installed Under this Section: Only new equipment and material, produced by manufacturers that are recognized nationally by the telecommunications industry and approved by Underwriters Laboratory shall be used as specified in this Section or on the Drawings.
 - 1. All mounting hardware
 - 2. All mounting brackets
 - 3. All power cords
- C. Related Sections:
 - 1. Division 01
 - 2. Section 23 09 00: Building Management System
 - 3. Section 26 05 00: Common Work Results for Electrical
 - 4. Section 27 10 00: Structured Cabling
 - 5. Section 28 13 00: Access Control / Security System
 - 6. Section 28 23 00: Digital Surveillance System

1.2 REFERENCES

- A. NEMA – National Electrical Manufacturer’s Association
- B. ANSI – American National Standards Institute
- C. NEC – National Electric Code
- D. RSEF – Relevant State Electrical and Fire Codes
- E. IEEE – Institute of Electrical and Electronic Engineers
- F. UL – Underwriters Laboratories, Inc.
- G. ANSI/EIA/TIA – 568A-1995 Commercial Building Telecommunications Wiring Standard
- H. ANSI/EIA/TIA – 568-B-2-1 Transmission Performance Category 6 Cabling Specifications for 4-Pair 100 Ohm

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- I. ANSI/EIA/TIA – 569A Commercial Building Standard for Telecommunications Pathways and Spaces
- J. ANSI/EIA/TIA – 606 The Administration Standard for the Telecommunications Pathways and Spaces
- K. ANSI/EIA/TIA – 607 Commercial Building Grounding and Bonding Requirements for Telecommunications
- L. ANSI/EIA/TIA – 598 Color Coding of Optical Fiber Cables
- M. EIA/TIATSB – 67 Transmission Performance Specifications for Field Testing of Unshielded Twisted-Pair Cabling Systems
- N. BICSI – Building Industry Consulting Service International publications:
 - 1. Telecommunications Distribution Methods Manual
 - 2. LAN and Internetworking Design Manual
 - 3. Telecommunications Cabling Installation Manual
 - 4. Customer Owned Outside Plant Design Manual
 - 5. Manufacturer’s recommendations and installation guidelines
- O. All cabling shall comply with all appropriate requirements of NEC Articles 770 and 800 and shall comply with the State Fire Codes as interpreted by the State Fire Marshall’s Department.
- P. All publications referred to in this document shall be the latest publicized edition.

1.3 SUBMITTALS

A. Product Data

- 1. Provide a complete list of current part numbers included in the system(s), product revision levels and confirm with District ITS during submittal phase.
- 2. If additional equipment is required to meet performance specifications of the system, Contractor shall provide the equipment with District ITS written approval prior to installation.

B. Certificates

- 1. Contractor shall carry the appropriate manufacturer certification for installation of the Data Communications and Wireless Equipment.
- 2. Contractor shall provide proof of certification to the District.

C. Qualifications

- 1. Contractor shall provide proof of training / certification to the District. The installing contractor must be certified with the manufacturer for at least twelve (12) months prior to the bid.

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2. Contractor shall assign competent person as Project Manager who has demonstrated the ability to supervise a project of similar size and scope. Submit a resume of the proposed Trade Contractor Project Manager for the District's review and acceptance. The Project Manager must attend meetings as required.
3. Contractor shall provide documentation to the District to demonstrate that it has been in the telecommunications contracting business for a minimum of five (5) years under the same name and are located within a four (4) hour response time of the District.
4. Installer shall include BICSI Cabling Installer certifications for all cabling being installed.

1.4 CLOSEOUT SUBMITTALS

- A. Contractor shall provide published escalation and priority handling procedures. This shall include the names and phone numbers, in organizational chart format, of the technicians and management responsible for supporting the District.
- B. Contractor shall describe its policies and plans to assist the District in the event of a catastrophic disaster to the facilities mentioned in this section.
- C. Contractor shall provide a port map indicating all port locations. The port map shall show the wall label and floor plan location for each data jack.
- D. Warranty and Performance Agreements.

1.5 QUALITY ASSURANCE

- A. Use adequate numbers of skilled workers thoroughly trained and experienced on the necessary crafts and completely familiar with the specified requirements and methods needed for the proper performance of the work of this Section.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials (except bulk materials) in manufacturer's unopened containers fully identified with manufacturer's name, trade name, type, class, grade, size and color.
- B. Store materials in unopened containers. Store off ground and under cover, protected from theft and damage.
- C. Deliver materials to the District
 1. Materials to be delivered to District not less than two weeks prior to Contractor's scheduled installation date.

1.7 PRE-INSTALLATION MEETING

- A. Schedule a pre-installation meeting with Architect, District Project Manager, District ITS Representative, and Contractor in attendance.

1.8 WARRANTY

A. Manufacturer Warranty:

1. MDF/BDF switch electronics: LAN electronics and associated software are to include a two (2) year manufacturer warranty for non-core gear. Core gear shall include a five (5) year manufacturer warranty.
2. IDF switch locations: LAN electronics and associated software shall be warranted for two (2) year manufacturer warranty.
3. All other products shall include the standard manufacturer warranties.
4. Wireless Access Points (WAPs) are excluded from the above-mentioned manufacturer warranty language.

B. Contractor Warranty:

1. Contractor shall provide installation warranty extending to the Data Communications Active Infrastructure protecting RSCCD against defects in workmanship for a minimum period of two (2) years in accordance with the contract documents. Such warranty shall provide all labor and materials necessary to correct a failed portion of the system and to demonstrate performance within original specifications after the repairs are accomplished.
2. Contractor shall be available 24-hour/7-day-per-week for on-site service to correct defects in installation or workmanship, without charge for labor, materials or parts. Component failure will be addressed directly with the manufacturer through the provided warranty; however issues related to product failure due to faulty or improper installation or workmanship by the Contractor shall be resolved by the Contractor.
3. Response time is defined as on-site presence of authorized maintenance personnel equipped with appropriate spare parts and diagnostic tools.
4. Once work has begun on repair of a critical problem, a technician shall remain on-site until the problem has been repaired. Contractor shall be allowed to change technicians at shift changes, however, the first technician shall not leave the site until the second has arrived and has been briefed on the problem.
5. If parts are required to fix a critical problem that is not available locally, they shall be shipped by the fastest possible means at no cost to the District.
6. During the warranty period, Contractor shall keep on-site detailed maintenance and repair records of all calls made to the facility.

PART 2 – PRODUCTS

2.1 LAN ELECTRONICS

- A. All equipment is to be certified new by Brocade for network switches and Aruba for wireless access points.
- B. No refurbished, used, after-market or gray-market components will be accepted.
- C. Contractor will be responsible for all mounting kits and brackets for the LAN electronics and Wireless equipment.
- D. Material must be rack mountable in the equipment racks as specified in Section 271000 Structured Cabling.
- E. BDF Switches
 - 1. Manufacturer: Brocade, District Standard – no or equals, refer to adopted Board Resolution No. 18-17
 - 2. Redundant power supplies (2x500W) part number RPS9+E and redundant tray fans (1x ICX7750-FAN-E – kit of 4) shall be provided for each switch.
 - 3. Redundant core switches, one pair, shall be Brocade, Model ICX7750-48F, most current replacement or equivalent Brocade technology model and software version. Confirm with District ITS prior to purchasing.
 - a. Premium licensing to accomplish Layer 3 features.
 - b. Two 10 GE SFP's per core switch shall be provided to create redundant uplinks to the IDF stacks.
 - c. Use interconnect / stacking cables, part number 40G-QSFP-QSFP-C-0101.
 - 4. Contractor shall verify the correct components and correct amount of components.
 - 5. Stack switches. Provide additional SFP direct attached copper cables; 1M, 3M, or 5M length as required.
 - a. Use Brocade Model ICX7150-48PF-2X10G or most current replacement part number. Confirm with District prior to purchasing.
 - b. Contractor shall verify the correct components and correct amount of components for a complete and fully operable system.

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F. IDF Switches

1. Manufacturer: Brocade, District Standard – no or equals, refer to adopted Board Resolution No. 18-17
2. Stack switches. Provide additional SFP direct attached copper cables; 1M, 3M, or 5M length as required.
 - a. Use Brocade Model ICX7150-48PF-2X10G or most current replacement part number. Confirm with District prior to purchasing.
 - b. Contractor shall verify the correct components and correct amount of components for a complete and fully operable system.

- G. ELECTRICAL: A central UPS system at MDF/BDF with connection to the IDF will be provided under Section 263323. The system is intended to provide 30 minutes of runtime for connected network equipment. The Contractor shall arrange connection of the UPS Ethernet Network Interface Card with SNMP capabilities for remote monitoring to the access layer network.

2.2 WIRELESS ACCESS POINTS AND ACCESSORIES

1. Manufacturer: Aruba Networks, District Standard – no or equals. “Refer to adopted Board Resolution No. 18-17”
 - a. Indoor – Aruba 320 Series
 - i. Part No. JW186A (AP-325 802.11n/ac 4x4:4 MU-MIMO Dual Radio Integrated Antenna AP)
 - b. Outdoor – Aruba 270 Series
 - i. Part No. JW178A (AP-275 802.11n/ac Dual 3x3:3 Radio Integrated Omni Antenna Outdoor AP)
 - ii. Part No. JW180A (AP-277 802.11n/ac Dual 3x3:3 Radio Integrated Directional Antenna Outdoor AP)
 - c. Mounting Kits
 - i. Part No. JW054A (AP-270-MNT-H1 AP-270 Series Outdoor AP Hanging or Tilt Install Mounting Kit)
 - ii. Part No. JW055A (AP-270-MNT-H2 AP-270 Series Access Flush Wall or Ceiling Mount)
 - iii. Part No. JW052A (AP-270-MNT-V1 AP-270 Series Outdoor Pole/Wall Long Mount Kit)
 - iv. Part No. JW053A (AP-270-MNT-V2 AP-270 Series Outdoor Pole/Wall Short Mount Kit)

- v. Part No. JW047A (AP-220-MNT-W1W Flat Surface Wall/Ceiling White AP Basic Flat Surface Mount Kit)

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Examine the areas and conditions under which the work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Contractor shall hold a pre-installation meeting with District Project Manager and District ITS Representative.
- B. Property damage caused by Contractor during the installation and testing process shall be replaced at no cost to the District.
- C. Contractor will be responsible for all mounting kits and brackets for the LAN electronics and Wireless equipment.

3.3 LOCATIONS

- A. Coordinate with other trades to assure proper and adequate provision in the work of those trades for interface with the work of this Section.
- B. Install the work of this Section in strict accordance with the original design, the approved Shop Drawings, pertinent requirements of governmental agencies having jurisdiction, and the manufacturer's recommended installation procedures as approved by RSCCD Project Manager, anchoring all components firmly into position for long life under hard use.

3.4 GENERAL INSTALLATION REQUIREMENTS

- A. Contractor shall provide a full suite of installation services and a turnkey solution. Specifically, this includes:
 - 1. Contractor shall submit a short written report on a weekly basis to the District Project Team. This report should contain the following information:
 - a. Summary of work completed for the week concluded.
 - b. Summary of work anticipated for the following week.
 - c. Any action items requested of the District ITS personnel.

- d. Any deviations from the implementation schedule.
2. Turnkey installation is defined as having all networking components including cabling, and LAN/WLAN electronics, mounting hardware, firmware working as individual components as well as a homogenous system.
3. Contractor will coordinate installation schedules with the District Project Manager so as to minimize the impact on day-to-day operation for the campus.

3.5 LAN ELECTRONICS INSTALLATION

- A. Contractor shall deliver network switches and configurable components to the District ITS Department prior to installation, Timing of this should be coordinated with the District ITS Department so that equipment arrives for configuration “just in time.” District ITS will coordinate with Contractor to attend to any DOA equipment that may arrive on site.
- B. The District ITS Department shall configure each WAP, switch and camera with the appropriate TCP/IP address and District configuration prior to Contractor installation.
- C. Contractor shall install switches per BDF/IDF as assigned by District ITS Department.
- D. Contractor shall coordinate with District ITS to connect the SNMP network interface card of the BDF UPS power supply to the access layer network, which will enable the District to notify at minimum the following items:
 - a. When utility power is lost and unit is running on battery backup;
 - b. Over and under voltage;
 - c. Battery issues;
 - d. Battery age; and
 - e. Unit operating temperature.
- E. At full utilization, including PoE, each UPS will include the appropriate extended run battery(s) capable of supplying 30 minutes of power.
- F. Access layer Gigabit Ethernet (1000BaseTX) PoE Switches will be located in each closet supporting interfaces to switched 100BaseT Ethernet and switched 1000BaseT Ethernet at station devices.
- G. All Unshielded Category 6 Twisted Pair (UTP) wiring will connect access layer switches to the station devices (PC’s, printers, etc.) All 100BaseTX/1000BaseTX interfaces will be 8-pin modular (RJ-45) type.
- H. District ITS will perform all the cable cross-connect and station patching tasks.

3.6 WIRELESS INSTALLATION

- A. Wireless controllers are existing.
- B. Install new WAPs and mounting hardware as per drawings.

- C. Labeling
 - 1. The WAP shall be labeled at the patch panel port using the device's hostname. Coordinate with District ITS to determine the hostname for each device.
 - 2. Label shall be printed, not handwritten, using a label maker device.

3.7 ACCEPTANCE TESTING

- A. All LAN and WLAN electronics specified in this document must meet manufacturer's standard tests.
- B. Device configurations must be reviewed and approved by the District before deployment in production environment to allow for changes and acceptance.
- C. Contractor shall perform a detailed post-install passive site survey for coverage and capacity validation.
- D. Contractor shall prepare detailed coverage heat maps, after the installation of the WAP's, using AirMagnet Wi-Fi Pro, AirMagnet Survey Pro or equal approved by the District Project Manager. Provide current certifications for the site surveyor for AirMagnet or District-approved equal. Provide a copy of the physical survey to District Project Manager prior to installation of Wireless Access Points ("WAP"). Heat maps shall identify:
 - 1. Access point quantity
 - 2. Access point locations (room & building)
 - 3. Access point protocol 802.11 g/n/ac
 - 4. Access point channel and signal strength
 - 5. Common access point configuration
 - 6. Seamless subnet roaming
 - 7. Non 802.11 interference in 2.4GHz and 5GHz bands
 - 8. Special antenna
 - 9. Physical end environmental requirements for access point placement
 - 10. Upgrades to existing access points (including hardware and/or software)

3.8 PROJECT RECORD DOCUMENTATION

- a. Prepare and submit electronic copies of as-builts and Layer 1 network diagrams updated to reflect the new work completed for project (i.e. site plans, cable, pathways, MDF/BDF/IDF cabinet elevations, equipment spreadsheets, and wireless heat maps).
- b. These documents must be delivered to the District Project Manager upon completion of work and before Final Inspection.

END OF SECTION 272000

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SECTION 273210 - TWO-WAY COMMUNICATION EMERGENCY TELEPHONE SYSTEM

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Furnish and install a complete microprocessor controlled, "full-duplex" circuitry voice communication, telephone access control system as described herein and shown on the plans. The system shall include all necessary boards, power supplies, strobe lights, loudspeakers, special mounting boxes, cable, connectors, and accessories for a complete operational communication system.

1.02 RELATED WORK

- A. Contractor shall coordinate all work with other contractors and trades where necessary.
- B. All necessary conduit, raceways, pull boxes, standard boxes (and special boxes provided by intercom manufacturer), shall be installed by the electrical contractor.
- C. Installation of the communication/access control systems shall be coordinated with the installation of other related systems.

1.03 QUALITY ASSURANCE

- A. Installation shall comply with all applicable codes.
- B. All equipment shall be new, in current production, and the standard products of a manufacturer of emergency telecommunications systems equipment.
- C. Manufacturer shall guarantee availability of parts and/or upgradeable circuitry, for a minimum of 7 years from date of shipment.
- D. If required, manufacturer shall be able to demonstrate features, functions and operating characteristics.
- E. System shall be installed by a factory authorized contractor, with technicians specifically trained in this system.

1.04 REFERENCE STANDARDS

- A. Federal Communications Commission (FCC) 1Z8898-62546-DI-T

1.05 SUBMITTALS

- A. Provisions: Comply with Section 01 30 00 SUBMITTALS
- B. Shall include an equipment list and data sheet, system description and block diagrams on equipment to be furnished.

- C. Shall include all data necessary to evaluate design, quality, and configuration of proposed equipment and systems(s).

1.06 WARRANTY

- A. Systems shall include a factory warranty that equipment is free from defects in design, material, manufacturing and operation.
- B. Factory warranty period shall be for two (2) years parts and workmanship; 24 months from date of shipment. Manufacturer shall not be responsible for improper use, handling, or installations of the product.
- C. Installing communications contractor shall guarantee the equipment, wire, cable, and installation for 12-months from date of acceptance.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

- A. The emergency telecommunications system shall provide a "full-duplex" voice communication from the unit location to the remote attendant. Half duplex or simplex type communication will not be allowed.
- B. The system shall be a microprocessor based system and shall provide voice communication and access control through a touch-tone, loop-start dedicated control office telephone line.
- C. The system shall be capable of autodialing a management telephone on detecting tamper criteria.
- D. Programming of the system shall be done remotely via touch-tone telephone or with remote programming software.
- E. The scope of the system shall include all necessary components for proper function and interface to existing telephone lines, and include all features and functions described herein and the equipment shown on the plans. System shall be capable of adding optional features, equipment and interfaces listed in the specifications even if not initially included or shown on the plans.
- F. A complete operational system shall be provided that can fully integrate and be monitored by SAC's remote attendant.

2.02 SYSTEM CONFIGURATION

- A. The system requires a touch-tone, loop-start dedicated central office telephone line to provide voice communication.

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- B. A complete system shall consist of the Emergency Telecommunication System and one or more pieces of the following equipment (see optional equipment); connecting cables, wiring, mounting boxes and power supplies required for a complete installation.
- C. The systems programmable features shall be retained in EEPROM memory, which guarantees that programmed data is not lost during power outages or chip removal.
- D. The telephone communication feature shall be maintained in full during a power outage via the shift of utility supplied operating power to phone line power back-up. There will be no internal or external batteries present.
- E. The emergency telecommunications system shall be mounted as shown on the plans.
- F. The system shall utilize an RJ11C or W phone jack.
- G. System integration and operation shall be coordinated with SAC's remote attendant.

2.03 SYSTEM FEATURES

- A. The system shall be capable of storing up to 10 phone numbers up to 16 digits in length dialed in a rollover manner until answered or terminated at the remote attendant.
- B. Emergency telecommunications system must be capable of generating an electronic site identification that reveals originating caller location and can be decoded on another electronic device of the receiving caller.
- C. The emergency telecommunications system shall be capable of sending DTMF tones after a call from the system if connected.
- D. The remote attendant can initiate a call to the unit at any time. A call does not need to originate from the unit to allow communication.

2.04 SYSTEM OPERATION

- A. User shall locate the single button on the face of the unit and depress for autodialing to establish communication.
- B. Once communication is established, authorized remote attendant will have full duplex communication until the call is terminated at the remote attendant site. The call CANNOT be terminated by the user at the unit location itself.

2.05 EQUIPMENT

- A. All Models
 - 1. Unit shall be completely powder coated with the customers specified paint color.
 - 2. Unit shall use vandal resistant screws on all exterior areas.
 - 3. The unit shall be triangular in shape as to increase the visibility of the identifying decals.
 - 4. The speaker holes shall be offset to protect the speaker from vandalism.

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5. The control board shall be mounted to the front of the unit to ease service.
 6. The units shall be capable of ADA (American Disabilities Act) compliant hands-free operation.
 7. The unit shall have an ADA compliant “call progress” lamp that flashed during use.
 8. The unit shall have an ADA compliant Braille plate to identify an emergency phone.
 9. The system shall come equipped with a double baffled underwater rated fiber material hands free speaker.
 10. Microphone shall be housed at a right angle to the front in an acoustical chamber to enhance clarity while protecting the device from vandalism
 11. The unit shall utilize a single call button to initiate two-way communication.
- B. Gai-Tronics, Model 397-001 Standard Flush Mount-Mount Emergency Telephone (Elevator lobby 2-Way Communications Phones)
1. Standard flush-mount installation in building interior
 2. Standard analog telephone line powered
 3. No external power or battery required
 4. Remote programming
 5. Three number rollover – unit dials up to three different numbers to ensure emergency calls are answered
 6. Microphone and speaker
 7. Large “Palm” activation button call for help
 8. Auto answer
 9. Silent monitoring
 10. Auxiliary switch activates peripheral equipment
 11. ADA compliant Braille “Help” tag, “Call Received” LED indicator
 12. Brushed stainless steel finish
 13. 16-gauge cold-rolled steel back box with black polyurethane finish
 14. Compatible with Strobe Light, Model 530FB with Strobe Surface Mounting Kit, 4115A

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Contractor shall install one (1) 4-pair, Category 6, underground OSP rated cable (if required), from each telephone location to nearest building Telecommunications Room.
- B. “2-Way Communication” phones shall be installed in the elevator lobbies on 2nd floor indicated on the Telecommunication floor plans. Each 2-way communication phone shall be accompanied with a local hearing impaired strobe.
 1. The telephones will be located in elevator lobbies 2nd floor and programmed thru the buildings’ phone system to ring-down to a preprogrammed series of phone numbers when the handset is taken off hook. The ring-down numbers shall be coordinated with and as directed by the Owner in coordination with SAC.

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2. The code requires the system to be approved by the fire department. The telephone should ring directly to the building's Fire Control Room and if no answer the next programmed number would be SAC campus police, however, final programming shall be as determined by Owner.
 3. The communications contractor shall coordinate with Div. 27.
 4. Architect will specify the proper signage placards to satisfy 2009 IBC 1007.8.2 DIRECTIONS.
- C. Unit shall be installed by qualified technicians who have been factory approved for installation.
- D. Wiring shall be uniform and in accordance with national electric codes and manufacturers instructions.
- E. Installation shall conform to manufacturer's written requirements for installation.
- F. Equipment shall be firmly secured, plumb and level.
- G. All splices shall be in easily accessible junction boxes or on terminal boards.
- H. All cable runs at the main control cabinets, in all auxiliary cabinets and at all phone blocks shall be tagged and identified.
- I. Coordinate all work with other effected trades and contractors.
- J. Fastenings:
1. Fasten on gypsum board wall surfaces with screws into wood or metal blocking, or with bolts or molly anchors, not less than ¼ inch diameter. Screwing into gypsum board or plaster with plugs will not be acceptable.
 2. Fasten into concrete or masonry with self-drilling masonry anchors Phillips, Redhead, Bulldog or Rawl Sabertooth.

3.02 SYSTEM INITIALIZING AND PROGRAMMING

- A. System shall include all software and/or instruction necessary for system configuration.
- B. System shall be turned on and adjustment made to meet requirements of specifications and on-site conditions.
- C. System shall be programmed to function as specified. Coordinate with College Representative for exact requirements.
- D. Feature codes and special programming shall be documented, printed and made available to all owners.

3.03 SYSTEM TEST PROCEDURES

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- A. System shall be completely tested to assure that the exchange and all components, stations, speakers and accessories are hooked-up and functioning properly.
- B. System shall be pre-tested by contractor and certified to function in accordance with plans and specifications.
- C. System shall be tested in presence of owner's representative.

3.04 OWNER INSTRUCTIONS

- A. Installation contractor shall conduct up to (1) hour of instructions in use and operation of the system to designated owner representatives, within (30) days of acceptance.
- B. Installation contractor shall conduct up to (1) hour for technical training, in programming, troubleshooting and service of the system, to designated owner representatives within (90) days of system acceptance.

3.05 MANUALS AND DRAWINGS

- A. Contractor shall provide owner with copies of standard factory prepared operation, installation and maintenance manuals. Manuals shall include typical wiring diagrams.
- B. Contractor shall provide owner with copies of any risers, layouts and special wiring diagrams showing any changes to standard drawings, if required on project.

END OF SECTION

SECTION 27 32 26 - RING-DOWN EMERGENCY TELEPHONES

PART 1 – GENERAL

1.01 SUMMARY

- A. Equipment and materials used shall be standard components that are manufactured and available for purchase as standard replacement parts as long as the product is commercially available from the manufacturer.

1.02 QUALITY ASSURANCE

- A. All phone installation, configurations, setup, program and related work shall be performed by contractor electronic technicians thoroughly trained by the manufacturer in the installation and service of the equipment provided.
- B. All equipment shall be warrantied against any defects in material and workmanship under normal use for a period of twenty-four (24) months from date of installation, provided that manufacturer receives a completed "Installation Certification" certifying the date on which the system has been installed. An "Installation Certification" card shall be enclosed with every unit. In the event that no "Installation Certification" is received by manufacturer, the twenty-four (24) months will commence on the date of shipment by the manufacturer.

1.03 CERTIFICATIONS AND STANDARDS

- A. The phone shall carry the following EMC approvals:
 - FCC (47 C.F.R. Part 15, Subpart B)
- B. The phone shall meet the following standards:
 - Accessibility
 - a. ADA: Standards for Accessible Design – 2010
 - b. ANSI ICC A117.1 (2009): Accessible and Usable Buildings and Facilities
 - c. NFPA 72: National Fire Alarm and Signaling Code – 2013
 - d. NFPA 101: Life Safety Code® 2012
 - e. Illinois Accessibility Code
 - Safety
 - a. UL 60950-1
 - b. UL 609250-22
 - Direct connection of Terminal Equipment (TE) to the Public Switched Telephone Network (PSTN)
 - a. FCC (47 C.F.R. Part 68)

1.04 REQUIREMENTS

- A. General

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1. The following information is provided to establish required system performance for a complete operating Emergency Phone System for the site. Contractor shall provide equipment, wiring and programming at all sites as necessary to provide a complete system as described herein and as shown on the drawings.
 2. Components provided under this scope of work shall be compatible with the SAC network phone system. Coordinate with the Owner on the necessary provisions.
 3. SAC will provide phone system interfaces from the site connection point. Contractor shall be responsible for providing equipment and connections at the site to achieve specified system performance when connected to the SAC network phone system.
- B. Purpose: The system is designed to allow communications from the device to the programmed responding location allowing the responder or school police to assist the caller.
1. Attributes
 - a. General
 - 1) Exterior Emergency phones with visual locating devices are located in public areas outside the buildings as shown on plans.
 - b. Exterior Emergency Phones
 - 1) Emergency phones utilize the campus network phone system dialing automatically to call a monitoring location.
 - 2) Each device shall be equipped with a blue light identifying the location of activation.
 - 3) Each device shall be equipped with a single pushbutton which will activate the calling function and the blue location light.

PART 2 – PRODUCTS

2.01 GENERAL

A. The phone shall:

1. Consist of an outdoor-rated vandal resistant ADA-compliant hands-free speakerphone communications device with a bonded PET and marine-grade stainless steel faceplate with metal button(s).
2. Be full duplex in operation.
3. Be programmable from a remote location.
4. Have a six number dialing capability, reverting to the subsequent number if the first is busy or does not respond.

2.02 HARDWARE

A. The phone faceplate shall:

1. Be constructed of a 304 grade stainless steel base plate bonded with a:

- a. Enhanced corrosion resistant #4 brushed 316 grade stainless steel signage plate.
 - b. UV-resistant Polyethylene Terephthalate (PET) dead-front signage panel.
2. Have a combined thickness of 0.086" (2.13mm)
 3. Measure 8.5" W x 11.5" H.
- B. The phone faceplate primary signage shall:
1. Be constructed of enhanced corrosion resistant 316 grade stainless steel with lettering and Braille raised for ADA compliance.
 2. Lettering shall be raised no less than 0.03125".
 3. Braille shall be raised no less than 0.025".
 4. Read "EMERGENCY".
 5. Be printed red and have a UV-resistant finish.
- C. The primary button shall:
1. Be a high quality 1.375" diameter push button (1.80" overall diameter) and switch in a single assembly.
 2. The switch shall be mechanically rated to 50,000 cycles (typical).
 3. Provide tactile feedback.
 4. Have an operating temperature range of -40°F (-40°C) to +185°F (+85°C).
 5. Have an enclosure design that is watertight as per IP67 rating.
 6. Be constructed of an aluminum alloy, with a clear chromate finish.
 7. Have a metal cap, painted red with a UV-resistant finish.
- D. The phone shall have three light emitting diode (LED) lit dead-front messages, labeled "CALLING", "ANSWERED", and "HELP ON THE WAY".
- E. The speaker shall:
1. Be a 3.5" round, RoHS compliant, outdoor rated speaker.
 2. Have an operating temperature range of -67°F (-55°C) to +185°F (+85°C).
 3. Be capable of withstanding a total immersion for 96 hours and operating without any deterioration of sound quality.
 4. Have a speaker cone constructed of a corrosion resistant material.

5. Be constructed of a neodymium magnet and a solid aluminum voice coil and shall be adequately protected from ferrous and non-ferrous particles via a sealed design.

F. The microphone shall:

1. Be a 6 mm diameter, aluminum construction, RoHS compliant, outdoor rated microphone.
2. Have an IP57 type enclosure to protect from dust and water.
3. Have an operating temperature range of -40°F (-40°C) to + 158°F (+70°C).
4. Operate within ± 3 db of initial sensitivity after being placed in a chamber at +40°C and 90 \pm 5% relative humidity for 240 hours. (Tested after 6 hours of conditioning at +25°C)

G. The phone shall weigh approximately 5 lbs.

H. The phone shall have an ABS back box mounted on four 6-32 studs to protect electronics from unintentional installer interaction.

2.03 AUDIO

- A. The phone shall support full duplex audio using G.711 PCM a-Law, G.711 PCM u-Law, G.729a, and G.723.1a compression.
- B. The phone shall be capable of providing 8-bit audio at up to 64Kbit/sec.
- C. The phone shall be capable of providing sound greater than 90dBC at one meter for normal conversation.
- D. The phone shall be capable of providing sound greater than 100dBC at one meter for paging mode.
- E. The phone shall support Voice Activity Detection and Comfort Noise Generation.
- F. The phone shall support Acoustic Echo Cancellation.
- G. The phone shall support Auto Gain Control.
- H. The phone shall have configurable Jitter Buffer.

2.04 FUNCTIONALITY

A. Web Server

1. The phone shall contain a built-in web server making configuration available to multiple clients in a standard operating system and browser environment using HTTP, without the need for additional software.
2. The web server shall require authentication with username and password.

B. IP Address

1. The phone shall support both fixed IP addresses and dynamically assigned IP addresses provided by a Dynamic Host Control Protocol (DHCP) server.
2. The phone shall support IPv4.

C. Bandwidth Management

1. The phone shall support Differentiated Services (DiffServ) to provide Quality of Service (QoS) and to prioritize traffic.

D. Voice over Internet Protocol (VoIP)

1. The phone shall be configurable with up to three SIP registrars. Each registrar can be configured for:
 - a. Broadcast Domain
 - b. SIP Username
 - c. SIP Password
 - d. SIP Registrar IP Address
 - e. SIP Registrar Port
 - f. SIP Re-registration Time
2. The phone shall be configurable with up to three outbound proxies. Each outbound proxy can be configured for:
 - a. Outbound Proxy Username
 - b. Outbound Proxy Password
 - c. Outbound Proxy IP Address

E. Telephone Calls

1. The phone shall be programmable with up to six different telephone numbers of up to 30 digits for each of six telephone number lists.
 - a. If the first number does not answer or is busy, the phone shall automatically call the second number.
 - b. If the second number does not answer or is busy, the phone shall automatically call the third number.
 - c. The phone shall continue dialing in round robin fashion until the call is answered or the call conversation timer limit expires.

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2. The phone shall have a call conversation timer that is user configurable from 1 to 360 minutes.
3. The phone shall have a ringback or busy timer that is user configurable from 1 to 60 seconds.
4. The phone shall have a hang-up on silence timer that is user configurable from 10 to 360 seconds.
5. When the call is finished, the phone shall automatically terminate the call.
6. The phone shall be capable of auto answering any call placed to it from another telephone.
7. The phone shall be capable of silently answering an incoming call for monitoring.

F. Hearing Impairment Aides (LEDs)

1. The phone shall illuminate an LED message, labeled "CALLING", when calling party has placed a call.
2. The phone shall illuminate an LED message, labeled "ANSWERED", when the call has been answered by the remote attendant.
3. The phone shall illuminate an LED message, labeled "HELP ON THE WAY", when the remote attendant enters a predefined DTMF command.

G. Voice Messages

1. The phone shall be programmable with up to five unique voice messages.
2. The phone shall be capable of automatically notifying the remote attendant of the emergency phone location via a recorded message that plays at the beginning of the phone conversation.
3. The voice messages shall be configured as responses to event triggers.

H. Event Functionality

1. The phone shall be equipped with integrated event functionality which can be triggered by:
 - a. Primary button activation
 - b. DTMF tone
 - c. Auxiliary Input activation
 - d. Auxiliary Input deactivation

- e. Call termination
2. The responses to triggers shall include:
 - a. Placing a telephone call
 - b. Activating one or multiple auxiliary outputs
 - c. Notification using TCP (ASCII format)
 - d. Activation of a voice message
 - e. Enabling paging mode
 - f. Disabling paging mode
 - g. Sending an email via SMTP
 3. Event functions shall be configurable from the web interface.
- I. Email Notification Profiles
1. The phone shall be configurable with up to four email recipients for each of three email notification profiles.
 2. The phone shall be configurable to send an email when triggered by:
 - a. Emergency Call
 - b. Information Call
 - c. System Restore – Ethernet up
 - d. System Restore – Firmware Upgrade Fail
 - e. SIP Registration
 - f. SIP Deregistration
 - g. Aux Output 1 Activation
 - h. Aux Output 2 Activation
 - i. Aux Output 3 Activation
 - j. Aux Input 1 Activation
 - k. Aux Input 1 Deactivation
 - l. Aux Input 2 Activation
 - m. Aux Input 2 Deactivation

- n. Aux Input 3 Activation
- o. Aux Input 3 Deactivation

J. Paging Mode

1. The phone shall support a user configurable paging mode, where the microphone is disabled and the audio is passed either to the speaker or to the line-level output.
2. The phone shall be configurable to enable paging mode automatically on incoming calls.
3. The phone shall be configurable to enable/disable paging mode based on DTMF events.
4. The phone shall support user configurable output gain for paging mode.

K. Diagnostics

1. The phone shall support logging of phone events, call statistics, call details, and auxiliary events.
2. The phone shall support diagnostic logging for the following modules:
 - a. Audio
 - b. Call Control
 - c. Command Module
 - d. Device Control
 - e. SIP Module
 - f. Timer
3. The phone shall support storage of logs in internal memory. Once the storage limit is reached, the phone will automatically overwrite with new logging data.
4. The phone shall be user configurable to transmit logging data to a SYSLOG server.
5. Self-Diagnostic Testing
 - a. The phone shall support self-diagnostic testing and reporting of the following hardware:
 1. Button/Switch integrity
 2. Speaker and Microphone audibility test

3. Microphone and Line-level output audibility test

- b. The phone shall be user configurable to report self-diagnostic test results by:
 - 1. Placing a phone call to a user specified number.
 - 2. Emailing a report to a user specified email recipient.

L. Protocol Support

- 1. The phone shall incorporate support for at least IP, HTTP, TCP, UDP, ICMP, RTP, SDP, SIP, RTCP, FTP, SSH, DHCP, ARP, DNS, and NTP.

M. Installation and Maintenance

- 1. The phone shall allow updates of the software (firmware) over the network, using FTP or HTTP.
- 2. Customer-specific settings, including statically assigned IP address, the local time and date, event functionality and audio configuration, shall be stored in non-volatile memory and shall not be lost during power cuts or soft reset.

2.05 INTERFACES

A. Audio

- 1. The phone shall be equipped with one line-level output, accessible from a removable terminal block.
- 2. The output shall have an impedance of 10K Ω

B. Inputs/Outputs

- 1. The phone shall be equipped with three auxiliary inputs, accessible from a removable terminal block.
 - a. The inputs are rated up to 10mA @ 8VDC each.
 - b. The inputs are opto-isolated, with isolated grounds.
- 2. The phone shall be equipped with three auxiliary outputs, accessible from a removable terminal block.
 - a. The outputs are rated up to 120mA @ 120VAC/DC each.
 - b. The outputs are opto-isolated, with isolated grounds.

C. Network Interfaces

- 1. The phone shall be equipped with two 100baseTX Fast Ethernet ports, and shall support auto sensing of network speed.

2. The second Ethernet port is designated a LAN port, and serves as a pass-through switch-port for third-party devices.

2.06 POWER REQUIREMENTS

- A. The phone shall be powered by one of the following power sources:
 1. Power over Ethernet according to IEEE802.3af – Class 3.
 2. 12VDC, dedicated line-regulated power supply – Nominal: 500mA; Maximum: 800mA
 3. 24VDC, dedicated line-regulated power supply – Nominal: 300mA; Maximum: 500mA
 4. 24VAC, dedicated line-regulated power supply – Nominal: 300mA; Maximum: 500mA

2.07 ENVIRONMENTAL

- A. The phone shall:
 1. Operate in a temperature range of -40°F (-40°C) to + 131°F (+55°C).
 2. Operate in a humidity range up to 95% RH (non-condensing).

2.08 MANUFACTURED UNITS

- A. The phone shall be a Talkphone VOIP-600E-ES-Single button Emergency IP Call Station.
- B. The following ComNet part numbers are included as part of Model WEBS-MT/R-RSC-001. Please note that Talkphone will NOT be providing the SFP modules for the network switch side (i.e. not providing SFPs for the RSCCD's Brocade switch).
- C. ComNet P/N: CNFE2MCPOEM
- D. Description: 100Mbps Media Converter, Power over Ethernet, Small Size, 48V PoE, Conformal Coated Printed Circuit Board Included
- E. ComNet P/N: PS-AMR3-24
- F. Description: 24VDC 36Watt (1.5A) DIN Rail High Temp Power Supply (-40°C to +71°C With -40°C Start-Up)
- G. ComNet P/N: SFP-2
- H. Description: 100fx, 1310nm, 2km, LC, 2 Fiber, MSA Compliant

PART 3 – EXECUTION

3.01 INSTALLATION

- A. The installer shall carefully follow instructions in documentation provided by the manufacturer to ensure all steps have been taken to provide a reliable, easy-to-operate system.
- B. All equipment shall be tested and configured in accordance with instructions provided by the manufacturer prior to installation.
- C. All firmware found in products shall be the latest and most up-to-date provided by the manufacturer.
- D. All equipment requiring users to log on using a password shall be configured with user/site-specific password(s). No system/product default passwords shall be allowed.

END OF SECTION 27 32 26

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SECTION 274116 – AUDIO / VIDEO SYSTEM

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. Division 27 & 28 basic materials and methods sections apply to work specified in this section.
- C. Refer to specification 271000 for category cable specifications for color requirements. Category cables used for transporting video, audio and controls simultaneously from transmitters to receivers and/or switchers, shall follow manufacturers recommend cabling specifications, refer to manufacturer for requirements.
- D. Refer to Board Resolution No. 18-17 for all District audiovisual standards (i.e. Extron). No substitutions allowed.

1.2 ADMINISTRATIVE REQUIREMENTS:

- A. Coordination:
 - 1. Coordinate final inspection of the systems installed, with engineer, three (3) weeks in advance.
 - 2. Obtain GANTT chart for construction time frame.

1.3 DESCRIPTION OF WORK:

- A. This specification shall be used as a guide line for the typical AV systems for conference/meeting rooms, common areas, Bookstore, the Coffee/Juice Bar, The Spot, and DSPTS J108 and J108-1. The AV contractor shall be responsible for the design, engineering and provision for completely operational, integrated systems according to the functional descriptions prescribed within this document. Any and all incidental components or piece parts not specifically called out in this document, but required for the function of the audiovisual system, shall be provided by the design-build integrator without additional cost to the Owner. Delivery of the work described in this document shall include, but not be limited to, the following areas:
- B. Conference/Meeting Rooms J104 & J109
 - 1. The purpose of this system is to display from a laptop computer at the table, or a variety of audio visual sources in the rack to a wall-mounted, ultra short-throw projector. To eliminate the need for multiple remotes, the system shall be operated via a simple control panel.
 - a. Video System
 - i. The AV contractor shall furnish and install a wall-mounted ultra short-

throw projector above a rigid, 100" diagonal wall-mounted screen surface that shall double as a whiteboard.

- ii. The AV contractor shall furnish and install AV over CAT6 transmitters and receivers as required.
- iii. Portable devices such as laptop computers and document cameras shall be connected to the system via HDMI or VGA (with audio) connections at the table. There shall be two (2) Cable Cubbies for such connections located over table legs to hide the necessary cable service loops under the table.
- iv. The AV contractor shall install an owner-furnished (OFE) Blu-ray player in the rack.
- v. A motorized pan/tilt/zoom (PTZ) USB camera shall be mounted on the wall next to the projection screen. It shall be connected to the in-room PC (OFOI) for use with software-based conferencing platforms such as Zoom, Skype, WebEx, BlueJeans, etc.

b. Audio System

- i. Audio shall be reproduced from ceiling-recessed speakers driven from an amplifier in the rack.
- ii. A flush-mounted ceiling mic array shall be integrated into the in-room PC (OFOI) for use with software-based conferencing platforms such as Zoom, Skype, WebEx, BlueJeans, etc.
- iii. An RF-based portable Assistive Listening System (ALS) with one (1) headworn transmitter and seven (7) receivers/headsets shall be provided and installed by the AV Contractor. This system shall be provided in a carrying case and be shared among all spaces in the building.
 - I. General – Assistive listening systems required in assembly areas, *conference and meeting rooms* shall comply with Section 11B-706.
 - II. Receiver jacks – Receivers required for use with an assistive listening system shall include a 1/8 inch (3.2mm) standard mono jack.
 - III. Receiver hearing-aid compatibility – Receivers required to be hearing-aid compatible shall interface with telecoils in hearing aids through the provision of neckloops.
 - IV. Sound pressure level – Assistive listening systems shall be capable of providing a sound pressure level of 110 dB minimum and 118 dB maximum with a dynamic range on the volume control of 50 dB.
 - V. Signal-to-noise ratio – The signal-to-noise ratio for internally

generated noise in assistive listening systems shall be 18 dB minimum.

- VI. Peak clipping level – Peak clipping shall not exceed 18 dB of clipping relative to the peaks of speech.

c. Control System

- i. The control system shall be the Utelogy software-based control system (OFOI). The control system shall control the room volume level, microphone level, transport controls, channel selection, and source selection.
- ii. The primary control panel for the room shall be an iPad running the Utelogy GUI. The iPad shall be housed and charged in a wall-mounted docking station “CP1”, as per the LV drawing set.
- iii. The backup control interface shall be an OFE rack-mounted PC with monitor, located in the millwork cabinet. The PC shall have dual HDMI outputs; one (1) for the local monitor and one (1) for connecting to the room display via the AV switcher.

d. Equipment Rack

- i. All AV processing and source equipment shall be securely rack mounted inside the full-height millwork cabinet (OFOI).

C. Divisible Conference Room J219 (Zones 1, 2, 3 & 4)

1. The purpose of this room is to operate as either two (2), three (3), or four (4) separate rooms, or one (1) large room, depending on the position of the operable walls separating them.

a. Video System

- i. The AV contractor shall furnish and install a wall-mounted 82” flat panel display on articulating arm in the three (3) smaller conference rooms (J219-1, J219-2, & J219-3). Room J219-3 shall also have an 87” x 139” (164” diagonal, 16:10 aspect ratio) motorized screen at the South Wall. The large conference room, J219-4, shall receive a large-format 110”x176” (208” diagonal, 16:10 aspect ratio) motorized screen at the East wall and an 87” x 139” (164” diagonal, 16:10 aspect ratio) motorized screen at the South wall. Only one screen shall be used depending on room orientation. Each screen shall have its own ceiling-mounted projector.
- ii. The AV contractor shall furnish and install video over CAT6 transmitters and receivers as required.
- iii. Since tables are moveable, portable devices such as laptop computers and document cameras shall be connected to the system via HDMI or VGA (with audio) connections on the floor boxes. For convenience, these connections shall be integrated into the OFE tables via four (4)

Extron 1200 Series Cable Cubbies. Wireless AV connectivity shall also be available. Rooms J219-3 and J219-4 have two (2) floor boxes the connections for the DTP transmitter for different room set-ups.

- iv. The AV contractor shall install an OFE rack-mounted Blu-ray player in each of the four (4) rooms.
- v. The AV contractor shall install an OFCI HDTV Tuner to receive local TV channels. Tuner box and channel package shall be provided by RSCCD.
- vi. RSCCD shall provide a small form factor networked PC to be installed in the AV Equipment Rack by the AV contractor.

b. Audio System

- i. Audio shall be played back via a distributed, mono 70V speaker system in the ceiling.
- ii. Wireless mics, both handheld and lapel, shall be integrated into the audio-visual system for rooms that require video conferencing. Due to its size, room J219-4 shall also require mic reinforcement through the ceiling speakers (in addition to being routed to the far side in conferencing applications). The AVC shall be responsible for determining the Group and Frequency for the wireless microphone system.
- iii. An RF-based portable Assistive Listening System (ALS) with one (1) headworn transmitter and seven (7) receivers/headsets shall be provided and installed by the AV Contractor. This system shall be provided in a carrying case and be shared among all spaces in the building.
 - I. General – Assistive listening systems required in assembly areas, *conference and meeting rooms* shall comply with Section 11B-706.
 - II. Receiver jacks – Receivers required for use with an assistive listening system shall include a 1/8 inch (3.2mm) standard mono jack.
 - III. Receiver hearing-aid compatibility – Receivers required to be hearing-aid compatible shall interface with telecoils in hearing aids through the provision of neckloops.
 - IV. Sound pressure level – Assistive listening systems shall be capable of providing a sound pressure level of 110 dB minimum and 118 dB maximum with a dynamic range on the volume control of 50 dB.
 - V. Signal-to-noise ratio – The signal-to-noise ratio for internally generated noise in assistive listening systems shall be 18 dB minimum.

VI. Peak clipping level – Peak clipping shall not exceed 18 dB of clipping relative to the peaks of speech.

c. Control System

- i. The control system shall be the Utology software-based control system (OFOI). The control system shall control the room volume level, microphone level, transport controls, channel selection, and source selection.
- ii. The primary control panel for the room shall be an iPad running the Utology GUI. The iPad shall be housed and charged in a wall-mounted docking station “CP1”, as per the LV drawing set.
- iii. The backup control interface shall be an OFE rack-mounted PC with monitor, located in the millwork cabinet. The PC shall have dual HDMI outputs; one (1) for the local monitor and one (1) for connecting to the room display via the AV switcher.

d. Equipment Rack

- i. All AV processing and source equipment related to the three (3) “Breakout Rooms” J219-1, J219-2 & J219-3 shall be securely rack mounted in a 16 RU rack inside a wall niche at the front of each room.
- ii. All AV processing and source equipment not specific to the three (3) “Breakout Rooms” mentioned above shall be securely rack mounted in a 25 RU rack inside a wall niche in J219-4.

D. Common Areas

1. The purpose of flat panels in these locations is to display either informational videos to those walking down the hallways, or to serve as digital signage.
 - a. Informational Displays (FP): All flat panels showing informational videos in hallway areas shall be 55”. AV contractor shall provide and install both the displays and digital signage players (if separate from display), following any applicable RSCCD standards.
 - b. Digital Signage (DS): These flat panels shall be 43” and oriented in portrait mode. The AV contractor shall provide and install these displays, as well as any digital signage software required by the District.

E. Campus Store

1. The purpose in the Bookstore is to display important/promotional information to shoppers near checkout counters, and to fill the store with background music. AV contractor shall provide and install all displays and digital signage units, as required, following any applicable RSCCD standards.
 - a. Video System
 - i. One (1) 65” display on the wall behind the main checkout (i.e. Cashier) counter.

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- ii. One (1) 65” display on the wall behind the Customer Service (i.e. Buyback, Refunds) counter.
 - b. Audio System
 - i. AV contractor shall furnish and install a distributed sound system throughout the Bookstore (J117) and Grab-N-Go area (J116) for background music.
 - ii. Music source shall consist of a centralized music player and amplifier in BDF room.
 - c. Control System
 - i. On/off shall be controlled via the handheld remote provided with the displays.
 - ii. Audio volume shall be controlled via a wall-mounted knob accessible only to staff.
- F. Coffee/Juice Bar (J118)
 - 1. The purpose in the Coffee/Juice Bar is to provide a digital menu board as well as an informational/promotional display.
 - a. Video System
 - i. AV contractor shall furnish and install three (3) 43” flat panel displays behind the checkout counter to serve as a digital menu board.
 - ii. AV contractor shall furnish and install one (1) 43” display, pole mounted from the ceiling, in the Northeast corner of the room. It shall be used for informational/promotional videos.
 - iii. Content for the above displays shall be provided by others.
 - b. Audio System
 - i. The menu displays will not utilize sound.
 - ii. Sound from the informational display shall come from built-in stereo speakers.
 - c. Control System
 - i. On/off and volume control (where applicable) of all displays shall be accomplished via the handheld remote provided with those displays.
- G. The Spot (J101)
 - 1. The purpose of this student gathering area is for recreation and entertainment.
 - a. Main Screen
 - i. The AV contractor shall furnish and install a ceiling-mounted projector along with a 58”x104” (119” diagonal, 16:9 aspect ratio) motorized screen.

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- ii. The AV contractor shall furnish and install a Blu-ray player (OFCI) in the credenza.
 - iii. The AV contractor shall install an OFCI HDTV Tuner to receive local TV channels. Tuner box and channel package shall be provided by RSCCD.
 - iv. All video sources available for viewing on the above projection system shall be located in a small AV rack under the Reception Desk at the back of the room.
 - v. Audio shall be played back via a distributed, mono 70V speaker system in the ceiling.
 - vi. There shall be a wireless microphone combo system for use with the presentation system using the ceiling projector and screen.
 - vii. The control system shall be the Utelogy software-based control system (OFOI). The control system shall control the room volume level, microphone level, transport controls, channel selection, and source selection.
 - viii. The primary control panel for the room shall be an iPad running the Utelogy GUI. The iPad shall be housed and charged in a wall-mounted docking station "CP1", as per the LV drawing set.
 - ix. The backup control interface shall be an OFE rack-mounted PC with monitor, located in the millwork cabinet. The PC shall have dual HDMI outputs; one (1) for the local monitor and one (1) for connecting to the room display via the AV switcher.
 - x. The control system shall be Utelogy software base control system on a local OFE PC. The control system shall control the room volume level, microphone level, transport controls, channel selection, and source selection shall be accomplished via the dashboard on the iPad at the Reception Desk.
- b. Video Game Displays
- i. The AV contractor shall furnish one (1) 46" flat panel display on each of two (2) equipment credenzas, one (1) on the West wall and one (1) on the East wall.
 - ii. The displays shall not be mounted, but shall instead sit on the credenzas using the included stand.
 - iii. Each video game console (Xbox, PS4, etc.) shall be OFOI and connect directly to its display for both video and audio.
 - iv. On/off and volume control shall be accomplished via the handheld remote included with the display.
 - v. These displays, and any connected sources, shall be locally-controlled with the display's included IR remote. They shall not be integrated into

the overall Utelogy control for the room.

c. Informational Display

- i. The AV contractor shall furnish one (1) 65" flat panel display on the wall behind the Reception Desk. The purpose shall be as an informational display only.
- ii. No audio shall come from this display.
- iii. On/off control shall be accomplished via the handheld remote included with the display.

2. All control processors, and controllers are to be on an un-switched power connection.
3. All cabling shall be installed in a minimum of 1" conduit to accessible ceiling space unless otherwise noted. Provide conduit to accessible ceiling space and then utilize non- continuous open top cable supports every 5'.

H. S.S.S.P. & Upward Bound (J209)

1. The purpose of this system is to display from a laptop computer at the table, or a variety of audio visual sources in the rack to a wall-mounted, ultra short-throw projector. To eliminate the need for multiple remotes, the system shall be operated via a simple control panel.

a. Video System

- i. The AV contractor shall furnish and install a wall-mounted ultra short-throw projector above a rigid, 100" diagonal wall-mounted screen surface that shall double as a whiteboard. The projector shall support both touch and pen for annotation.
- ii. The AV contractor shall furnish and install AV over CAT6 transmitters and receivers as required.
- iii. Portable devices such as laptop computers and document cameras shall be connected to the system via HDMI or VGA (with audio) connections at the instructor's station. There shall be one (1) Cable Cubby for such connections located in the instructor's station, and the millwork contractor providing it shall be responsible for cutting the necessary opening on-site (using a metal routing template provided by the AVC).
- iv. The AVC shall install an owner-furnished (OFE) Blu-ray player in the rack.

b. Audio System

- i. Audio shall be reproduced from ceiling-recessed speakers driven from an amplifier in the rack.
- ii. An RF-based portable Assistive Listening System (ALS) with one (1) headworn transmitter and seven (7) receivers/headsets shall be provided and installed by the AV Contractor. This system shall be provided in a carrying case and be shared among all spaces in the

building.

- I. General – Assistive listening systems required in assembly areas, *conference and meeting rooms* shall comply with Section 11B-706.
- II. Receiver jacks – Receivers required for use with an assistive listening system shall include a 1/8 inch (3.2mm) standard mono jack.
- III. Receiver hearing-aid compatibility – Receivers required to be hearing-aid compatible shall interface with telecoils in hearing aids through the provision of neckloops.
- IV. Sound pressure level – Assistive listening systems shall be capable of providing a sound pressure level of 110 dB minimum and 118 dB maximum with a dynamic range on the volume control of 50 dB.
- V. Signal-to-noise ratio – The signal-to-noise ratio for internally generated noise in assistive listening systems shall be 18 dB minimum.
- VI. Peak clipping level – Peak clipping shall not exceed 18 dB of clipping relative to the peaks of speech.

c. Control System

- i. The control system shall be the Utelogy software-based control system (OFOI). The control system shall control the room volume level, microphone level, transport controls, channel selection, and source selection.
- ii. The primary control panel for the room shall be an iPad running the Utelogy GUI. The iPad shall be housed and charged in a wall-mounted docking station “CP1”, as per the LV drawing set.
- iii. The backup control interface shall be an OFE rack-mounted PC with monitor, located in the millwork cabinet. The PC shall have dual HDMI outputs; one (1) for the local monitor and one (1) for connecting to the room display via the AV switcher.

d. Equipment Rack

- i. All AV processing and source equipment shall be securely rack mounted inside the full-height millwork cabinet (OFOI).
- ii. The millwork cabinet shall have proper natural air ventilation (intake at the toe kick and exhaust at the top rear) to maximize lifespan of equipment therein.

1.4 QUALITY ASSURANCE:

A. Manufacturers:

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1. Firms regularly engaged in manufacture of audio visual systems, components, and accessories, of types, capacities and characteristics required, whose products have been in satisfactory use in similar service for not less than 5 years.
 - B. AV Contractor:
 1. AV Contractor shall have worked satisfactorily for a minimum of (5) years of completing systems equal to this scope, quality, type and complexity.
 2. Key personal assigned to the project shall each have minimum of (10) years of experience in completing systems equal to this scope, quality, type and complexity.
 3. The AV contractor shall be the factory authorized distributor for the geographical area and shall maintain complete installation and service facilities during the construction of this project.
 4. Shall have current manufacture certificates for each equipment and/or system listed within this specification.
 - C. Contractor must follow the standards described with-in:
 1. BICSI/INFOCOMM AV Design Reference manual
 2. ANSI/INFOCOMM 2M-2010 Standard guide for Audiovisual Systems Design and Coordination Processes
 3. ANSI/INFOCOMM 10:2013 Audiovisual Systems Performance Verification Guide
 - D. All work shall be done by expert technicians qualified in the field with knowledge of systems and detailed requirements for fine-tuned performance. Workmanship shall comply with standard professional practice concerning grounding, shielding, cable dressing, cable termination and equipment mounting. All mounting holes shall be utilized for any equipment.
- 1.5 SUBMITTALS:
- A. All submittals shall be submitted in a digital format with bookmarks for each section of equipment. Any submittals that are partial or incomplete shall be rejected and count as one of the submittals allowance.
 - B. Provide a complete bill of materials for all components, accessories and hardware to be provided in order to assemble a complete and working system as described within the contract documents. Provide an itemized list of all equipment to be supplied.
 - C. Submit manufacturer's data and installation details for all devices, plates, cables and similar equipment. Product data showing multiple options, products and/or models shall be clearly marked identifying the specific options, products and/or models being provided.
 - D. Submit all manufacture training, 3rd party and/or organization certificates for each equipment and/or system required for the implementation of this specification
- 1.6 WARRANTY:
- A. Systems shall be guaranteed for a period of two (2) years from the date of substantial completion against defective materials, inferior workmanship or improper installation adjustment. Guarantee shall cover all parts and labor.

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- B. If system failure causes audiovisual system to be inoperative or unusable for its intended purpose, contractor, when notified of the problem shall repair system so it will be operational and usable within three (3) business days. If defective components cannot be repaired in time, provide temporary equipment as required.
- C. Contractor shall supply two (2) year warranty on all programming of each system, where within this time period the owner can make changes. During this time the programs shall be password protected, at any time during the two (2) year the owner can terminate the warranty and request the programming of each system. At this time the programs are to be turned over to the owner and all passwords are to be removed. The owner shall own all rights to the programming after this time, to be used in this facility.
- D. Contractor shall honor component warranties for term established by manufacturer, if greater than warranty time frame mentioned above.

PART 2 – PRODUCTS

2.1 GENERAL:

- A. All equipment shall be installed as shown on the drawings and in strict accordance with the specifications. Any errors, conflicts, or omissions discovered in the specifications or the drawings shall be submitted in writing to the engineer for clarification. Construction shall not proceed until questions have been resolved.
- B. All equipment shall be new and of current model.
 - 1. Should model numbers used in this specification be retired, provide the manufacturer's updated model type and note in submittal the discrepancy.
- C. Provide a power Sequencer for powering down any AV equipment, follow proper powering down procedures for all equipment requiring power.
- D. All limiters and/or compressors shall be set to prevent operators from over and/or under-adjusting sound levels.
- E. System shall be capable of reproducing voice, audio and video from inputs to Loudspeakers, and displays as required. Provide appropriate cables for a complete and working system.
- F. System shall have no hum, noise, RFI pick up or distortion shall be audible when operating under normal conditions. Shall reproduce material at a level of (80 to 85) dBA without audible distortion. All input levels shall be pre-set so system may be operated without going into feedback under normal conditions.
- G. Audio and Video signals shall be transmitted on Category cable with appropriate extenders, when transmission may pick up noise, or exceed normal lengths. Provide required extenders as necessary.
- H. Refer to riser diagrams and plans for device and equipment locations.
- I. Basis of Design. Provide equipment as specified in section 2.2 and 2.4 for the various audio-visual systems. Pre-approved manufacturers of audio-visual equipment are as follows:

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1. All user interface control devices such as Touch panels and keypads, shall only be approved equipment specified within this specification.
 2. Engineer has final say if equipment is equal or better than the specified equipment. Bidders wishing to provide equipment other than the equipment specified shall submit proposed substitute equipment to Engineer (5) working days prior to submitting their bid. Submittals for prior approval shall include description of equipment, design intent, complete riser diagrams for proposed equipment, equipment specifications, cut sheets of proposed equipment, reason for alternate equipment and Engineer may request physical equipment to test and demo. Acceptance of proposed equipment by Engineer shall not relieve Contractor from responsibility to provide audio-visual systems equal to those specified in this Section. Contractor shall be ultimately responsible for providing complete and working audio-visual systems that function, control and operate in the same manner as the specified equipment
 3. Equipment submitted in Bid proposal that have not been approved by Engineer in writing shall not be accepted and shall be replaced by approved equipment at contractor's expense. Equipment not listed within this specification, or contract documents that is required for a complete and workings system, shall be of professional grade and used in the same manner as needed for a complete and working system.
- J. Master quotes do not relieve contractor from performing their due diligence for equipment type, quantity, and quantity of room types. Any errors, conflicts, or omissions between the drawings and/or specifications and master quotes shall be the responsibility of the contractor to resolve. Master quotes may not have all the equipment to provide a complete and working system, contract shall be responsible to verify that everything is in their bid for a complete and working system prior to submitting their bid.

2.2 GENERAL EQUIPMENT REQUIREMENTS:

- A. All AV equipment within furniture or millwork shall have appropriate in-furniture racks provided by the AV contractor. Coordinate with architectural drawings and specifications for credenza/furniture provided.
- B. Rack equipment:
 1. All AV racks within this specification shall have the following accessories and/or features, depending on the model of the rack, ether rack mountable or built into the rack.
 - a. Surge protection for all devices located within the rack.
 - b. Cable management.
 - c. Power strips
 - d. Power Sequencers for powering on/off equipment.

2.3 CABLING

- A. Cable as specified is manufactured by Gepco, where equals of West Penn and Belden are

acceptable. Cables are to be labeled within 6" from both ends with the source and destination clearly legible.

- B. Cables shall be grouped according to their signal type, grouped cables shall be Velcroed together, and NO zip ties shall be used.
- C. Cables shall not receive excessive force when being installed.
- D. Cables that have been damaged during installation shall be replaced at contractor's expense. Contractor shall verify that all connections are in proper working order, terminated correctly and provide documentation to engineer prior to final walk through.
- E. Cables listed below may or may not be plenum rated, it shall be the responsibility of the contractor to determine if plenum rated cable is required. The AHJ shall have the final say if plenum cable is required, and replacement of cabling shall be at no cost to the owner.

2.4 EQUIPMENT REQUIRED PER ROOM TYPE

See "EXHIBIT B – MAJOR EQUIPMENT LIST"

PART 3 – EXECUTION

3.1 INSTALLATION OF AUDIO/VISUAL SYSTEMS:

- A. Install Audio-Visual systems and ancillary equipment as indicated on drawings and in accordance with equipment manufacturer's written instructions, and the NEC, and with recognized industry practices, to ensure that the system fulfill requirements.
- B. Coordinate with other work, including raceways, electrical boxes and fittings work, as necessary to interface installation of Audio-Visual systems with other work.
- C. Use extreme care in handling, fishing and pulling of electronic cable to avoid damage to cable. Avoid excessive number of bends. Contractor is responsible for replacing cable that has been mishandled or suffers from poor performance due to installation. Cables shall not be spliced, specified junction boxes, conduit, cabling, pull strings, loudspeaker enclosures and equipment cabinets are properly installed and labeled with labeling requirements previously mentioned.
- D. Contractor shall ensure that no solid or decorative structure shall impeded audio broadcast from loudspeakers and that no structure greater than 3/4 inch is permanently placed in front of the loudspeakers.
- E. Firmly secure all equipment in place that is not intended for portability.
- F. Mount permanently and/or provide mechanical index insuring precise alignment of the projected image of optical projectors.
- G. Provide adequate structural support for components. Provide fastenings and supports with a safety load factor of at least five.

3.2 FIELD QUALITY CONTROL:

A. TESTING:

1. Upon completion of installation of each system and after electrical circuitry has been energized, demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units on site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with testing.
2. Before inspection by owner and engineer, and after completion of the installation, conduct system tests and make necessary corrections for proper system operation including, but not limited:
 - a. Test for compliance with the functional requirements and performance standards.
 - b. Adjust, balance and align equipment for optimum quality and to meet the manufacturer's published specifications.
 - c. Prepare and maintain documentation of performance tests, including numerical values of established equipment settings, for reference during the system acceptance tests. Submit final results to owner and Engineer.
 - d. Prepare and maintain documentation of performance tests, including numerical values of established equipment settings, for reference during the System Acceptance Tests. Submit final results to owner and Engineer.
 - e. Test signal: Establish a nominal test signal level to be input to the speech and program sound systems. Record preliminary signal level.
 - f. Loudspeaker-Line Impedance: Measure at 250 Hz, 1 kHz, and 4 kHz the impedance and resistance of each loudspeaker line leaving the sound equipment rack with the line disconnected from its normal driving source.
 - g. Measure the hum and noise levels of the overall system for each microphone input channel and line-level input channel.
 - h. Adjust gain controls for optimum signal-to-noise with 0 dBu at a line-level input.
 - i. Provide uniformity coverage of ± 2 dBA, measure octave band of pink noise test signal, at 1, 2, and 4 kHz, played through loudspeaker system.
 - j. Perform polarity checks of loudspeaker lines by means of a polarity tester or use DC source at one end of each line and a voltmeter at the other end. Loudspeaker lines shall be identically polarized with respect to color coding.
 - k. Loose parts and poor workmanship or soldering shall be replaced.
 - l. Sweep Loudspeaker systems with high-level sine wave or 1/3 octave pink noise source. Correct causes of buzzes or rattles related to Loudspeakers or enclosures. Notify owner of external causes of buzzes or rattles.
3. Rough Balance: Balance system well enough that it can be tested before final inspection.

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B. RECORD DRAWINGS:

1. Provide a complete set of “as built” drawings showing wiring, specific interconnections between all equipment and internal wiring of equipment

3.3 OPERATING AND MAINTENANCE MANNUALS:

- A. Operating and maintenance manuals shall be submitted prior to testing of system. Total of (2) manuals, shall be delivered to the Company. Manuals shall include all model numbers, service, installation, and programming information.

3.4 TRAINING:

- A. Provide one (1) session of one (1) hour of training on the operation of the eight (8) room types listed below, at job site, at no cost to owner.
1. Meeting Rooms J104 & J109
 2. Conference Center J219
 3. Digital Signage software
 4. Campus Store
 5. Coffee/Juice Bar (J107-1)
 6. The Spot (J101)
 7. Open Computer Lab (J108-1)
 8. S.S.S.P. & Upward Bound (J209)
- B. Training shall be recorded and provided online to the owner using a private hyperlink. The video(s) shall be downloadable from that link into a common file type readable by Windows Media Player (mp4, mov, etc.) for the owner to redistribute/repost as necessary.
- C. The second training shall take place within a month of the first training to answer any questions that have developed after initial use of the systems.

END OF SECTION 274116

	PlanNet Consulting Confidential	C	8/1/2018	D	E Page 1
1	Exhibit B - MAJOR EQUIPMENT AND APPROVED			Version/Date:	8/1/2018
2	MANUFACTURERS LIST				
3					
4	MEETING-CONF. ROOM				
5					
6	OFE/ OFCI?	Qty	Description	Brand	Model #
7	Meeting Rm. - [J104 & J109]				
8	Displays/Screens				
9	PRJ1	1	BrightLink Pro 1460Ui Short-Throw WUXGA Interactive Projector @ 4,400 lumens (w/ wall mount)	Epson	V11H726520W
10		1	100" diagonal whiteboard projection screen, thin frame, full-length marker tray	Da-Lite	25940T
11					
12	Video Systems				
13	CC1	2	Cable Cubby 1200	Extron	70-1037-02
14		2	(2) AC & (2) USB Charging Outlets	Extron	60-1697-01
15		2	Cable Retraction System, HDMI	Extron	70-1065-04
16		2	Cable Retraction System, VGA w/ Audio	Extron	70-1065-11
17		2	Cable Retraction System, Network	Extron	70-1065-03
18		1	Installation Routing Template for Cable Cubby 1200	Extron	70-1041-80
19	TX1	2	DTP T DSW 4K 233; 3-Input Switcher & DTP 4K Transmitter	Extron	60-1487-12
20	RX1	1	DTP HDMI 4K 230 Rx	Extron	60-1271-13
21	SW1	1	IN1608xi; 8-Input Scaling Presentation Switcher, HDCP compliant	Extron	60-1238-81
22	DVD1	1	*OFE* Blu-ray Player	TBD	TBD
25	CAM1	1	USB PTZ camera	Logitech	PTZ Pro
26		1	Extension system for Logitech PTZ Pro	TBD	TBD
27	PC1	1	*OFE* In-room PC w/ keyboard & mouse	TBD	TBD
28	WPG1	1	ShareLink 250, Wireless Presentation Gateway w/ built-in WAP	Extron	60-1558-01
29					
30	Audio				
31	DSP1	1	12 x 8 microphone mixer/DSP w/ USB, VoIP, & Dante	Biamp	TesiraFORTE DAN VT
32	S1	4	4.5" Low Profile Ceiling Speaker	QSC	AD-C4T-LP
33	MIC1	1	Ceiling Array Microphone	Shure	MXA910
34	AMP1	1	XPA 2001, 70V Mono Amplifier	Extron	60-850-01
35	ALS1	0	IR-based Assistive Listening Transmitter/Radiator, 2-receiver kit	Listen	LS-91-01
	ALS1	1	*PRICE REFLECTED IN CONF. CTR. 219* RF-based Portable Assistive Listening Kit (includes bodypack transmitter w/ headworn mic, (7) bodypack receivers w/ hearing aid-compatible ear speakers)	Listen	LS-06-072
36					
37					
38	Control System				
39	DOC1	1	Secure wall docking station for iPad	TBD	TBD
40	TP1	1	10" (approx.) iPad	Apple	TBD
41	CI1	1	IP-to-IR Adapter, PoE powered	Global Cache	IP2IR-P
42	CI2	1	IP-to-Serial Adapter, PoE powered	Global Cache	IP2SL-P
43	NSW1	1	8-port PoE Gigabit switch	Netgear	GS608PP
44					
45	Other/Miscellaneous				
46	RCK1	1	Rolling Rack with wood top and plexi door	Middle Atlantic	PTRK-2126MDK
47		1	Keyboard sliding shelf w/ flip-up 16" 1080p LCD monitor & HDMI input	Vertiv (formerly Avocent)	TBD
48		1	Miscellaneous Cables, connectors and materials	TBD	TBD

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1	Exhibit B - MAJOR EQUIPMENT AND APPROVED			Version/Date:	8/1/2018
2	MANUFACTURERS LIST			PlanNet Consulting	
3					
4	CONFERENCE CENTER J219				
5					
6	OFE/ OFCI?	Qty	Description	Brand	Model #
7	Divisible Conf. Ctr. J219 - [J219-1, J219-2, J219-3, J219-4]				
8	Displays/Screens				
9	DISP1-1	3	82" TV LED 4K display (219-1, 219-2 & 219-3)	Samsung	UN82MU8000
10		3	Articulating Thin wall mount w/ interface bracket	Chief	PNRIWUB
11		3	In-Wall Back Box - Provided & installed by others	Chief	PAC501B
12	PRJ1	3	Laser Projector (6,000 lumen) 4K enhanced, HDBaseT input	Epson	Pro L1100U
13		3	RPA Elite Series Projector Mount (including mounting hardware)	Chief	RPMAU
14	SCN1	1	Tensioned Large Advantage Electrol Screen, 110"x176" (208" diag.)	Da-Lite	70243L
15	SCN2	2	Tensioned Contour Electrol Screen, High-Contrast Matte White, 87"x139" (164" diag.)	Da-Lite	37613L
16					
17	Video Systems				
18	CC1	4	Cable Cubby 1200	Extron	70-1037-02
19		4	(2) AC & (2) USB Charging Outlets	Extron	60-1697-01
20		4	Cable Retraction System, HDMI	Extron	70-1065-04
21		4	Cable Retraction System, VGA w/ Audio	Extron	70-1065-11
22		4	Cable Retraction System, Network	Extron	70-1065-03
23	TX1	4	DTP T DSW 4K 233; 3-Input Switcher & DTP 4K	Extron	60-1487-12
24	TX2	1	DTP HDMI 4K 230 Tx (J219-3 82" display)	Extron	60-1271-12
25	RX1	3	DTP HDMI 4K 230 Rx (82" displays)	Extron	60-1271-13
26	SW1	4	IN1608xi; 8-Input Scaling Presentation Switcher, HDCP compliant	Extron	60-1238-81
27	WPG1	4	ShareLink 250, Wireless Presentation Gateway w/ built-in WAP	Extron	60-1558-01
28		4	*OFE* Blu-ray Player	Sony/Samsung	TBD
29		4	*OFE* Cable/Satellite Tuner	OFCI	TBD
30		4	*OFE* Small Form Factor PC	OFCI	TBD
31					
32					
33	Audio				
34	SPK1	12	4.5" Low Profile Ceiling Speaker	QSC	AD-C4T-LP
35	AMP2	2	4-Channel Energy Star Rated Amplifier	QSC	SPA4-100
36	DSP1	2	12 x 8 microphone mixer/DSP w/ USB, VoIP, & Dante	Biamp	TesiraFORTE DAN VT
37	MIC2	3	Ceiling Mics (Zones 1, 2, 3)	Audix	M3
38	WMIC1	1	Wireless Combo System w/ Handheld & Lav (Zone 4)	Shure	GLXD124R/85
39	ALS2	0	IR-based Assistive Listening Transmitter/Radiator, 4-receiver kit	Listen	LS-92-01
40	ALS1	1	RF-based Portable Assistive Listening Kit (includes bodypack transmitter w/ headworn mic, (7) bodypack receivers w/ hearing aid-compatible ear speakers)	Listen	LS-06-072
41	MIX1	1	24-channel mixing console	Allen & Heath	ZED-24
42	RP1	1	1RU Custom Rack Panel	TBD	TBD
43					

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1	Exhibit B - MAJOR EQUIPMENT AND APPROVED			Version/Date:	8/1/2018
2	MANUFACTURERS LIST			PlanNet Consulting	
3					
4	CONFERENCE CENTER J219				
5					
6	OFE/ OFCI?	Qty	Description	Brand	Model #
44	Control System				
45	TP1	4	iPad based Control System w/ Wall Docking Station	Apple/Utology through WAPs	TBD
46	NSW2	1	16-port PoE Gigabit switch (J219-4)	Netgear	JGS516PE
47	NSW1	3	8-port PoE Gigabit switch (J219-1/2/3)	Netgear	GS608PP
48	CI1	8	IP-to-IR Adapter, PoE powered	Global Cache	IP2IR-P
49	CI2	2	IP-to-RELAY Adapter, PoE powered (1 - RM 219-3, 1 - RM 219-4)	Global Cache	IP2CC-P
50	CI3	3	IP-to-Serial Adapter, PoE powered (projectors)	Global Cache	IP2SL-P
51					
52	Other/Miscellaneous				
53		1	25RU Full-Size Rack, 27" Depth (w/o rear door)	Middle Atlantic	BGR-25SA27MDK-EA
54		1	Caster Base	Middle Atlantic	CBS-BGR
55		1	Lacing Bar Accessory Kit	Middle Atlantic	LL-MP21
56		1	Keyboard sliding shelf w/ flip-up 16" 1080p LCD monitor & HDMI input	Vertiv (formerly Avocent)	TBD
57		1	2RU Drawer	Middle Atlantic	D2LK
58		3	16RU Low-Profile Furniture Rack Frame, 18" Depth	Middle Atlantic	CFR-16-18
59		3	Runner Kit, 18"D	Middle Atlantic	5-RS18
60		3	Horizontal Power Strip	Middle Atlantic	PD-915R-SP
61		2	Horizontal Lacing Bars, L-Shaped (10-pack)	Middle Atlantic	LBP-1A
62		3	Keyboard sliding shelf w/ flip-up 16" 1080p LCD monitor & HDMI input	Vertiv (formerly Avocent)	TBD
63		1	Miscellaneous Cables, connectors and materials	TBD	TBD
64					

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1	Exhibit B - MAJOR EQUIPMENT AND APPROVED			Version/Date:	8/1/2018
2	MANUFACTURERS LIST			PlanNet Consulting	
3					
4	COMMON AREAS				
5					
6	OFE/ OFCI?	Qty	Description	Brand	Model #
7	Common Areas				
8	Displays/Screens				
9	DISP3-1	9	55" Info Displays (landscape orientation @ +72"AFF), on board chip media player	Samsung Pro	PM55F
10	DISP2-1	10	43" Digital Signage TVs (portrait orientation @ +66"AFF), on board chip media player	Samsung Pro	PM43F
11		9	Articulating Thin wall mount w/ interface bracket	Chief	TS525TU
12		10	Articulating Thin wall mount w/ interface bracket	Chief	TS325TU
13		19	In-Wall Storage Box (white)	Chief	PAC526FW
14					
15					
16	Video Systems				
17		2	HDMI cable & wall plate	TBD	TBD
18					
19					
20	Other/Miscellaneous				
21					
22		19	Miscellaneous Cables, connectors and materials	TBD	TBD
23					

1 **Exhibit B - MAJOR EQUIPMENT AND APPROVED**
 2 **MANUFACTURERS LIST**

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3
 4 **CAMPUS STORE**

5
 6 **OFE/ OFCI? Qty Description Brand Model #**

7 **Campus Store - [J106-1]**

8 **Displays/Screens**

9 DISP4-1 2 65" TV (@ Refund/Buyback Counters, 1 in millwork) Samsung QN65F
 10 2 Articulating Thin wall mount w/ interface bracket Chief TS525TU
 11 2 In-Wall Back Box - Provided & installed by others Chief PAC526
 12
 13

14 **Video Systems**

15 2 Digital Signage Player Samsung SBB-AQ7
 16
 17

18 **Audio**

19 S1 6 4.5" Low Profile Ceiling Speaker QSC AD-C4T-LP
 20 S2 2 4.5" Surface-Mount Speaker QSC AD-S4T
 21 AMP2 2 4-Channel Energy Star Rated Amplifier QSC SPA4-100
 22 VC1 1 100W Stainless Steel Volume Control Knob, 1-gang AtlasIED AT100
 23

24 **Other/Miscellaneous**

25 1 Miscellaneous Cables, connectors and materials TBD TBD
 26

1	Exhibit B - MAJOR EQUIPMENT AND APPROVED			Version/Date:	8/1/2018
2	MANUFACTURERS LIST			PlanNet Consulting	
3					
4	COFFEE - JUICE BAR				
5					
6	OFE/ OFCI?	Qty	Description	Brand	Model #
7	Coffee/Juice Bar - [J107-1]				
8			Displays/Screens		
9	DISP2-1	10	43" Digital Signage TVs (portrait orientation @ +66" AFF), on board chip media player	Samsung Pro	PM43F
10		1	Ceiling-Mounted Menu Board Mounting System	Chief	LCM3X1U
11		1	Ceiling-Mounted Display Mounting System	Chief	TBD
12		3	Medium size tilting wall mount	Chief	MTM1U
13					
14					
15					
16			Audio		
17	SPK1	1	4.5" Low Profile Ceiling Speaker	QSC	AD-C4T-LP
18					
19					
20			Other/Miscellaneous		
21		1	Miscellaneous Cables, connectors and materials	TBD	TBD
22					

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1	Exhibit B - MAJOR EQUIPMENT AND APPROVED			Version/Date:	8/1/2018
2	MANUFACTURERS LIST			PlanNet Consulting	
3					
4	THE SPOT				
5					
6	OFE/ OFCI?	Qty	Description	Brand	Model #
7	The Spot - [J101]				
8	Displays/Screens				
9	DISP3-1	1	65" TV (digital signage)	Samsung	QN65F
10	DISP4-1	2	46" TV (video game TVs)	Samsung	UH46FS
11		1	Articulating Thin wall mount w/ interface bracket (signage display)	Chief	TS525TU
12		1	In-Wall Back Box - Provided & installed by others (signage display)	Chief	PAC526
13		1	Laser Projector (6,000 lumen) 4K enhanced, HDBaseT input	Epson	Pro L1100U
14		1	RPA Elite Series Projector Mount (including mounting hardware)	Chief	RPM AU
15	SCRN3	1	Tensioned Contour Electrol Screen, High-Contrast Matte White, 87"x139" (164" diag.)	Da-Lite	37613L
16					
17	Video Systems				
18		2	*OFE* Video Game Console	OFCI	TBD
19		1	*OFE* Blu-ray Player	Sony/Samsung	TBD
20		1	*OFE* Cable/Satellite Tuner	OFCI	TBD
21		1	*OFE* Small Form Factor PC	OFCI	TBD
22		1	Digital Signage Player	TBD	TBD
23	SW1	1	IN1608xi; 8-Input Scaling Presentation Switcher, HDCP compliant	Extron	60-1238-81
24					
25	Audio				
32		6	4.5" Low Profile Ceiling Speaker	QSC	AD-C4T-LP
33	AMP3	1	2-Channel Energy Star Rated Amplifier	QSC	SPA2-60
34		1	Wireless Combo System w/ Handheld & Lav	Shure	GLXD124R/85
35	DSP1	1	12 x 8 microphone mixer/DSP w/ USB, VoIP, & Dante	Biamp	TesiraFORTE DAN VT
36	ALS1	0	IR-based Assistive Listening Transmitter/Radiator, 2-receiver kit	Listen	LS-91-01
	ALS1	1	*PRICE REFLECTED IN CONF. CTR. 219* RF-based Portable Assistive Listening Kit (includes bodypack transmitter w/ headworn mic, (7) bodypack receivers w/ hearing aid-compatible ear speakers)	Listen	LS-06-072
37					
38					
39	Control System				
44	TP1	1	iPad based Control System w/ Wall Docking Station	Apple	TBD
45	NSW1	1	8-port PoE Gigabit switch	NETGEAR	GS608NA
46	CI1	2	IP-to-IR Adapter, PoE powered	Global Cache	IP2IR-P
47	CI2	1	IP-to-RELAY Adapter, PoE powered (1 - RM 219-3, 1 - RM 219-4)	Global Cache	IP2CC-P
48	CI3	1	IP-to-Serial Adapter, PoE powered (projectors)	Global Cache	IP2SL-P
49					
50					
51	Other/Miscellaneous				
52		1	Small Equipment Rack with sliders	Middle Atlantic	CFR-12-16
53		1	Digital Signage Player	Samsung	SBB-AQ7
54		1	Miscellaneous Cables, connectors and materials	TBD	TBD
55					

1	Exhibit B - MAJOR EQUIPMENT AND APPROVED			Version/Date:	8/1/2018
2	MANUFACTURERS LIST			PlanNet Consulting	
3					
4	OFFICE				
5					
6	OFE/ OFCI?	Qty	Description	Brand	Model #
7	Office				
8	Displays/Screens				
16	DISP2-1	1	43" TV	Samsung Pro	PM43F
17		1	Articulating Thin wall mount w/ interface bracket	Chief	TS525TU
18		1	In-Wall Back Box - Provided & installed by others	Chief	PAC526
19					
20					
21	Other/Miscellaneous				
22		1	Miscellaneous Cables, connectors and materials	TBD	TBD
23					

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1	Exhibit B - MAJOR EQUIPMENT AND APPROVED			Version/Date:	8/1/2018
2	MANUFACTURERS LIST			PlanNet Consulting	
3					
4	TUTORING				
5					
6	OFE/ OFCI?	Qty	Description	Brand	Model #
7	Private Tutoring (3) - [J207-3, J207-4 & J207-5]				
8	Displays/Screens				
9	DISP2-1	1	43" TV (for Queuing Displays & Int'l Students Area)	Samsung Pro	PM43F
10		1	Articulating Thin wall mount w/ interface bracket	Chief	TS525TU
11		1	In-Wall Back Box - Provided & installed by others	Chief	PAC526
12					
13					
14	Other/Miscellaneous				
15		1	Miscellaneous Cables, connectors and materials	TBD	TBD
16					

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1	Exhibit B - MAJOR EQUIPMENT AND APPROVED			Version/Date:	8/1/2018
2	MANUFACTURERS LIST			PlanNet Consulting	
3					
4	COMP LAB				
5					
6	OFE/ OFCI?	Qty	Description	Brand	Model #
7	Open Computer Lab - [J103-1]				
8	Displays/Screens				
9		1	BrightLink Pro 1460Ui Short-Throw WUXGA Interactive Projector @ 4,400 lumens (w/ wall mount)	Epson	V11H726520W
10		1	100" diagonal whiteboard projection screen, thin frame, full-length marker tray	Da-Lite	25940T
11					
12					
13	Video Systems				
14	WPG1	1	ShareLink 250 W U; Wireless Collaboration Gateway - Dual Band	Extron	60-1558-01
15					
16					
17	Other/Miscellaneous				
18		1	Miscellaneous Cables, connectors and materials	TBD	TBD

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1	Exhibit B - MAJOR EQUIPMENT AND APPROVED			Version/Date:	8/1/2018
2	MANUFACTURERS LIST			PlanNet Consulting	
3					
4	UPWARD BOUND				
5					
6	OFE/ OFCI?	Qty	Description	Brand	Model #
7	S.S.S.P. & Upward Bound - [J209]				
8	Displays/Screens				
9	PRJ1	1	BrightLink Pro 1460Ui Short-Throw WUXGA Interactive Projector @ 4,400 lumens (w/ wall mount)	Epson	V11H726520W
10		1	100" diagonal whiteboard projection screen, thin frame, full-length marker tray	Da-Lite	25940T
11					
12					
13	Video Systems				
14	CC1	2	Cable Cubby 1200	Extron	70-1037-02
15		2	(2) AC & (2) USB Charging Outlets	Extron	60-1697-01
16		2	Cable Retraction System, HDMI	Extron	70-1065-04
17		2	Cable Retraction System, VGA w/ Audio	Extron	70-1065-11
18		2	Cable Retraction System, Network	Extron	70-1065-03
19		1	Installation Routing Template for Cable Cubby 1200	Extron	70-1041-80
20	TX1	2	DTP T DSW 4K 233; 3-Input Switcher & DTP 4K	Extron	60-1487-12
21	RX1	1	DTP HDMI 4K 230 Rx	Extron	60-1271-13
22	SW1	1	IN1608xi; 8-Input Scaling Presentation Switcher, HDCP compliant	Extron	60-1238-81
23	DVD1	1	*OFE* Blu-ray Player	TBD	TBD
26	CAM1	0	USB PTZ camera	Logitech	PTZ Pro
27		0	Extension system for Logitech PTZ Pro	TBD	TBD
28	CAM1	1	USB camera	Logitech	C920
29	PC1	1	*OFE* In-room PC w/ keyboard & mouse	TBD	TBD
30	WPG1	1	ShareLink 250, Wireless Presentation Gateway w/ built-in WAP	Extron	60-1558-01
31					
32					
33	Audio				
34	DSP1	1	12 x 8 microphone mixer/DSP w/ USB, VoIP, & Dante	Biamp	TesiraFORTE DAN VT
35	S1	4	4.5" Low Profile Ceiling Speaker	QSC	AD-C4T-LP
36	AMP1	1	XPA 2001, 70V Mono Amplifier *PRICE REFLECTED IN CONF. CTR. 219* RF-based	Extron	60-850-01
39	ALS1	1	Portable Assistive Listening Kit (includes bodypack transmitter w/ headworn mic, (7) bodypack receivers w/ hearing aid-compatible ear speakers)	Listen	LS-06-072

1 **Exhibit B - MAJOR EQUIPMENT AND APPROVED**
 2 **MANUFACTURERS LIST**

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3
 4 **UPWARD BOUND**

6	OFE/ OFCI?	Qty	Description	Brand	Model #
40					
41					
42	Control System				
43	DOC1	1	Secure wall docking station for iPad	TBD	TBD
44	TP1	1	10" (approx.) iPad	Apple	TBD
45	CI1	1	IP-to-IR Adapter, PoE powered	Global Cache	IP2IR-P
46	CI2	1	IP-to-Serial Adapter, PoE powered	Global Cache	IP2SL-P
47	NSW1	1	8-port PoE Gigabit switch	Netgear	GS608PP
48					
49					
50	Other/Miscellaneous				
51	RCK1	1	Rolling Rack with wood top and plexi door	Middle Atlantic	PTRK-2126MDK
52		1	Keyboard sliding shelf w/ flip-up 16" 1080p LCD monitor & HDMI input	Vertiv (formerly Avocent)	TBD
53		1	Miscellaneous Cables, connectors and materials	TBD	TBD
54					
55					
56	AVC Additions				
57					

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1	Exhibit B - MAJOR EQUIPMENT AND APPROVED			Version/Date:	8/1/2018
2	MANUFACTURERS LIST				
3					
4	MEETING-CONF. ROOM				
5					
6	OFF/ OFCI?	Qty	Description	Brand	Model #
7	Meeting Rm. - [J104 & J109]				
8	Displays/Screens				
9	PRJ1	1	BrightLink Pro 1460Ui Short-Throw WUXGA Interactive Projector @ 4,400 lumens (w/ wall mount)	Epson	V11H726520W
10		1	100" diagonal whiteboard projection screen, thin frame, full-length marker tray	Da-Lite	25940T
11					
12	Video Systems				
13	CC1	2	Cable Cubby 1200	Extron	70-1037-02
14		2	(2) AC & (2) USB Charging Outlets	Extron	60-1697-01
15		2	Cable Retraction System, HDMI	Extron	70-1065-04
16		2	Cable Retraction System, VGA w/ Audio	Extron	70-1065-11
17		2	Cable Retraction System, Network	Extron	70-1065-03
18		1	Installation Routing Template for Cable Cubby 1200	Extron	70-1041-80
19	TX1	2	DTP T DSW 4K 233; 3-Input Switcher & DTP 4K Transmitter	Extron	60-1487-12
20	RX1	1	DTP HDMI 4K 230 Rx	Extron	60-1271-13
21	SW1	1	IN1608xi; 8-Input Scaling Presentation Switcher, HDCP compliant	Extron	60-1238-81
22	DVD1	1	*OFF* Blu-ray Player	TBD	TBD
25	CAM1	1	USB PTZ camera	Logitech	PTZ Pro
26		1	Extension system for Logitech PTZ Pro	TBD	TBD
27	PC1	1	*OFF* In-room PC w/ keyboard & mouse	TBD	TBD
28	WPG1	1	ShareLink 250, Wireless Presentation Gateway w/ built-in WAP	Extron	60-1558-01
29					
30	Audio				
31	DSP1	1	12 x 8 microphone mixer/DSP w/ USB, VoIP, & Dante	Biamp	TesiraFORTE DAN VT
32	S1	4	4.5" Low Profile Ceiling Speaker	QSC	AD-C4T-LP
33	MIC1	1	Ceiling Array Microphone	Shure	MXA910
34	AMP1	1	XPA 2001, 70V Mono Amplifier	Extron	60-850-01
35	ALS1	0	IR based Assistive Listening Transmitter/Radiator, 2-receiver kit	Listen	LS-91-01
	ALS1	1	*PRICE REFLECTED IN CONF. CTR. 219* RF-based Portable Assistive Listening Kit (includes bodepack transmitter w/ headworn mic, (7) bodepack receivers w/ hearing aid-compatible ear speakers)	Listen	LS-06-072
36					
37					
38	Control System				
39	DOC1	1	Secure wall docking station for iPad	TBD	TBD
40	TP1	1	10" (approx.) iPad	Apple	TBD
41	CI1	1	IP-to-IR Adapter, PoE powered	Global Cache	IP2IR-P
42	CI2	1	IP-to-Serial Adapter, PoE powered	Global Cache	IP2SL-P
43	NSW1	1	8-port PoE Gigabit switch	Netgear	GS608PP
44					
45	Other/Miscellaneous				
46	RCK1	1	Rolling Rack with wood top and plexi door	Middle Atlantic	PTRK-2126MDK
47		1	Keyboard sliding shelf w/ flip-up 16" 1080p LCD monitor & HDMI input	Vertiv (formerly Avocent)	TBD
48		1	Miscellaneous Cables, connectors and materials	TBD	TBD

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1	Exhibit B - MAJOR EQUIPMENT AND APPROVED			Version/Date:	8/1/2018
2	MANUFACTURERS LIST			PlanNet Consulting	
3					
4	CONFERENCE CENTER J219				
5					
6	OFE/ OFCI?	Qty	Description	Brand	Model #
7	Divisible Conf. Ctr. J219 - [J219-1, J219-2, J219-3, J219-4]				
8	Displays/Screens				
9	DISP1-1	3	82" TV LED 4K display (219-1, 219-2 & 219-3)	Samsung	UN82MU8000
10		3	Articulating Thin wall mount w/ interface bracket	Chief	PNRIWUB
11		3	In-Wall Back Box - Provided & installed by others	Chief	PAC501B
12	PRJ1	3	Laser Projector (6,000 lumen) 4K enhanced, HDBaseT input	Epson	Pro L1100U
13		3	RPA Elite Series Projector Mount (including mounting hardware)	Chief	RPMAU
14	SCN1	1	Tensioned Large Advantage Electrol Screen, 110"x176" (208" diag.)	Da-Lite	70243L
15	SCN2	2	Tensioned Contour Electrol Screen, High-Contrast Matte White, 87"x139" (164" diag.)	Da-Lite	37613L
16					
17	Video Systems				
18	CC1	4	Cable Cubby 1200	Extron	70-1037-02
19		4	(2) AC & (2) USB Charging Outlets	Extron	60-1697-01
20		4	Cable Retraction System, HDMI	Extron	70-1065-04
21		4	Cable Retraction System, VGA w/ Audio	Extron	70-1065-11
22		4	Cable Retraction System, Network	Extron	70-1065-03
23	TX1	4	DTP T DSW 4K 233; 3-Input Switcher & DTP 4K	Extron	60-1487-12
24	TX2	1	DTP HDMI 4K 230 Tx (J219-3 82" display)	Extron	60-1271-12
25	RX1	3	DTP HDMI 4K 230 Rx (82" displays)	Extron	60-1271-13
26	SW1	4	IN1608xi; 8-Input Scaling Presentation Switcher, HDCP compliant	Extron	60-1238-81
27	WPG1	4	ShareLink 250, Wireless Presentation Gateway w/ built-in WAP	Extron	60-1558-01
28		4	*OFE* Blu-ray Player	Sony/Samsung	TBD
29		4	*OFE* Cable/Satellite Tuner	OFCI	TBD
30		4	*OFE* Small Form Factor PC	OFCI	TBD
31					
32					
33	Audio				
34	SPK1	12	4.5" Low Profile Ceiling Speaker	QSC	AD-C4T-LP
35	AMP2	2	4-Channel Energy Star Rated Amplifier	QSC	SPA4-100
36	DSP1	2	12 x 8 microphone mixer/DSP w/ USB, VoIP, & Dante	Biamp	TesiraFORTE DAN VT
37	MIC2	3	Ceiling Mics (Zones 1, 2, 3)	Audix	M3
38	WMIC1	1	Wireless Combo System w/ Handheld & Lav (Zone 4)	Shure	GLXD124R/85
39	ALS2	0	IR-based Assistive Listening Transmitter/Radiator, 4-receiver kit	Listen	LS-92-01
40	ALS1	1	RF-based Portable Assistive Listening Kit (includes bodypack transmitter w/ headworn mic, (7) bodypack receivers w/ hearing aid-compatible ear speakers)	Listen	LS-06-072
41	MIX1	1	24-channel mixing console	Allen & Heath	ZED-24
42	RP1	1	1RU Custom Rack Panel	TBD	TBD
43					

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1	Exhibit B - MAJOR EQUIPMENT AND APPROVED			Version/Date:	8/1/2018
2	MANUFACTURERS LIST			PlanNet Consulting	
3					
4	CONFERENCE CENTER J219				
5					
6	OFE/ OFCI?	Qty	Description	Brand	Model #
44	Control System				
45	TP1	4	iPad based Control System w/ Wall Docking Station	Apple/Utology through WAPs	TBD
46	NSW2	1	16-port PoE Gigabit switch (J219-4)	Netgear	JGS516PE
47	NSW1	3	8-port PoE Gigabit switch (J219-1/2/3)	Netgear	GS608PP
48	CI1	8	IP-to-IR Adapter, PoE powered	Global Cache	IP2IR-P
49	CI2	2	IP-to-RELAY Adapter, PoE powered (1 - RM 219-3, 1 - RM 219-4)	Global Cache	IP2CC-P
50	CI3	3	IP-to-Serial Adapter, PoE powered (projectors)	Global Cache	IP2SL-P
51					
52	Other/Miscellaneous				
53		1	25RU Full-Size Rack, 27" Depth (w/o rear door)	Middle Atlantic	BGR-25SA27MDK-EA
54		1	Caster Base	Middle Atlantic	CBS-BGR
55		1	Lacing Bar Accessory Kit	Middle Atlantic	LL-MP21
56		1	Keyboard sliding shelf w/ flip-up 16" 1080p LCD monitor & HDMI input	Vertiv (formerly Avocent)	TBD
57		1	2RU Drawer	Middle Atlantic	D2LK
58		3	16RU Low-Profile Furniture Rack Frame, 18" Depth	Middle Atlantic	CFR-16-18
59		3	Runner Kit, 18"D	Middle Atlantic	5-RS18
60		3	Horizontal Power Strip	Middle Atlantic	PD-915R-SP
61		2	Horizontal Lacing Bars, L-Shaped (10-pack)	Middle Atlantic	LBP-1A
62		3	Keyboard sliding shelf w/ flip-up 16" 1080p LCD monitor & HDMI input	Vertiv (formerly Avocent)	TBD
63		1	Miscellaneous Cables, connectors and materials	TBD	TBD
64					

1	Exhibit B - MAJOR EQUIPMENT AND APPROVED			Version/Date:	8/1/2018
2	MANUFACTURERS LIST			PlanNet Consulting	
3					
4	COMMON AREAS				
5					
6	OFE/ OFCI?	Qty	Description	Brand	Model #
7	Common Areas				
8			Displays/Screens		
9	DISP3-1	9	55" Info Displays (landscape orientation @ +72"AFF), on board chip media player	Samsung Pro	PM55F
10	DISP2-1	10	43" Digital Signage TVs (portrait orientation @ +66"AFF), on board chip media player	Samsung Pro	PM43F
11		9	Articulating Thin wall mount w/ interface bracket	Chief	TS525TU
12		10	Articulating Thin wall mount w/ interface bracket	Chief	TS325TU
13		19	In-Wall Storage Box (white)	Chief	PAC526FW
14					
15					
16			Video Systems		
17		2	HDMI cable & wall plate	TBD	TBD
18					
19					
20			Other/Miscellaneous		
21					
22		19	Miscellaneous Cables, connectors and materials	TBD	TBD
23					

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1	Exhibit B - MAJOR EQUIPMENT AND APPROVED			Version/Date:	8/1/2018
2	MANUFACTURERS LIST			PlanNet Consulting	
3					
4	CAMPUS STORE				
5					
6	OFE/ OFCI?	Qty	Description	Brand	Model #
7	Campus Store - [J106-1]				
8	Displays/Screens				
9	DISP4-1	2	65" TV (@ Refund/Buyback Counters, 1 in millwork)	Samsung	QN65F
10		2	Articulating Thin wall mount w/ interface bracket	Chief	TS525TU
11		2	In-Wall Back Box - Provided & installed by others	Chief	PAC526
12					
13					
14	Video Systems				
15		2	Digital Signage Player	Samsung	SBB-AQ7
16					
17					
18	Audio				
19	S1	6	4.5" Low Profile Ceiling Speaker	QSC	AD-C4T-LP
20	S2	2	4.5" Surface-Mount Speaker	QSC	AD-S4T
21	AMP2	2	4-Channel Energy Star Rated Amplifier	QSC	SPA4-100
22	VC1	1	100W Stainless Steel Volume Control Knob, 1-gang	AtlasIED	AT100
23					
24	Other/Miscellaneous				
25		1	Miscellaneous Cables, connectors and materials	TBD	TBD
26					

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3					
4	COFFEE - JUICE BAR				
5					
6	OFE/ OFCI?	Qty	Description	Brand	Model #
7	Coffee/Juice Bar - [J107-1]				
8	Displays/Screens				
9	DISP2-1	10	43" Digital Signage TVs (portrait orientation @ +66" AFF), on board chip media player	Samsung Pro	PM43F
10		1	Ceiling-Mounted Menu Board Mounting System	Chief	LCM3X1U
11		1	Ceiling-Mounted Display Mounting System	Chief	TBD
12		3	Medium size tilting wall mount	Chief	MTM1U
13					
14					
15					
16	Audio				
17	SPK1	1	4.5" Low Profile Ceiling Speaker	QSC	AD-C4T-LP
18					
19					
20	Other/Miscellaneous				
21		1	Miscellaneous Cables, connectors and materials	TBD	TBD
22					

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3					
4	THE SPOT				
5					
6	OFE/ OFCI?	Qty	Description	Brand	Model #
7	The Spot - [J101]				
8	Displays/Screens				
9	DISP3-1	1	65" TV (digital signage)	Samsung	QN65F
10	DISP4-1	2	46" TV (video game TVs)	Samsung	UH46FS
11		1	Articulating Thin wall mount w/ interface bracket (signage display)	Chief	TS525TU
12		1	In-Wall Back Box - Provided & installed by others (signage display)	Chief	PAC526
13		1	Laser Projector (6,000 lumen) 4K enhanced, HDBaseT input	Epson	Pro L1100U
14		1	RPA Elite Series Projector Mount (including mounting hardware)	Chief	RPM AU
15	SCRN3	1	Tensioned Contour Electrol Screen, High-Contrast Matte White, 87"x139" (164" diag.)	Da-Lite	37613L
16					
17	Video Systems				
18		2	*OFE* Video Game Console	OFCI	TBD
19		1	*OFE* Blu-ray Player	Sony/Samsung	TBD
20		1	*OFE* Cable/Satellite Tuner	OFCI	TBD
21		1	*OFE* Small Form Factor PC	OFCI	TBD
22		1	Digital Signage Player	TBD	TBD
23	SW1	1	IN1608xi; 8-Input Scaling Presentation Switcher, HDCP compliant	Extron	60-1238-81
24					
25	Audio				
32		6	4.5" Low Profile Ceiling Speaker	QSC	AD-C4T-LP
33	AMP3	1	2-Channel Energy Star Rated Amplifier	QSC	SPA2-60
34		1	Wireless Combo System w/ Handheld & Lav	Shure	GLXD124R/85
35	DSP1	1	12 x 8 microphone mixer/DSP w/ USB, VoIP, & Dante	Biamp	TesiraFORTE DAN VT
36	ALS1	0	IR-based Assistive Listening Transmitter/Radiator, 2-receiver kit	Listen	LS-91-01
	ALS1	1	*PRICE REFLECTED IN CONF. CTR. 219* RF-based Portable Assistive Listening Kit (includes bodypack transmitter w/ headworn mic, (7) bodypack receivers w/ hearing aid-compatible ear speakers)	Listen	LS-06-072
37					
38					
39	Control System				
44	TP1	1	iPad based Control System w/ Wall Docking Station	Apple	TBD
45	NSW1	1	8-port PoE Gigabit switch	NETGEAR	GS608NA
46	CI1	2	IP-to-IR Adapter, PoE powered	Global Cache	IP2IR-P
47	CI2	1	IP-to-RELAY Adapter, PoE powered (1 - RM 219-3, 1 - RM 219-4)	Global Cache	IP2CC-P
48	CI3	1	IP-to-Serial Adapter, PoE powered (projectors)	Global Cache	IP2SL-P
49					
50					
51	Other/Miscellaneous				
52		1	Small Equipment Rack with sliders	Middle Atlantic	CFR-12-16
53		1	Digital Signage Player	Samsung	SBB-AQ7
54		1	Miscellaneous Cables, connectors and materials	TBD	TBD
55					

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3
 4 **OFFICE**

5
 6 **OFE/
 OFCI?**

Qty

Description

Brand

Model #

7 **Office**

8 **Displays/Screens**

16 DISP2-1

1

43" TV

Samsung Pro

PM43F

17

1

Articulating Thin wall mount w/ interface bracket

Chief

TS525TU

18

1

In-Wall Back Box - Provided & installed by others

Chief

PAC526

19

20

21 **Other/Miscellaneous**

22

1

Miscellaneous Cables, connectors and materials

TBD

TBD

23

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3					
4	TUTORING				
5					
6	OFE/ OFCI?	Qty	Description	Brand	Model #
7	Private Tutoring (3) - [J207-3, J207-4 & J207-5]				
8	Displays/Screens				
9	DISP2-1	1	43" TV (for Queuing Displays & Int'l Students Area)	Samsung Pro	PM43F
10		1	Articulating Thin wall mount w/ interface bracket	Chief	TS525TU
11		1	In-Wall Back Box - Provided & installed by others	Chief	PAC526
12					
13					
14	Other/Miscellaneous				
15		1	Miscellaneous Cables, connectors and materials	TBD	TBD
16					

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3					
4	COMP LAB				
5					
6	OFE/ OFCI?	Qty	Description	Brand	Model #
7	Open Computer Lab - [J108-1]				
8	Displays/Screens				
9		1	BrightLink Pro 1460Ui Short-Throw WUXGA Interactive Projector @ 4,400 lumens (w/ wall mount)	Epson	V11H726520W
10		1	100" diagonal whiteboard projection screen, thin frame, full-length marker tray	Da-Lite	25940T
11					
12					
13	Video Systems				
14	WPG1	1	ShareLink 250 W U; Wireless Collaboration Gateway - Dual Band	Extron	60-1558-01
15					
16					
17	Other/Miscellaneous				
18		1	Miscellaneous Cables, connectors and materials	TBD	TBD

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3					
4	UPWARD BOUND				
5					
6	OFE/ OFCI?	Qty	Description	Brand	Model #
7	S.S.S.P. & Upward Bound - [J209]				
8	Displays/Screens				
9	PRJ1	1	BrightLink Pro 1460Ui Short-Throw WUXGA Interactive Projector @ 4,400 lumens (w/ wall mount)	Epson	V11H726520W
10		1	100" diagonal whiteboard projection screen, thin frame, full-length marker tray	Da-Lite	25940T
11					
12					
13	Video Systems				
14	CC1	2	Cable Cubby 1200	Extron	70-1037-02
15		2	(2) AC & (2) USB Charging Outlets	Extron	60-1697-01
16		2	Cable Retraction System, HDMI	Extron	70-1065-04
17		2	Cable Retraction System, VGA w/ Audio	Extron	70-1065-11
18		2	Cable Retraction System, Network	Extron	70-1065-03
19		1	Installation Routing Template for Cable Cubby 1200	Extron	70-1041-80
20	TX1	2	DTP T DSW 4K 233; 3-Input Switcher & DTP 4K	Extron	60-1487-12
21	RX1	1	DTP HDMI 4K 230 Rx	Extron	60-1271-13
22	SW1	1	IN1608xi; 8-Input Scaling Presentation Switcher, HDCP compliant	Extron	60-1238-81
23	DVD1	1	*OFE* Blu-ray Player	TBD	TBD
26	CAM1	0	USB PTZ camera	Logitech	PTZ Pro
27		0	Extension system for Logitech PTZ Pro	TBD	TBD
28	CAM1	1	USB camera	Logitech	C920
29	PC1	1	*OFE* In-room PC w/ keyboard & mouse	TBD	TBD
30	WPG1	1	ShareLink 250, Wireless Presentation Gateway w/ built-in WAP	Extron	60-1558-01
31					
32					
33	Audio				
34	DSP1	1	12 x 8 microphone mixer/DSP w/ USB, VoIP, & Dante	Biamp	TesiraFORTE DAN VT
35	S1	4	4.5" Low Profile Ceiling Speaker	QSC	AD-C4T-LP
36	AMP1	1	XPA 2001, 70V Mono Amplifier *PRICE REFLECTED IN CONF. CTR. 219* RF-based	Extron	60-850-01
39	ALS1	1	Portable Assistive Listening Kit (includes bodypack transmitter w/ headworn mic, (7) bodypack receivers w/ hearing aid-compatible ear speakers)	Listen	LS-06-072

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3
 4 **UPWARD BOUND**

5	OFE/ OFCI?	Qty	Description	Brand	Model #
6					
40					
41					
42	Control System				
43	DOC1	1	Secure wall docking station for iPad	TBD	TBD
44	TP1	1	10" (approx.) iPad	Apple	TBD
45	CI1	1	IP-to-IR Adapter, PoE powered	Global Cache	IP2IR-P
46	CI2	1	IP-to-Serial Adapter, PoE powered	Global Cache	IP2SL-P
47	NSW1	1	8-port PoE Gigabit switch	Netgear	GS608PP
48					
49					
50	Other/Miscellaneous				
51	RCK1	1	Rolling Rack with wood top and plexi door	Middle Atlantic	PTRK-2126MDK
52		1	Keyboard sliding shelf w/ flip-up 16" 1080p LCD monitor & HDMI input	Vertiv (formerly Avocent)	TBD
53		1	Miscellaneous Cables, connectors and materials	TBD	TBD
54					
55					
56	AVC Additions				
57					

SECTION 275313 - WIRELESS CLOCK SYSTEM

PART 1 – GENERAL

1.1 GENERAL REQUIREMENTS & SCOPE

- A. Furnish and install a complete new Time Synchronization System using the Primex Wireless XR Time Synchronization System.
- B. Furnish and install all system equipment, devices, accessories, and material in accordance with these specifications and drawing to provide a complete and operating system.
- C. All bids shall be based on the equipment as specified herein. The model designations are that of Primex Wireless, Inc. RSCCD must approve any alternate system in advance of installation.
- D. This will be a turnkey installation. Contractor is responsible for the design, procurement and installation to ensure that all materials and labor are included to install a complete system per these specifications, existing campus wide wireless clock system, and the drawings.
- E. Any materials or equipment not specifically addressed identified in the specifications or drawings and required to provide a complete and functional system, shall be provided at no additional charge to RSCCD.
- F. Contractor shall be responsible for all coordination meetings with RSCCD representatives to ensure design and installation is in compliance with District Standards.

1.2 SECTION INCLUDES

- A. Transmitter (Master)
 - B. Satellite Transmitter
 - C. GPS Receiver
 - D. System Devices
- Analog Clocks

1.3 RELATED SECTIONS

- A. Division 26 “Electrical” (120 volt grounded outlet required for transmitter)
- B. Division 26 Section “Common Work Results for Electrical”

1.4 REFERENCES

- 1. National Fire Protection Association (NFPA): 1. NFPA 70 - National Electrical Code (NEC).
- 2. Manufacturer Installation and User Guides.

1.5 DEFINITIONS

- A. GPS: Global Positioning System, a worldwide system that employs a constellation of satellites in an integrated network to determine geographic location anywhere in the world, and which employs and transmits Universal Coordinated Time, the world's most accurate and reliable time.
- B. NTP: Network Time Protocol, used for synchronizing the clocks on computer networks and devices from either a public server or a separate server on a private local area network.
- C. UTC: Universal Coordinated Time

1.6 SYSTEM DESCRIPTION

- A. System shall continually wirelessly synchronize clocks and/or timers, and shall be capable of clock readouts in multiple time zones where desired.
- B. System shall operate on a 72MHz frequency. The 72MHz frequency transmitter efficiently sends time synchronization signals through commercial building materials to ensure all devices receive important time updates, even for Daylight Saving Time and after a power outage.
- C. The system transmitters can be configured with a variety of power output levels to provide coverage for a single building or an entire campus.
- D. The system supports an FCC license for operation of a 72MHz transmitter result in safe and interference free operation for users.
- E. System shall provide wireless time from a master time source. This time source will be the clock from a defined NTP server that the XR transmitter can access via the customer Local Area Network (LAN). The master time will be synchronized to UTC.
- F. Hard wiring for data communication will not be required to the clocks installed for the system.
- G. Clocks shall automatically adjust for Daylight Saving Time.
- H. Each clock and/or timer and every other component in the system shall use both precise time and synchronized time.
- I. Analog Clocks shall be synchronized to within 10 milliseconds 6 times per day when operating clock strikes 2:01 AM, 6:01 AM, 10:01 AM, 2:01 PM, 6:01 PM, and 10:01 PM, and the system shall have an internal oscillator that maintains plus or minus one second per day between synchronization, so that clock accuracy shall not exceed plus or minus 0.2 seconds.
- J. The system shall include an internal clock reference so that failure to detect the master time source shall not result in the clocks failing to indicate time. Additionally, XR transmitters will have an internal battery backup of up to eight hours in the event of a power failure so that settings and the correct master time will be instantly recalled upon restoration of power.
- K. System shall incorporate a "fail-safe" design so that failure of any component shall not cause failure of the system. Upon restoration of power or repair of failed component, the

system shall resume normal operation without the need to reset the system or any component thereof.

- L. If transmitter stops transmitting valid time signals due to power failure, the clocks will continue to function as accurate quartz clocks until a valid time signal is decoded. If signal transmission is not restored after 48 hours, the second hand will “five step” as a visual indicator that the signal has been lost. Should the clocks lose power and signal, the clocks will not function.
- M. Clock locations shall be as indicated and clocks shall be fully portable, capable of being relocated at any time.
- N. System must operate in accordance with a “Radio Station Authorization”, Form FCC 601 – LM, granted by the Federal Communications Commission (FCC). This license will be issued to and held by the end user.

1.7 REGULATORY REQUIREMENTS

- A. Equipment and components furnished shall be of manufacturer latest model.
- B. System shall be installed in compliance with local and state authorities having jurisdiction.
- C. The end user will hold a license, known as a “Radio Station Authorization” granted by the FCC. This license grants the end user protected use for wireless transmission at the designated frequency. This license will designate a unique “call sign” for each end user.
- D. Transmitter and receiver shall comply with Part 90 of FCC rules as follows: This device may not cause harmful interference. This device must accept interference received, including interference that may cause undesired operation. Transmitter frequency shall be governed by FCC Part 90.35. Transmitter output power shall be governed by FCC Part 90 257 (b).

1.8 SUBMITTALS

- A. Product Data: Submit complete catalog data for each component, describing physical characteristics and method of installation. Submit brochure showing available colors, styles, sizes, and finishes of clocks.
- B. Samples: Submit one specified system device model(s) for approval. Approved sample(s) shall be tagged and shall be installed in the work at location directed.
- C. Manufacturer Instructions: Submit complete installation, set-up and maintenance instructions.
- D. Floor plans indicating the location of system transmitter(s), approved by manufacturer, will be submitted to owner prior to installation.
- E. Operating License: Submit evidence of application for FCC Radio Station Authorization prior to installing equipment. Furnish the license or a copy of the application for the license, to the Owner/End User prior to operating the equipment. The original license must be delivered to the Owner/End User.

1.9 QUALITY ASSURANCE

- A. Permits: Operating license for the transmitter from the FCC.

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- B. Qualifications: Manufacturer: Company specializing in manufacturing commercial time system products with a minimum of 10 continuous years of documented experience including 10 or more years of experience producing GPS wireless time systems.
- C. Installer: Company with a minimum 5 years documented experience in the installation of commercial time systems.
- D. Prior to installation a site survey must be performed to determine proper transmitter placement.

1.10 DELIVERY STORAGE AND HANDLING

- A. Deliver all components to the site in the manufacturer original packaging.
- B. Packaging shall contain manufacturer name and address, product identification number, and other related information.
- C. Store equipment in finished building, unopened containers until ready for installation.

1.11 PROJECT SITE CONDITIONS

- A. Clocks and/or Timers shall not be installed until painting and other finish work in each room is complete.
- B. Transmitter - External Antenna: Coordinate installation of system antenna for access to the roof to comply with safety standards detailed in manufacturer instructions and per local codes.
- C. GPS Receiver: Coordinate installation of GPS receiver for access to the roof or exterior side wall per manufacturer installation instructions

1.12 SYSTEM STARTUP

- A. At completion of installation and prior to final acceptance, turn on the equipment; ensure that all equipment is operating properly, and that all system devices and components are functioning.

1.13 WARRANTY

- A. Manufacturer will provide a one year warranty on GPS receiver, transmitter, and satellite transmitter. All other devices and components will have a 1 year warranty.

PART 2 – PRODUCTS

2.1 MANUFACTURER

- A. Primex Wireless, Inc., Analog 12.5” series electric model. District Standard - no or equals, refer to adopted Board Resolution No. 18-17

2.2 SEQUENCE OF OPERATION

- A. The system shall perform in the sequence of operation as described.
 - 1. Configure and install system appliance detailed in manufacturer installation instructions.
 - 2. Configure and install system devices per model specifications detailed in manufacturer installation instructions.
- B. Transmitter Operation
 - 1. When power is first applied to the transmitter, it checks for and displays the software version. It then checks the position of the switches and stores their position in memory. The transmitter looks for the master time source.
- C. Master Time Source Operation
 - 1. NTP Time Source: With the transmitter in NTP mode, it connects over the Ethernet to the IP address of the NTP server. This IP address is programmed into the transmitter as part of its configuration. Once the connection to the NTP server is acknowledged, it downloads time data and synchronizes its internal master clock to NTP time. The transmitter then starts to transmit its internal time once every second. The transmitter updates its internal clock in this mode once per hour.
- D. Clock and/or Timer Operation
 - 1. After initial setup, the clock and/or timer will shut off the receiver. Six times each day an Analog Clock microprocessor will activate the receiver and starting with the stored channel it will again look for a valid time signal. Every 10 minutes a Clock/Timer will activate the receiver and starting with the stored channel it will again look for a valid time signal. If necessary, the clocks will resynchronize to the correct time.
 - 2. If an Analog clock has not decoded a valid time signal for a pre-determined number of days, it will go to a step mode. If a clock goes into step mode, recheck power connectivity first and then determine if the clock synchronizes to master time source before attempting other troubleshooting methods.
 - 3. If a Clock/Timer has not decoded a valid time signal for a pre-determined number of days, the display colon indicator will flash continuously until a valid time signal is received.

2.3 EQUIPMENT

- A. Transmitter Equipment

Model	Antenna	Time Source
5 Watt Transmitter (49 channel)	External	NTP and GPS
30 Watt Transmitter (49 channel)	External	NTP and GPS

- B. 5 and 30 Watt Transmitter

1. The transmitter shall meet all the following specifications:

Parameter	Specification
Transmission Frequency Range	72.020 to 72.980 MHz. US: Each range is reserved by the FCC for licensed fixed mobile broadcasts.
Transmission Power at external antenna	5 watts (37 dBm) ERP and 30 watts (45 dBm) ERP
Radio Technology	Narrowband FM
Channels	Channel 1 through 16 (72.10-72.40 MHz) Channel 51 through 74 (72.42 - 72.98MHz)
Channel Bandwidth	20 kHz maximum
Transition Mode	One-way communication
Data Rate	2 KBps
Operating Range	32°F - 122°F (0° - 50°C)
Exciter Output Power	+26 to +30 dBm
Frequency Deviation	+/- 4 kHz
Transmitter Power Requirements	120 VAC 60 Hz
Internal Power Requirements	5 VDC
Current Draw	5 Watt: 0.9V 30 Watt: 1.41A
Carrier frequency stability	+/- 20 ppm
Amplifier Output Bandwidth (max)	20MHz
Amplifier Gain Flatness	+/- 1 db at 72 - 76 MHz
Fixed Output	5W output (37dBm) ERP 30W output (45 dBm) ERP
Harmonics (-dBc)	See FCC Part 90 requirements
Spurious	-60 dBc
VSWR (max)	1:3
Impedance	50 ohms

Parameter	Specification
Connector to Antenna	N-male
Housing/Enclosure	Black metal case 22"W x 17"H x 22"D (55.88cm x 43.18 cm x 55.88cm)

2. Internal clock: Transmitter shall contain an internal clock such that failure to update time from source will not disable the operation of the clocks.
3. Transmitter shall include a surge suppressor/battery backup and a mounting shelf.
4. Transmitter shall have the following switches:
 - a. Time zone adjustment switches for all time zones in the world. Includes: Eastern, Central, Mountain, Pacific, Alaska, and Hawaii.
 - b. DIP Switch to allow the following configuration: Daylight Saving Time bypass option, 12-hour or 24-hour display, GPS or NTP time source, Local or LAN configuration, UTC+ or UTC-, 30 minute UTC offset option.
 - c. The DIP switches and channel switches are disabled during production by the manufacturer as the broadcast channel number and time zone are to be predetermined during the FCC licensing process based on end user location and existing wireless services operating in the area. The end user will be required to contact Primex Wireless if, for any reason, a different broadcast channel is required, since the request would require a modification of the license, requiring approval by the FCC, or if a different time source is desired.
5. Transmitter housing shall incorporate a display, which shall include the following:
 - a. Time readout
 - b. AM and PM indicator if 12-hour time display is set
 - c. Day and date readout
 - d. Time zone indicator including Standard or Daylight Savings Time
 - e. On screen menu to verify diagnostics, errors, time updates, and switch settings, toggled by sequence of push buttons next to display.
 - f. Status LEDs: Green to determine time broadcast, yellow which flashes in the event of lack of time update after 48 hours, red which flashes to indicate connection or internal transmitter problem. The green broadcast mode LED will be solid to indicate the transmitter is broadcasting its signal, and dark to indicate the transmitter is in standby mode and not broadcasting.

C. External Antenna

1. The antenna connects to the transmitter via a 100 foot (30.5m) 50-ohm coaxial cable.

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2. 5 and 30 Watt models: External Antenna must be installed by Primex Wireless or a certified Primex Wireless installer.
3. Transmitter shall include an external antenna that meets the below specifications.

Parameter	Specification
Antenna Dimension	Radiating element 29.4 inches (747mm)
Ground Radials	41.5 inches (1063 mm)
Equivalent Flat Plate Area	0.68ft ² (0.063m ²)
Polarization	Vertical
H-plane Beamwidth	Omni
E-plane Beamwidth	78 degrees (half power)
Max. Input power	75 watts@ 50 degrees
Gain	0 dBd. VSWR (max)<: 1.5
Frequency Range	68-78MHz (broadband)
Impedance	50 ohms
Lightning Protection	Direct Ground
Connector	N female
Mount	Pole or Wall Mountable. Mounting hardware supplied.
Certification	FCC Part 90 Accepted IC RSS-119 Accepted
Mask	Options: Non-Penetrating Antenna Mast Kit. Installer must provide ballast material per manufacturer instructions. Penetrating Antenna Mast Kit.
Mask Wind Survival Rating	120mph (200kph)

- D. NTP Time Source
 1. Transmitter will allow for either NTP time input or GPS satellite time input with use of a GPS Receiver unit.
 2. Unit shall obtain current time from NTP through an Ethernet port.
- E. Satellite Transmitter
 1. Transmitter shall meet the following specifications:

Parameter	Specification
Frequency	72 MHz
Transmission Power	1 watt maximum
Antenna	Mounted on top of the housing, 46.0 inch L (116.8cm)
Power	Input: 120 VAC, 50/60 Hz Output: 9 volt DC
Daylight Savings Time	Bypass switch
Dimensions	5.75”L x 4.25”H x 1.25”D (14.6cm x 10.8cm x 3.16cm)
Weight	.075 lb (.34kg)
Operating Range	-32°-158°F (-36° to 70°C)

2. Satellite Transmitter shall receive the signal from a Wireless Receiver Switch and transmit the signal to the system devices in its vicinity, which are out of range from the system transmitter.
3. Transmitter shall include a wireless receiver switch, surge suppressor/battery backup, and mounting shelf.
4. A 5 foot (1.52m) RS232 cable connects receiver switch to the satellite transmitter.
5. Antenna mounted on top of the switch housing, 12.5 inch L (31.75cm).

F. Transmitter Rack

1. Transmitter rack, 3” (76.2mm) x 16.5” (419mm) x 18” gauge metal, epoxy covered, will be supplied.

G. Event Scheduler Pro Software (Programmable Count Down Timer)

1. Provide scheduling software for installation and programming by owner.
2. Software shall be compatible with the following PC operating systems: Windows NT with Service Pack 6a, Windows NT, Windows XP, Windows Vista, and Windows 7. End user/owner will require valid administrator rights to install the software.
3. Software shall be provided from manufacturer in a form of a CD, suitable for operation in standard CD-ROM drives.

H. Analog Clocks

1. Analog Clocks shall meet the following specifications:
 - a. Analog clocks shall be wall mounted.
 - b. Face shall be white. Hour and minute hands shall be black.
 - c. Clock frames and lenses are of durable thermoplastic.
 - d. Clocks shall have a tamper proof/theft resistant clock-lock mounting slots.

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- e. Analog clocks shall be capable of automatically adjusting for Daylight Saving Time. An on-off switch located on the transmitter shall disable this function if desired.
 - f. Clock shall have 120 VAC or 24 VAC power supply built into the clock assembly.
 - g. If power is interrupted, the clock will stop until power resumes. Upon resumption of power, the clock will self-correct to the current time.
 - h. Electric (AC) models will include a cord with pigtail.
 - i. Time shall be automatically updated from the transmitter 6 times per day.
 - j. If the transmitter stops transmitting valid time signals due to power failure, the clocks will continue to function as accurate quartz clocks until a valid time signal is decoded. If signal transmission is not restored after 96 hours, the second hand will "five -step" as a visual indicator that the signal has been lost. Should the clocks lose power and signal, the clocks will not function.
 - k. Analog clock receivers shall be as follows: Receiver sensitivity: >-110 dBm, Receiver power: Dual Alkaline batteries supplied by manufacturer or AC-powered: 24VAC or 120VAC, Antenna type: internal, Antenna gain: -7 dBd.
2. Supply Models, Traditional Series Analog Clock
- a. Electric Model, 12.5" (31.75cm) Black, 24VAC or 120VAC
- I. Wire Guard Accessory
- 1. Provide Clock Wire Guard(s) to protect against accidental damage or vandalism with a clock wire guard accessory.
 - 2. Cable Connection Sealant: Radio Shack Coaxial Cable Connector Sealant 278-1645, or approved electrical grade silicone sealant.
 - 3. Supply the following models:
 - a. 14" x 14" Analog Wire Guard (for 12.5" clock)

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Examine conditions with the Installer present for compliance with requirements and other conditions affecting the performance of the system and the system devices.
- B. Do not proceed until unsatisfactory conditions have been corrected.
- C. Verify that construction is complete in spaces to receive equipment and that rooms are clean and dry.
- D. Verify that 120 volt electrical outlet is located within 6 feet (1.83m) of location of transmitter and the outlet is operational and properly grounded.

- E. Code Blue and Elapsed Timer: Verify single gang electrical box for switch control is mounted and within 15 feet (4.5m) of elapsed timer. Verify pathway for connecting cable is available and compliant to local building codes.
- F. AC-powered devices: Verify that electrical power outlet is near location of clock or timer and the outlet is operational and properly grounded.

3.2 INSTALLATION

- A. General: Install system in accordance with applicable codes.
- B. Install system equipment in accordance with manufacturer written instructions.
- C. Provide all system equipment necessary for a complete and operable system.
- D. GPS Unit (INTERNAL Antenna Transmitter Model only):
 - 1. Install GPS unit on roof in location indicated, in clear view of the sky.
 - 2. Install unit in location free from standing water and above accumulations of leaves or debris.
 - 3. Seal cable connection to GPS with cable connection sealant.
 - 4. Any added cable lengths must be protected from outside elements.
- E. GPS Unit (EXTERNAL Antenna Transmitter Model only):
 - 1. Locate transmitter in telecommunications room in a central location in the building.
 - 2. Clearance around all side of the transmitter to comply with local building codes.
- F. Master Time Source (NTP will be used as master time source):
 - 1. Connect CAT6 EIA/TIA standard Ethernet cable from transmitter LAN port to available network drop.
 - 2. Set GPS/LAN DIP switch to NTP.
- G. Transmitter (EXTERNAL Antenna only)
 - 1. Transmitter is connected to external antenna via a 50 ohm coaxial cable. Typical length – 100 feet (30.5m)
 - 2. Cable routing should comply with ANSI EIA/TIA-569 and local building codes.
 - 3. If cable is routed through conduit, the conduit should be a minimum of 2 inch (50.8mm) diameter.
 - 4. Transmitter enclosure must be bonded to an earth ground per ANSI EIA/TIA 607, NEC Article 250, and local building codes.
 - 5. Antenna should be mounted to a mast on the roof of the building connecting to the transmitter via a 50-ohm coaxial cable.
 - 6. Consult manufacturer instruction manual for specific clearances and mounting instructions.

7. Antenna must be bonded to an earth ground per ANSI EIA/TIA 607, NEC Article 250, and local building codes.
- H. Transmitter (INTERNAL Antenna only)
1. Locate transmitter where indicated, a minimum of 2 to 3 feet (.6 to 1 meter) above the floor, away from large metal objects such as filing cabinets, lockers or metal framed walls.
 2. Transmitter(s) will be placed at locations indicated within specifications and drawings.
 3. Connect antenna to transmitter, using care not to strip threads.
 4. Connect power supply to the transmitter.
 5. Set the channel number on the display to correspond to the FCC license.
 6. Plug power supply into electrical outlet.
- I. Analog Clocks
1. Furnish all equipment necessary for a complete and operational system.
 2. Perform the following operations with each clock:
 - a. Configure and set clock to correct time in accordance with manufacturer instructions.
 - b. Observe clock until valid signals are received and clock adjusts itself to correct time.
 - c. Install each clock per its model mounting specifications per manufacturer instructions and mounting instructions at the indicated location.
- J. Wire Guards
1. Secure to wall, using approved theft-resistant fasteners.
- 3.3 FIELD INSPECTION
- A. Inspection: Make observations to verify that system devices and components are properly labeled.
 - B. Prior to final acceptance, inspect each system device and component, adjust as required, and replace parts which are found defective.
- 3.4 MANUFACTURER SERVICES
- A. If needed, provide technical assistance as demonstrated in the manufacturer guides, on product start-up and system setup, to owners or installers representatives via phone, fax, or email.
 - B. Installation and user guides shall be provided.
- 3.5 CLEANING
- A. Prior to final acceptance, clean exposed surfaces of devices, using cleaning methods recommended by manufacturer.

- B. Remove temporary labels from clock faces. Do not remove labels from backs of clocks.

3.6 DEMONSTRATION

- A. Provide training to Owner's representative on setting, adjusting and configuring device and routine maintenance.
- B. Provide training to Owner's representative on installing the software, adjusting and programming the transmitter, setting and adjusting system devices and routine maintenance.

3.7 PROTECTION

- A. Protect finished installation until final acceptance of the project.

3.8 TESTING

All devices must be tested at their operational location under normal operational conditions to assure reception of signal.

END OF SECTION 275313

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SECTION 281300 – ACCESS CONTROL

PART 1 - GENERAL

1.1 SUMMARY

Contractor shall provide all materials, hardware, software, fabrication, coordination efforts and installation, programming, testing, documentation, and training in conformity with manufacturers' documentation, specifications contained herein, and applicable Codes and authorities having jurisdiction for the implementation of a complete Access Control System (ACS).

Documents do not show or list every item to be provided. When an item not shown or listed is clearly necessary for proper installation and operation of the equipment and systems, Contractor shall provide, install, test and certify the item at no increase to contract price.

Contractor shall be responsible for coordination of all access control system related installation issues with any and all stakeholders, DISTRICT IT Department, and other trades. This includes programming of all software and hardware, connections/interfaces. Coordination of conduit/pathways, and power requirements for security devices directly with electrical contractor when necessary to complete installation.

The system envelope will have access control functionality primarily at the perimeter entrance doors, elevator lobbies and other specific doors and areas as shown on the Design Drawings. Interior spaces will include secure access to the corridors, main cluster entry doors in the buildings, elevator cab readers and the receiving dock. The ACS and VSS shall functionally integrate, thus allowing a visual image of a perimeter breach where cameras are placed. An example would be a "door forced open" alarm where the associated camera would show a visual image of the door in alarm condition.

Access controlled doors and perimeter "exit doors" will have door position switches that seal off the perimeter during off hours. If this perimeter is breached it will cause an alarm that will indicate a security breach at the monitoring station. In case of an emergency the access-controlled doors can be "locked down".

The perimeter doors will be unlocked during regular hours and controlled by credentials and schedules for off hours access. The inside areas shall be key controlled as defined by DISTRICT. The keys shall be used for doors that need to be secure but not electronically controlled.

The Access Control system will be capable of fully supporting Elevator Cab Card readers which can restrict access to certain floors based on programmed access levels. If an individual does not possess a legitimate credential or access level, the car will not move, or will return to the ground floor. It will be the responsibility of the Security Integrator to coordinate with the Elevator Control Company for the proper installation and control of this functionality and of cable requirements within the elevator travel cable.

Alarm signals from the system shall register at the designated monitoring station as an "alarm". The alarm signal shall include the time, date, location, and ID number of the alarm point.

The Security Contractor shall be responsible for the programming and testing of the dual credentialed key-fobs provided by others. The key-fobs are part of dorm space locks as well as the access to the perimeter doors. The Security Contractor shall test key-fobs on

1.2 PROJECT SCOPE

The Contractor shall be responsible for fully implementing the functions described in the specifications and shown on the Design Drawings and Specification Documents, which may not show or list every item required or to be provided. When an item not shown or listed is clearly necessary for proper installation and operation of equipment or the system(s), the contractor shall provide this equipment, components, or software at no additional cost to the Owner.

Provide and submit all required documentation as outlined in the Submittals section and referenced elsewhere within this specification, including written notice prior to demonstration for Final Acceptance.

Contractor shall connect ACS panels to the Campus Access Control System. Contractor shall coordinate with the DISTRICT on type and manufacturer of the existing Campus ACS.

1.3 REFERENCES

Published specifications, standards, tests, codes, or recommended standards of trade, industry, or governmental organizations apply to work in these Sections, including:

1. ADA - Americans with Disabilities Act
2. ASCII - American Standard Code for Information Interchange
3. ASTM - American Society for Testing and Materials
4. EIA - Electronic Industry Association
5. NEMA - National Electrical Manufacturers' Association
6. NFPA - National Fire Protection Association
7. NEC - National Electrical Code
8. CEO - California Electrical Code
9. UL - Underwriters Laboratories, Inc.
10. ASIS - American Society for Industrial Security

Electronic devices radiating “RE” energy shall comply with Federal Communication Commission regulations, particularly Part 15, and shall meet minimum Class “B” requirements. Provide FCC certificate numbers indicating that the FCC has approved products.

1.4 QUALITY ASSURANCE

A nationally recognized test laboratory shall list all equipment supplied where applicable.

All equipment and accessories to be the product of a manufacturer regularly engaged in its manufacture.

All items of a given type shall be the products of the same manufacturer.

All items shall be new and of the latest technology and version-level; no discontinued models or products are acceptable.

No Beta products shall be offered or will be accepted.

The manufacturer, or their Authorized Representative, shall confirm that within 100 miles of the project site there is an established agency which:

1. Provides a full-Service Operation and stocks a full complement of replacement 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.

The Contractor shall be a fully certified Dealer by the Campus ACS to sell, install, and maintain all system, subsystems, components, and software required in the United States.

The Contractor shall have at least five (5) years’ experience designing, selling, installing and maintaining the Campus access control system, and shall possess all applicable Contractor licenses.

Contractor shall be capable of performing service or maintenance work on these specified and/or accepted systems.

1.5 SUBMITTALS

Provide the following Shop Drawings and Data Sheet submission to DISTRICT at the start of the project: Data Sheet submittals indicating Manufacturers name, model number, and a full description of the component and UL Listing for all equipment supplied. Indicate or high light all model numbers of equipment to be reviewed.

Shop Drawing Submittals complete with point-to-point wiring diagrams for all connected components, Fire Alarm Interface connections, device location floor plans, device schedules,

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block/riser diagrams, mounting details for all mounted components, calculations, etc. Provide dimensioned elevation, mounting, and wiring details for all consoles, racks, control panels, and fabricated equipment being supplied under this section.

Training Program documentation, including name and qualifications of trainer(s), schedule of training, curricula, and written training materials.

Partial or "Typical" drawings will not be accepted. All drawings shall be done in CAD.

Provide a complete Bill of Materials with quantities of equipment supplied.

Provide an Access Control List of devices requiring IP addresses. These addresses shall be programmed into all connected devices, with this list used to program network switches restricting network connections to approved devices only.

Provide a narrative of proposed programming, including device names and descriptions, timings, sequence of operations, etc.

Service information, including address of nearest representative. Provide written approval from each manufacturer affirming that Contractor is certified and approved for systems installation and service for all systems in this Section.

Provide the following subsequent to the Shop Drawings and Data Sheet submission the following items;

1. Provide all Test Reports as indicated in Section 3.03 when completed in a timely manner for approval.
2. Provide complete Operation and Maintenance manuals for all approved equipment installed. This O&M manual shall be available for Training classes and be part of the Training materials. This document manual must be approved and available for use in Training and Final Acceptance.
3. Provide all documentation referenced in under the Warranty section referenced within this specification, and provide Warranty Certificate indicating customer name, site address, system under warranty, date warranty begins and ends, service department contact information and manufacturer contact information.

Submittals must be complete, as in all items listed above under Shop Drawings and Data Sheets shall be submitted at one time together as a package. Incomplete or partial Shop Drawings and Data Sheets submittals shall be rejected.

The Security Consultant and DISTRICT reserve the right to reject any submittals determined to be incomplete. Operation and Maintenance manual shall be submitted prior to demonstration for Final Acceptance and Training.

1.6 SUBSTITUTIONS

Manufacturers listed as acceptable are normally engaged in the type of work specified. The listing of equipment part numbers or particular types of systems by specific manufacturers is to establish the performance, quality and parameters of the equipment and material specified.

1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

All equipment provided shall be new, not used, and shall be shipped in original packages to prevent damage or entry of foreign matter. All handling shall be in accordance with manufacturers' recommendations. Contractor shall provide any required protective covering during construction.

The Contractor shall replace, at no expense to DISTRICT, equipment and material damaged during storage and installation as directed by DISTRICT.

Products delivered to the job site in racks and consoles shall be protected from dust, dirt and foreign matter. All racks and consoles shall be protected from dents, bumps and scratching.

1.8 WARRANTY

The Contractor and manufacturer(s) shall warranty all equipment, materials and installation labor for a minimum of two (2) years from the date of written notification of Acceptance by DISTRICT.

During the Warranty Period, upon notification of a problem by DISTRICT, the Contractor shall ensure that a competent and qualified field service technician arrives on site to correct the problem within 24 hours of notification. If a problem can be corrected remotely to DISTRICT's reasonable satisfaction, the on-site arrival time commitment shall be waived.

At least sixty (60) calendar days prior to expiration of Warranty, Contractor shall provide DISTRICT with post-Warranty maintenance contract proposals. The terms and condition of any such post-Warranty program shall be consistent with those offered to the provider's most favored customer(s).

PART 2 - PRODUCTS

2.1 SYSTEM OVERVIEW

The Access Control system shall operate on a dedicated security system network shared with the video surveillance system, forming the foundation of the Integrated Security System. This dedicated security network does not connect with the business network, however, this equipment is co-located in the same communications closet as the business network equipment, possibly in the same rack. Rack space shall be provisioned for this equipment in the Communications Infrastructure design within the Communications Closets. The specifications for this dedicated security system network shall be found in Section 28 23 00 Video Surveillance System.

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The Access Control Block Riser Drawing indicates access control system components will be mounted in the Communications Closets indicating a connection to a local Category 6 Patch panel or reference a network port connection for this equipment. The Security Contractor shall provide all fiber optic and Category 6 patch cords to connect the access control equipment to the dedicated security network.

The Video Surveillance System Block Riser shall indicate the Ethernet network switches connecting to the fiber optic backbone which is part of the Structured Cabling System, an engineered and certified system provided and installed by the Communications contractor. The Security Contractor shall not provide or install any cabling or fiber for the Security System Network except the patch cords as indicated.

The Security Contractor shall incorporate all requirements of the dedicated network electronics as outlined in the 28 23 00 Video Surveillance Specifications for materials, labor and required testing including all required submissions of test documentation as part of the access control system and/or the Integrated Security System.

The access control system shall be an inter-connected group of components consisting of but not limited to the following devices:

1. Fiber optic and Category 6 patch cords
2. Access control units (ACUs)
3. Communication devices
4. Readers
5. Credentials
6. Door Contacts
7. Request to Exit devices
8. Electrified Door Hardware
9. Power Supplies
10. Other equipment as specified

The system shall be capable of the following functions:

11. Regulate and monitor access at system-controlled doors.
12. Control access to elevator floors and monitor elevator floor button activity.
13. Interface with a telephone entry system – phone bill and no phone bill types.

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14. Monitor connected detectors or sensors (supervised and auxiliary inputs) with the ability to manually or automatically arm and disarm them.
15. Control event-initiated devices connected to system outputs, such as alarms or digital video recorders, with the ability to automatically or manually arm or disarm them.
16. Report an alarm and or supervisory condition.
17. Distribute an annunciated alarm condition via an email notification off-site.
18. Establish a hierarchy of alarm types to prioritize handling alarm conditions.
19. Maintain a comprehensive database recording all site activity.
20. Operate an optional, fully integrated photo badge and verification module allowing for a complete ID badging operation.
21. Operate an optional integrated interactive mapping application.
22. Operate an optional integrated visitor management application.
23. Operate an optional integrated guard tour application.
24. Interface with select intrusion alarm panels.
25. Offer remote system access via the Internet or a corporate intranet with an optional WEB module.
26. Provide capability of Remote Viewing and Mobile Viewing.

2.2 FIELD DEVICES

Card Readers

1. Card Readers shall be HID Global Multiclass SE, multiformat, multifrequency, transmitting at 125Khz to support proximity, and 13.56 Mhz supporting Smartcard capability, or approved equal.
2. Standard switch mount type shall be RP40, or RPK40 with keypad, where indicated.
3. Mullion mount shall be RP15.
4. Mini mullion mount shall be RP10.
5. Refer to Architectural Door Hardware List, Specifications and Design Drawings for further details.

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6. Refer to Door Detail drawings which indicate infrastructure rough in details for conduit and back boxes.
7. Refer to the Block Riser Drawings for cable and wire types used for various devices.
8. For wire and cable installation requirements, refer to the wire and cable section for details.

Credentials – Key Fobs

9. Credentials shall be furnished by the Contractor for this project.
10. Contractor shall provide 2500 credentials.
11. Credential type shall be coordinated with DISTRICT. Credentials shall not be purchased until approved by DISTRICT.

Door Contacts

12. Door alarm contacts shall be GE/Sentrol 1076 or 1076D or approved equal.
13. Door Contacts may be internal of electrified door locking hardware when a power transfer hinge is specified.
14. Color of contact shall match the door frame finish as closely as possible.
15. The contact and magnet housing shall snap-lock into a 1” diameter hole. The contact shall be SPST, where indicated on the Design Drawings. DPDT type shall be indicated where needed.
16. All contacts and inputs to the ACP shall be on a “supervised” circuit. An end of line resistor shall be installed at the alarm contact location and not at the control panel location.
17. Refer to Architectural Door Hardware List, Specifications and Design Drawings for further details.
18. Refer to Door Detail drawings which indicate infrastructure rough in details for conduit and back boxes.
19. Refer to the Block Riser Drawings for cable and wire types used for various devices.
20. For wire and cable installation requirements, refer to the wire and cable section for details.

Overhead Door Contact/Roof Hatch Contact

21. Surface mounted contacts shall be GE Security 2204 overhead door contact.

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22. Furnish and install alarm contacts at the floor for roll up type doors and/or hatches that require wide gap surface mounted contacts.
23. The contact shall be loop type, open or closed, SPDT, 3" gap distance, with 18" flexible stainless-steel cable housing.
24. Refer to Architectural Door Hardware List, Specifications and Design Drawings for further details.
25. Refer to Door Detail drawings which indicate infrastructure rough in details for conduit and back boxes.
26. Refer to the Block Riser Drawings for cable and wire types used for various devices.
27. For wire and cable installation requirements, refer to the wire and cable section for details.

Request to Exit Device

28. Request to exit PIR type motion sensor shall be Allegion/Schlage SCAN II or Bosch DS160 with 1 gang trim plate.
29. Wherever possible, request-to-exit (REX) functionality should be integrated into the electrified locking hardware.
30. Where an integrated solution for request to exit is not provided or provisioned by the selected locking hardware, furnish and install a PIR type motion detector designed for request to exit applications at all locations as indicated on the Design Drawings.
31. Some doors will be monitored for door position only and may not have a reader and REX device.
32. Power input shall be 12-30 V DC/AC
33. Refer to Architectural Door Hardware List, Specifications and Design Drawings for further details.
34. Refer to Door Detail drawings which indicate infrastructure rough in details for conduit and back boxes.
35. Refer to the Block Riser Drawings for cable and wire types used for various devices.

Electrified Locking Door Hardware

36. Door Hardware shall be specified by the Architect and is provided and installed by the locking hardware Contractor.

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37. Refer to the Architectural Door Hardware list, Index, and Door Hardware Specifications for further details.
38. Fire Rated, Panic Hardware, Electric Strikes and Magnetic locks shall be installed and wired as per manufacturer recommendations, local and other Codes, and the Authority Having Jurisdiction per door, for all doors.
39. Contractor shall coordinate with all other trades and stakeholders as required to ensure complete and proper installation and deliver a fully functional door(s) controlled or monitored by the Access Control system.
40. Security Contractor to test all functions at all access-controlled doors.
41. Refer to Architectural Door Hardware List, Specifications and Design Drawings for further details.
42. Refer to Door Detail drawings which indicate infrastructure rough in details for conduit and back boxes.
43. Refer to the Block Riser Drawings for cable and wire types used for various devices.
44. For wire and cable installation requirements, refer to the wire and cable section for details.

Power Supplies and Locking Hardware Power Supplies

45. Access Control peripheral devices shall be powered by Altronix, SDC, Allegion brands, or Assa Abloy brands power supplies. All power supplies shall be UL Listed.
46. Install 24VDC power supplies to power all electrically controlled door locks as required.
47. It is the responsibility of the Contractor to coordinate facility power requirements with the project electrical contractor for power connections where needed and Fire Alarm connections where needed.
48. Size all power supplies to permit simultaneous continuous-duty activation of all door locks, with an additional minimum 20% capacity on each supply. Calculate voltage drop to locks and size lock control wiring to provide proper lock operation.
49. Run individual lock power circuits from a separate fused output on Power Distribution Modules, located within the access control panel.
50. All Low Battery and AC Loss connections shall be terminated into the system for monitoring.
51. Provide Sealed Lead Acid (SLA) battery back-up sufficient for 4 hours standby plus 25 activations for all DC locks.

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52. Provide a separate enclosure for the batteries if the batteries will not fit securely in power supply enclosure “right-side-up”. Do not lay batteries on their sides or ends in order to fit them into the enclosure. Do not expose wiring between the power supplies and the batteries.
53. Refer to Architectural Door Hardware List, Specifications and Design Drawings for further details.
54. Refer to Door Detail drawings which indicate infrastructure rough in details for conduit and back boxes.
55. Refer to the Block Riser Drawings for cable and wire types used for various devices.
56. For wire and cable installation requirements, refer to the wire and cable section for details.

Fire Alarm Interface Connection

57. Provide as required per the current code (NFPA 72), a connection from the access control system to the Fire Alarm system to respond to this input of an emergency condition as per all local and national codes, ordinances, statutes and/or rules, guidelines and directives of the governing local Authority Having Jurisdiction.
58. Access Control shall provide, as per code, a door unlock function to unlock all doors that require this action when an active, authorized alarm signal is activated, or by direct interruption of the lock power circuit for doors in the path of egress equipped with access control and electrified door hardware.
59. Fire Alarm interface connection shall comply with NFPA 70, 72 and National Electrical Code requirements.
60. All Fire Alarm connections shall be included in the Shop Drawing package for review, and in the As Built Drawing set.

Local Door Alarm

61. Provide door management alarms for local and remote monitoring and annunciation of the status of the doors (door prop/door held, door intrusion/door forced or secure) as indicated on the Security Device Drawings.
62. The LDA shall be capable of operating in a “stand-alone” configuration or with an access control system, utilizing all reader technologies: i.e. proximity, weigand, mag stripe, bar code or biometrics.
63. Local sounder (field selectable volume 96 or 103 dB @ 3 feet) shall be used to indicate both door prop/door held, and intrusion/door forced conditions after a user selectable quiet, or access, time (0 seconds to 90 minutes) has expired. Sounder shall be incorporated into the faceplate of the LDA.

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64. Form C (N/O and N/C) contacts shall be available for the following outputs: Door Contact Status, Door Prop Alarm, Intrusion/Tamper Alarm and Bypass/Key Switch Status.
65. The alarm (intrusion) contact shall change state upon the recognition of an alarm or tamper condition to alert remote monitoring equipment.
66. The unit shall remain in alarm until reset by integral key switch, remotely through a dry contact or automatically through an onboard timer (user settable from 0 seconds to 5 minutes or MANUAL).
67. An integral key switch shall be available for alarm shunt or alarm reset and be incorporated into the faceplate of the LDA.
68. A Bi-Color status LED shall be incorporated into the faceplate of the LDA.
69. A remote LED output shall be provided to control a bi-color LED that follows the actions of the faceplate mounted LED.
70. Inputs shall include a N/C Dry Contact for the door, Voltage Sense (12-24 VAC/DC) to monitor electric lock voltages and a N/O or N/C Dry Contact Shunt Input.
71. The following timers shall be user settable: Auto-reset, Alarm delay, Silent time and Shunt Delay.
72. The LDA shall be mounted in the wall adjacent to the monitored door at 42" above finished floor. The unit shall mount in a standard 2 gang (3 gang for rim cylinder key switch model) electrical box with a minimum depth of 2 1/2".
73. Refer to Architectural Door Hardware List, Specifications and Design Drawings for further details.
74. Refer to Door Detail drawings which indicate infrastructure rough in details for conduit and back boxes.
75. Refer to the Block Riser Drawings for cable and wire types used for various devices.
76. For wire and cable installation requirements, refer to the wire and cable section for details.
77. The LDA shall be Designed Security, Inc. Model ES4200-K1-T1, or Kouba Systems LDA9602.

Duress Button

78. Under counter/desk door release with momentary pushbutton, surface mount, black abs plastic box with two mounting ears.
79. S.P.D.T. contacts, rated 4 amps @ 28 VDC.

- 80. UL Listed and C.S.A. certified components.
- 81. Duress button shall be from Alarm Controls, Model TS-18.

2.3 WIRE AND CABLE

Cabling shall be West Penn, Belden, Mohawk, Windy City or SmartWire.

All cabling shall be plenum (CMP) rated.

All Cables shall be U.L. Listed, and appropriate for the application.

Contractor shall be responsible for providing proper cable supports where conduit, cable trays and/or cable paths are not provided. (Rods and J-Hooks) Cable will be run free air above ceiling areas with plenum rated cable. Firewall penetrations must be coordinated with the General Contractor.

Contractor shall follow the manufacturer's recommendation for cabling. Wire and Cable sizes, number of conductors, shielding, or other data listed in this specification or shown on Drawings are a guide to the correct product required to achieve a working system and represent minimum acceptable equipment. Cabling shall be sized and installed according to local electrical code requirements.

Wire splices are not permitted in any circuit. If a splice cannot be avoided, the splice work shall be submitted for review and approval prior to installation of cable run affected. The submittals shall include the following details; the reason for the splice, a detailed drawing of the splice, all wire types involved, termination details, physical protection, and protection from the elements must be submitted.

All Cable shall be run in unbroken lengths of 1000 feet or less. When Cable cannot be run in unbroken lengths due to Cable spool limitations over 1000 feet, splices shall be made in junction boxes with terminal blocks or terminal strips and fork spade lugs. All splices and junction boxes shall be clearly marked on the final drawings.

Cables are to be shielded as necessary with drain wires properly terminated and grounded. Use proper grounding practices to eliminate ground loops and terminate drain wires as factory recommends to prevent unwanted voltages and electrical noise from degrading system performance.

Contractor shall utilize existing pathways, conduit and cable trays were applicable. Any cabling or raceway exposed to weather shall be rated for that use.

All 12 or 24VDC power cabling shall be of stranded construction. For connections requiring pressure captive connection, wire shall be tinned prior to insertion into pressure connectors.

All Cable shall be labeled at origin and termination, referencing to a master legend schedule as shown on submittal Drawings.

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1. Labeling and any splice locations shall be noted on as-built Drawings.
2. All Labels shall be done using machine generated cable tags in the “flagged” position.
3. Hand written labels are not acceptable.

Wiring shall be grouped and harnessed to facilitate access to all equipment, as well as maintenance and replacement of equipment.

Use of Velcro cable management is specified. Use of tie wraps/zip ties for cable bundle management is not permitted.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

Systems shall be complete and operational in all respects.

The Contractor shall furnish and install all equipment necessary to build the Integrated Security System as referenced herein

All wall, floor, and ceiling penetrations, regardless of fire rating, must be properly sleeved with conduit and properly sealed using approved fire stopping materials and sealants.

All security equipment, junction boxes, terminal cans, etc. installed in public accessible areas shall be installed utilizing tamper proof mounting hardware. Contractor shall provide a minimum of 2 driver bits or hand tools for each type and size of security fastener provided.

The Security Contractor shall provide seismic restraint for all equipment, including equipment racks, consoles, etc.

3.2 PROGRAMMING

Contractor shall provide initial programming for all applicable systems. Contractor programming shall include, but not be limited to:

English-language description of each alarm location.

Programming of the head-end equipment.

Programming of Access Control Software.

Integration to the Video surveillance system.

The Contractor shall submit to DISTRICT for the review, prior to work being initiated, the proposed programming, including device names and descriptions, timings, sequence of operations, etc.

Upon DISTRICT's request, the Contractor shall reprogram each system one time during the Warranty Period at no additional cost. At no additional charge, the Contractor shall update the system software to the most recent version available at the time of the reprogram.

3.3 TESTS AND REPORTS

The Contractor shall perform system tests using personnel who have attended a manufacturer's training school for installation and testing of the systems as described herein. The Contractor shall perform testing with the test instruments as specified/directed by the manufacturer.

Testing by means other than the manufacturer's procedures will not be acceptable unless agreed to in advance in writing by DISTRICT, Security Consultant and the equipment manufacturer.

Upon completion of the installation of the Security Systems, the Contractor shall submit written reports including, but not limited to, the following information:

A complete list of all equipment installed, including serial numbers of major components.

Certification that all equipment is properly installed, programmed, functional, 100% operational, and in conformance with contract Specifications and Drawings.

Test reports of all access control system cable infrastructure, tested devices, and equipment operation to indicate the system is substantially complete and ready for demonstration.

Test technician's name, company and date of test.

Following review of the test report(s) by DISTRICT, the Contractor shall perform a test of Security System equipment in the presence of DISTRICT and the Consultant. Test(s) shall include performance tests of all equipment and material required by the contract. The Contractor shall be responsible for all additional costs to DISTRICT if retesting is required. At a minimum, perform tests to demonstrate that:

All systems operate normally and are free from grounding problems and open circuits.

Systems operate properly on battery backup.

All software functions properly as specified, and all equipment is fully programmed.

Sixty days prior to expiration of Warranty, Contractor shall retest all systems as described herein, and submit a test report of findings. All items covered by Warranty shall be corrected immediately. The Warranty shall remain in effect until the Contractor corrects 100% of defective items.

3.4 AS-BUILT DRAWINGS

The Contractor shall maintain a complete set of prints of contract Drawings on-site as the work on the Access Control System is being completed. As work is installed, Contractor shall record all installation details and correct location of work including all critical dimensions.

Upon completion of the project, Contractor shall provide all as built information as CAD Drawings (.dwg), and submit to DISTRICT for review. No hand-drawn as-built drawings shall be accepted.

The Contractor shall provide four (4) sets of As-built Drawings, plus one (1) set of CAD disks, to DISTRICT. One (1) additional complete set shall remain on the job site secured on the wall adjacent to the control panels at the head end.

3.5 TRAINING

The Contractor shall provide a minimum of four (4) copies of Operation and Maintenance manuals for all equipment furnished under the Security Systems sub-sections. These manuals are to be available for training.

Provide a minimum of eight (8) hours of scheduled training for the equipment furnished under this Section, including programming, operation, service, and maintenance.

Training shall be by engineers or technicians highly skilled in the systems and certified by manufacturer as qualified to train in the particular systems.

Training shall be conducted at dates and times directed by the DISTRICT's representative. Training shall be provided for all security staff personnel and system end-users.

DISTRICT, prior to release of retention compensation, shall require verification of completion of training.

3.6 DISTRICT IT REQUIREMENTS

The Security Contractor shall coordinate with the IT department (IT) for all network and telecom connections to keep within the level and consistency of workmanship quality, materials selection and installation methods for all work performed in any Telecommunications Room (TR). Security Contractor shall request an IP address table from the IT department (IT) for all devices requiring an IP address. The address table must be approved prior to deploying and programming devices and a Report submitted for review at demonstration of Final Acceptance.

END OF SECTION 281300

SECTION 282300 – VIDEO SURVEILLANCE SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. The Contractor shall provide all materials, hardware, software, fabrication, coordination and installation, programming, testing, documentation, and training in conformity with manufacturers' documentation, the specifications contained herein, all applicable Codes and authorities having jurisdiction for the implementation of a complete Video Surveillance System (VSS). Refer to Scope of Work section within this specification for further details.
- B. The Security Contractor shall be responsible for coordination of all VSS system related installation issues with any and all stakeholders, DISTRICT IT Department, and other trades. This includes programming of all software and hardware, connections/interfaces. Coordination of conduit/pathways, and power requirements for security devices directly with electrical contractor when necessary to complete installation. Refer to Scope of Work section within this specification for further details.

1.2 PROJECT SCOPE

- A. The Contractor shall be responsible for fully implementing the functions described in the specifications and shown on the Design Drawings and Specification Documents, which may not show or list every item required or to be provided. When an item not shown or listed is clearly necessary for proper installation and operation of equipment or the system(s), the contractor shall provide this equipment, components, or software at no additional cost to the Owner.
- B. Provide and submit all required documentation as a single submission at the beginning of the project, as outlined in the Submittals section and referenced elsewhere within this specification, including written notice prior to demonstration for Final Acceptance.
- C. All cameras for this project shall be recorded at the existing legacy video surveillance recording server running Version 5, by ONSSI. There will be no local recording server required. The camera recording stream profile for all new cameras shall be the same as currently used, 15 frames per second, 2048 Kbps, H.264 compression, I-frame 1, with retention for 30 days.
- D. The Integrated Access Control and Video Surveillance System shall communicate using the existing fiber optic network provided and installed by the Communications contractor. Refer to 2.19 Dedicated Security Network Section in this specification for additional information.
- E. The Security Contractor shall coordinate all his work and work in harmony with other trades on the project as well as with A/E personnel and contractors performing work under a separate contract where all work is contributing to the overall project. Cooperate fully with the Architect or his agents so work may be carried out smoothly, without interfering with or delaying work under this contract or work by Architect. This would include timely submission of documents

and/or notices of impending scheduled events or milestones where others are required to attend or participate in reviews, site walks, testing, commissioning and demonstration for Final Acceptance with the A/E personnel.

1.3 RELATED SECTIONS

- A. 28 13 00 Access Control
- B. Division 1
- C. 14 21 00 Electric Traction Elevator
- D. 27 10 00 Structured Cabling

1.4 REFERENCES

- A. Published specifications, standards, tests, codes, or recommended standards of trade, industry, or governmental organizations apply to work in these Sections, including:
 - 1. ADA - Americans with Disabilities Act
 - 2. ASCII - American Standard Code for Information Interchange
 - 3. ASTM - American Society for Testing and Materials
 - 4. EIA – Electronic Industry Association
 - 5. NEMA - National Electrical Manufacturers' Association
 - 6. NFPA - National Fire Protection Association
 - 7. NEC - National Electrical Code
 - 8. UL - Underwriters Laboratories, Inc.
 - 9. ASIS – American Society for Industrial Security
 - 10. FCC – Federal Communications Commission
 - 11. OSHA – Occupational Safety and Health Administration
 - 12. IEEE – Institute of Electrical and Electronic Engineers
 - 13. ANSI – American National Standards Institute
 - 14. State and Local Fire Marshal

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- B. Electronic devices radiating “RE” energy shall comply with Federal Communication Commission regulations, particularly Part 15, and shall meet minimum Class “B” requirements. Provide FCC certificate numbers indicating that the FCC has approved products.
- C. Where any of the above standards or codes differs with the contract documents and specification, the more stringent requirements shall take precedence. Any cost necessary to meet any AHJ requirements shall be included in Contractor’s price.

1.5 QUALITY ASSURANCE

- A. Contractor and any Subcontractors shall be responsible for and familiar with all city, county, state, and federal codes, rules, ordinance, and regulations of the AHJ and their interpretations, which are in effect for these Premises.
- B. The latest issue of all recognized codes, standards, and recommended practices of the following agencies in effect on the date of award of a contract shall form a part of this specification.
- C. A nationally recognized test laboratory shall list all equipment supplied where applicable.
- D. All equipment and accessories to be the product of a manufacturer regularly engaged in its manufacture.
- E. All items of a given type shall be the products of the same manufacturer.
- F. All items shall be new and of the latest technology and version-level; no discontinued models or products are acceptable.
- G. No Beta products will be accepted.
- H. The manufacturer, or their Authorized Representative, shall confirm that within 100 miles of the project site there is an established agency which:
 - 1. Provides a full-Service Operation and stocks a full complement of replacement 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.
- I. Contractor shall be a factory authorized representative of Milestone Systems, licensed to sell, install, and maintain all system, subsystems, components, and software required in the United States, and shall present a copy of their certificate designating them as a factory authorized distributor/installer.
- J. Contractor shall have at least five (5) years’ experience designing, selling, installing and maintaining the VMS/VSS equipment being bid, and shall possess all applicable Contractor licenses.

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- K. Skilled technicians are to perform all installation, commissioning, programming and testing and are, at a minimum, to be factory trained and certified to work with the video surveillance system.
- L. Contractor shall employ a competent Foreman to be in responsible charge of the Work. Foreman shall be on the project site daily during the execution of the Work.
- M. Contractor's Foreman shall be a regular employee, principle, or officer of Contractor, who is thoroughly experienced in projects of a similar size and type. Contractor shall not use contract employees or Subcontractors as Foremen.
- N. All software provided shall be the latest version available by the manufacturer upon final acceptance of the system. This includes Microsoft products contained as part of the system. All of the latest updates and patches shall be installed at the time of acceptance.
- O. Contractor shall make application for and obtain any and all permits required by federal, state, county, city, or other authority having jurisdiction over the work.

1.6 SUBMITTALS

- A. Provide the following Data Sheets, NVR Storage calculations, and Shop Drawing package documentation as a complete submission to DISTRICT at the start of the project.
 - 1. Provide a complete Bill of Materials with quantities of equipment supplied.
 - 2. Data Sheet submittals indicating manufacturers name, model number, and a full description of the component and UL Listing for all equipment supplied.
 - a. Provide a Data Sheet for every item listed in the Bill of Material.
 - b. Indicate or high light all model numbers of equipment to be reviewed prior to submission for approval.
 - 3. Provide NVR Storage Calculations - to size the NVR hard disk size, submit a report or screen shot of the camera or NVR manufacturer's website for video storage calculation, for all cameras indicated in the Design Drawings, add to that 20% spare disk capacity. Motion detected alarm events will be recorded and saved as a "Clip" to the NVR. Alarm clips older than 30 days can be overwritten or programmed to be deleted to make room for newer alarm clips.
 - a. Camera alarm recording stream profile for all camera/NVR storage calculations is based on;
 - i 30% motion detection with 2 minutes pre- and post-event.
 - ii 30 days' retention.
 - iii Native resolution of the given camera.

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- iv 30 frames per second.
 - v Variable bit rate.
 - vi H.264 compression.
4. Shop Drawing package shall be submitted and is the foundation of the As built package, and shall include the following details;
- a. Provide dimensioned elevations and details for all consoles, racks and fabricated equipment being supplied under this section.
 - b. Device location floor/site plans with each device having a unique ID.
 - c. Block Riser/Network Diagram of all devices in the system.
 - d. Facility power connections.
 - e. Device Schedules of all cameras in the project.
 - f. Mounting details for all mounted components, cameras, etc.
5. Partial or "Typical" drawings will not be accepted.
- a. All drawings shall be done in CAD drafting software.
 - b. Duplication of Design/Bid Drawings submitted as a Shop Drawing package shall be rejected.
6. To ensure compatibility with an existing legacy network, and a project is an extension of an existing legacy system, the Security Contractor shall submit a list in electronic format/spreadsheet of all new devices with unique device ID's and mac addresses that require connection to the existing network. This information will be merged with existing equipment information and become an approved Table of IP addresses for the Security Contractor to use for his new equipment IP addresses.
7. Training Program documentation, including name and qualifications of trainer(s), schedule of training, curricula, and written training materials. As built drawings shall be available as part of the Training program.
8. Service information, including address of nearest representative. Provide written approval from each manufacturer affirming that Contractor is certified and approved for systems installation and service for all systems in this Section.
- B. Provide the following items subsequent to the Shop Drawings and Data Sheet submission;
- 1. Provide all Test Reports as indicated in Section 3.3 TESTS AND REPORTS when completed in a timely manner for approval.

2. Provide (5) complete Operation and Maintenance manuals for all approved equipment installed. This O&M manual shall be available for Training classes and be part of the Training materials. This document manual must be approved and available for use in Training and Final Acceptance.
 3. Provide all documentation referenced in under the Warranty section referenced within this specification, and provide Warranty Certificate indicating customer name, site address, system under warranty, date warranty begins and ends, service department contact information and manufacturer contact information.
- C. Submittals must be complete, as in all items listed above under Shop Drawings and Data Sheets shall be submitted at one time together as a package. Incomplete or partial Shop Drawings and Data Sheets submittals shall be rejected.
 - D. The Security Consultant and DISTRICT reserve the right to reject any submittals determined to be incomplete.
 - E. Operation and Maintenance manual shall be submitted prior to demonstration for Final Acceptance and Training.

1.7 SUBSTITUTIONS

- A. All materials and equipment shall conform to these specifications. No substitute equipment or materials may be used unless accepted in advance in writing by DISTRICT and the Security Consultant.
- B. Manufacturers listed as acceptable are normally engaged in the type of work specified. The listing of equipment part numbers or particular types of systems by specific manufacturers is to establish the performance, quality, and parameters of the equipment and material specified.

1.8 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. All equipment provided shall be new, not used, and shall be shipped in original packages to prevent damage or entry of foreign matter. All handling shall be in accordance with manufacturers' recommendations. Protective covering shall be provided by Contractor during construction.
- B. Components to be stored for future use shall be kept inside a well ventilated space protected from weather, damage, breakage, and scoring of finishes. The Contractor shall replace, at no expense to DISTRICT, equipment and material damaged during storage and installation as directed by DISTRICT.
- C. Products delivered to the job site in racks and consoles shall be protected from dust, dirt and foreign matter. All racks and consoles shall be protected from dents, bumps and scratching. Contractor shall replace all parts damaged in shipping or in storage with new at no cost to the Owner.

- D. Used components are not permitted for installation at the Premises.

1.9 WARRANTY

- A. Contractor warrants that all Work furnished (material and labor) under this Contract will be of good quality, free from faults and defects, and in conformance with the Project Drawings and Specifications.
- B. Contractor shall provide a parts and labor guarantee on all Work. Unless otherwise specified herein, Contractor's guarantee shall be for a period of two (2) year from date of Acceptance, except where any specific guarantees from a supplier or equipment manufacturer extends for a longer time.
- C. Contractor's guarantee shall cover all costs associated with troubleshooting, repair, and replacement of defective Work, including costs of labor, transportation, lodging, materials, and equipment.
- D. Guarantee shall not cover any damage to material or equipment caused by accident, misuse, unauthorized modification or repair by the Owners, civil unrest, or acts of god.
- E. Provide a Certificate of Warranty to include Site name, date Warranty begin and ends, Service Provider contact information, complete street address and phone number. Contractor and manufacturer(s) shall warranty all equipment, materials and installation labor for a minimum of two (2) year in accordance with the contract documents.
- F. During the Warranty Period, upon notification of a problem by DISTRICT, the Contractor shall ensure that a competent and qualified field service technician arrives on site to correct the problem within 24 hours of notification. If a problem can be corrected remotely to DISTRICT's reasonable satisfaction, the on-site arrival time commitment shall be waived.
- G. At least sixty (60) calendar days prior to expiration of Warranty, Contractor shall provide DISTRICT with post-Warranty maintenance contract proposals. The terms and condition of any such post-Warranty program shall be consistent with those offered to the provider's most favored customer(s).

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. System specifications, functionality, system capabilities and products outlined in this specification are based on the following;
 - 1. Ocularis Enterprise, version 5, from On-Net Surveillance Systems Inc., One Blue Hill Plaza, 7th Floor, PO Box 1555, Phone: (845) 732-7900, Fax: (845) 732-7999, Web: www.onssi.com, E-mail: sales@onssi.com.

2. Acceptable IP camera manufacturer shall be Sony.

2.2 SYSTEM OVERVIEW

- A. The video surveillance management system will be used forensically to “look” at each camera and record motion detected events only, as alarm clips. It will not have continuous recording of all cameras and will not be monitored.
- B. The workstation to be provided shall be used to administer both the video surveillance and access control systems.
- C. The VSS shall support cameras in Elevator cabs utilizing 2 wire transmission technology with a corner mount IP camera to capture activity and persons entering, on, and exiting the elevator cab(s). Security Contractor shall coordinate wire needs for the travel cable and installation of the camera with the Elevator provider. All equipment necessary to make the elevator cameras fully operational is the responsibility of the Security Contractor.
- D. The Video Surveillance system shall operate on a dedicated security system network shared with the access control system, forming the foundation of the Integrated Security System. This dedicated security network does not connect with the business network, however, this equipment is co-located in the same communications closet as the business network equipment, possibly in the same rack. Rack and wall space shall be provisioned for this equipment in the Communications Infrastructure design within the Telecommunications Closets. The specifications for this dedicated security system network shall be found in elsewhere in these specifications.
 1. The Access Control Block Riser Drawing shows access control system components wall mounted in the Communications Closets indicating a connection to a local Category 6 Patch panel or reference a network port connection for this equipment. The Security Contractor shall provide all fiber optic and Category 6 patch cords to connect the access control equipment to the dedicated security network.
 2. The Video Surveillance System Block Riser shall indicate the Ethernet network switches connecting to the fiber optic backbone which is part of the Structured Cabling System, an engineered and certified system provided and installed by the Communications contractor. The Security Contractor shall not provide or install any cabling or fiber for the Security System Network except the patch cords as indicated.
 3. There are dedicated fiber optic strands within the existing network assigned for use by the dedicated security network, and the Security Contractor shall coordinate what fibers are identified for his equipment prior to installing this equipment. These fibers shall be identified and recorded in the As built or Record Drawings and submitted as part of the Project Close Out documentation.
 4. The Security Contractor shall incorporate all requirements of the dedicated network electronics as outlined in the 28 23 00 Video Surveillance Specifications for materials, labor and required testing including all required submissions of test documentation as part of the access control system and/or the Integrated Security System.

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5. All Video Surveillance Cameras shall be Sony.
6. Camera locations must be confirmed with District Project Manager, and District ITS Department. Final alignment of field of view to be verified for every camera by District Project Manager prior to final acceptance.
7. It is not the intent to cover the entire campus only the areas of concern.
8. Coordinate final placement of cameras with District Project Manager and District ITS Department prior to installation.
9. Coordinate final alignment of cameras with District Project Manager and District ITS Department prior to acceptance.
10. Integrate into existing storage and management system. (Existing storage is 300 TB storage array).
11. Drawings must have a camera schedule that indicates the following: camera model number, part number, mounting type, required accessories, power requirements, licensing and software options.
12. Locate reset for GFCI circuit no higher than 5 feet above finished grade for pole mounted cameras.
13. Design cabling to allow for a 15'15-foot cable coil for ease of CCTV relocation/adjustment where drop ceilings occur.
14. Where ceiling condition is open, coordinate exact locations with District Project Manager and District ITS Department.
15. All cameras shall be mounted horizontally unless approved in advance by the District Project Manager and District ITS Department. If wall mounted method is approved, cameras shall be mounted on a gooseneck mount.

2.3 DEDICATED SECURITY NETWORK

- A. The Video Surveillance and Access Control Systems shall communicate using the existing single mode fiber optic network provided and installed by the communications contractor. There will be no need for the Security Contractor to provide and install any fiber optic and Category 6 cabling infrastructure for video surveillance. The Category 6 horizontal drop provided by the communications contractor is complete from the patch panel in the Telecommunications Room (TR) to the biscuit (or single gang faceplate with modular jacks) installed in the 5S type box at each camera location. The Security Contractor shall provide all required Category 6 patch cords with a Red sheath color and snagless boot for all security device connections.
- B. Typically, the existing single mode fiber optic network topology is a STAR configuration from the Main Distribution Frame (MDF) to the TR's. One fiber optic switch shall aggregate all the

fiber optic cables at the head end, and all edge switches located in the TR's shall connect to single mode fibers terminated on the fiber aggregation switch in the head end/MDF.

- C. Typically required in the MDF, is an edge switch that will be needed for the connection of local edge devices, cameras, and access control panels/servers/appliances to the dedicated security network. If more than one edge switch is required in any TR (or MDF) to support security devices, all additional switches shall be stacked underneath the primary switch and connected via optical patch cords to the SFP ports via modules. Only one switch per TR can be connected to the fiber optic backbone infrastructure. This group of switches, modules, optical patch cords and existing single mode fiber backbone shall form the dedicated security network.
- D. The Design Drawings (Video Surveillance Block/Riser) will indicate all the Telecommunications Rooms (TR) that have switch locations based on the security design. Edge switches will be deployed only where there are security devices needed, possibly not all TR's will have edge switches in them.
- E. Prior to installation, the Security Contractor shall provide and install the newest firmware available from the manufacturer for all switches provided, program all switches with VLAN's, enable Spanning Tree Protocol to inhibit loop connections between switches, and define and configure each switch for Trunking and QoS features to support maximum bandwidth capability.
- F. The Security Contractor shall provide the following cyber security measures to restrict unauthorized access to the network switch by changing all factory default passwords to credentials acceptable to DISTRICT, and other security settings which shall be enabled, programmed or configured to provide a minimum of network security as listed;
 - 1. Provide a minimum of two Virtual Local Area Network (VLAN) to support the isolation of data traffic for each of the following data traffic types;
 - a. A dedicated VLAN for video surveillance and Access Control together.
 - b. A dedicated VLAN for future use.
 - 2. Disable all unused ports.
 - 3. Enable (RJ45) Port Security feature to inhibit the disconnection of the security device and the connection of another device such as a laptop.
 - 4. Disable Front Panel button functions/Enable Front Panel Security features.
 - 5. Change the default password for Administrator account.
 - 6. Change the password for the Console port.
 - 7. Provide an Access Control List based on the IP address of all approved IP devices for the video surveillance and access control systems.

2.4 FIELD DEVICES

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- A. IP Network Cameras – Indoor and Outdoor
- B. DISTRICT shall provide all cameras to the Contractor for installation.
 - 1. The fixed IP dome type network cameras shall be: SONY SNC-EM631, SONY SNC-XM631, or most current version series for indoor applications.
 - 2. The fixed IP dome type network cameras shall be: SONY SNC-EM632R or most current version, for outdoor applications.
 - 3. All outdoor cameras shall have lightning and surge protection devices.
 - 4. The Security Contractor shall determine the lens required to support the field of view at installation location of each camera.
 - 5. All IP network cameras shall utilize Power over Ethernet (IEEE 802.3af) except outdoor PTZ's (if required).
 - 6. The Security Contractor shall provide and install Red sheath color Category 6 patch cords and connect all IP cameras to the dedicated security network.
 - 7. The Security Contractor shall verify all camera lenses and field of view requirements with DISTRICT and the Security Consultant by submitting all lens selections for approval prior to installation.
- C. Lightning and Surge Protection
 - 1. All outdoor equipment shall have UL Listed lightning and surge protection devices.
 - 2. Surge protection devices shall be UL Listed from Ditek Corporation.
 - 3. Contractor shall select the device for the application and include it in all required project documentation for approval.
 - 4. Devices shall be installed in approved locations only.
- D. IP Camera Housings, Mounts and Accessories
 - 1. All cameras shall be installed with the proper mounting kits for drop tile or hard ceiling types, wall or pole mount, or pendants as indicated. All accessories, mounts and pendant adapters shall be from the manufacturer and support the specified model of camera.
 - 2. Secure all cameras and housings as per manufacturer recommendations appropriate to structural requirements and construction conditions. Utilize tamperproof-mounting hardware.
 - 3. Camera housings installed in ceilings shall have secondary safety attachments to building structure independent of ceiling, fire sprinkler, conduit, or other system supports as per AHJ and applicable codes.

4. For exterior cameras, use appropriate environmentally controlled weather resistant camera enclosures designed for hot and cold climate applications, where temperatures can exceed far above 100°F and below -20 °F

E. Elevator Camera System

1. The elevator camera shall be vandal resistant ceiling-mount or ceiling mount type, providing effective performance while incorporating grip-less design for maximum safety.
2. The elevator cameras will all need to utilize the single pair or double pair of traveler cable wiring to transmit their signal to the network. To accomplish this, the use of Network Video Technologies Ethernet over 2-wire transceivers with PoE will need to be used.
 - a. There will need to be a transceiver at the camera side (far end) that accepts the CAT6 patch cord from the camera and another transceiver at the opposite end (near end) of the traveler cable that will connect via CAT6 cabling to the network switch via the patch panel in the IDF.
 - b. A 56VDC power supply will feed power at the (near end), this transceiver which will then transmit PoE power for the camera side transceiver and the IP camera itself.
3. The Security Contractor shall coordinate with the Elevator Service Company, whom is responsible for all traveler cabling and Elevator Cab hardware rough in and/or installation. Coordinate with Elevator Service Company to verify whom shall provide installation of the camera system inside of the elevator cab
4. The elevator camera shall be: SONY SNC-XM631 or equivalent to be coordinated with the DISTRICT.
5. The Security Contractor shall provide and install White sheath color Category 6 patch cords and connect to the dedicated security network.

F. Ethernet Media Converters

1. Media Converters can be deployed to convert a signal to travel on Ethernet compatible media/cable where needed. Many types and applications are available for use and shall be acceptable from Network Video Technologies or Comnet brand.
2. Security Contractor shall select the devices for use and submit Data Sheets for approval of all devices and shall show them in the Shop Drawing package where used at all locations.

G. Ethernet Extenders

1. Any camera or IP device that will have a cabling length of more than 300 feet will require and Ethernet extender.
2. Ethernet extenders shall be placed in approved locations when used. Devices shall not be hidden in locations that cannot be easily access or maintained with certain ease.

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3. Security Contractor shall select the devices for use and submit Data Sheets for approval of all devices and shall show them in the Shop Drawing package where used at all locations.
4. Devices from Veracity Outreach Max family of products shall be approved, no substitutions permitted.

2.5 WIRE AND CABLE

- A. The Security Contractor shall provide and install all fiber optic patch cords for switch connections to the dedicated security network.
- B. Except as specifically noted to the contrary herein, all primary camera cabling shall be unshielded twisted pair (UTP) Category-6, which is the DISTRICTIT/telecom UTP cable standard. This cabling shall be provided by the selected project low-voltage IT/telecom cabling contractor and shall not be part of the Security Contractor's scope.
- C. Unless specifically noted to the contrary on Security drawings, all cable runs for security cameras shall be one (1) Category-6 unshielded twisted pair (Cat-6 UTP) cable to each camera location terminated in a Cat-6 RJ-45 modular female jacks at the camera location. The Demark for the Security Contractor shall be the RJ45 female jack at the camera. Cat- 6 UTP cables (provided by others) shall be terminated in the appropriate TR on Cat-6 patch panels provided by others.
- D. At the TR end of each UTP cable, it shall be the responsibility of the Security Contractor to provide a Red sheath color CAT-6 patch cord and make all connections from the Cat-6 patch panels to the respective security equipment/systems. Such work shall be coordinated in advance with DISTRICT IT and all DISTRICT IT standards and practices for such work shall be adhered to.
- E. At the security device end of each UTP cable, it shall be the responsibility of the Security Contractor to provide and install a Red sheath colored Cat-6 UTP patch cord and make the connections from the Cat-6 female jack to the camera. Such work shall be coordinated in advance with DISTRICT IT and all IT standards and practices for such work shall be adhered to
- F. Specific Cat-6 UTP cabling information shall be referenced in Division 27 Specifications for low-voltage cabling for brand, make, model and acceptable patch cord installation standards including labeling.
- G. Use of Velcro cable management is specified. Use of tie wraps for cable bundle management is not permitted.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

- A. Systems shall be complete and operational in all respects.

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- B. The Contractor shall furnish and install all equipment necessary to build the Integrated Security System as referenced herein.
- C. All wall, floor, and ceiling penetrations, regardless of fire rating, must be properly sleeved with conduit and properly sealed using approved fire stopping materials and sealants, according to DISTRICT standards.
- D. All security equipment, junction boxes, terminal cans, etc. installed in public accessible areas shall be installed utilizing tamper proof mounting hardware. Contractor shall provide a minimum of 2 driver bits or hand tools for each type and size of security fastener provided.
- E. The Contractor shall provide seismic restraint for all equipment, including equipment racks, consoles, etc.

3.2 PROGRAMMING

- A. Contractor shall provide initial programming for all applicable systems. Contractor programming shall include, but not be limited to:
 - 1. English-language description of each alarm location.
 - 2. Programming of the head-end equipment.
 - 3. Programming of Video Management Software.
- B. Submit to DISTRICT for the review of the proposed programming, including device names and descriptions, timings, sequence of operations, etc.
- C. Upon DISTRICT's request, the Contractor shall reprogram each system one time during the Warranty Period at no additional cost. At no additional charge, the Contractor shall update the system software to the most recent version available at the time of the reprogram.

3.3 TESTS AND REPORTS

- A. The Contractor shall perform system tests using personnel who have attended a manufacturer's training school for installation and testing of the systems as described herein. The Contractor shall perform testing with the test instruments as specified/directed by the manufacturer. Testing by means other than the manufacturer's procedures will not be acceptable unless agreed to in advance in writing by DISTRICT, Security Consultant and the equipment manufacturer.
- B. Upon completion of the installation of the Security Systems, the Contractor shall submit written reports including, but not limited to, the following information:
 - 1. A complete list of all equipment installed, including serial numbers of major components.
 - 2. Certification that all equipment is properly installed, programmed, functional, 100% operational, and in conformance with contract Specifications and Drawings.

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3. Test reports of all connected devices and equipment, including IP addresses, device Id's and test results indicating pass/fail of device operation.
 4. Test technician's name, company and date of test.
- C. Following review of the test report(s) by DISTRICT, the Contractor shall perform a test of Security System equipment in the presence of DISTRICT and the Consultant. Test(s) shall include performance tests of all equipment and material required by the contract. The Contractor shall be responsible for all additional costs to DISTRICT if retesting is required. At a minimum, perform tests to demonstrate that:
1. All systems are free from grounding problems and open circuits.
 2. Systems operate properly on battery backup.
 3. All software functions properly as specified, and all equipment is fully programmed.
 4. The Security Contractor shall disable all unused ports of all switches deployed in the dedicated security network. Provide and submit a written Test Report that indicates all the unused ports are disabled. This test report shall be available at time of demonstration of Final Acceptance.
- D. Sixty days prior to expiration of Warranty, Contractor shall retest all systems as described herein, and submit a test report of findings. All items covered by Warranty shall be corrected immediately. The Warranty shall remain in effect until the Contractor corrects 100% of defective items.

3.4 TRAINING

- A. The Contractor shall provide a minimum of four (4) copies of Operation and Maintenance manuals for all equipment furnished under the Security Systems sub-sections. These manuals are to be available during training.
- B. Provide a minimum of eight (8) hours of scheduled training for the equipment furnished under this Section, including programming, operation, service, and maintenance.
- C. Training shall be by engineers or technicians highly skilled in the systems and certified by manufacturer as qualified to train in the particular systems.
- D. Training shall be conducted at dates and times directed by DISTRICT's representative. Training shall be provided for all security staff personnel and system end-users.
- E. DISTRICT, prior to release of retention compensation, shall require verification of completion of training.

3.5 IT REQUIREMENTS

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- A. The Security Contractor shall coordinate with the IT department (IT) for all network and telecom connections to keep within the level and consistency of workmanship quality, materials selection and installation methods for all work performed in any Telecommunications Room (TR).
- B. Security Contractor shall request an IP address table from the IT department (IT) for all devices requiring an IP address. The address table must be approved prior to deploying and programming devices and a Report submitted for review at demonstration of Final Acceptance.
- C. Refer to Section 3.03 Tests and Reports for further information.

END OF SECTION 282300

SECTION 283100 – FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1 RELATED SECTIONS

- A. Section 230900 – Building Management System

1.2 DESCRIPTION

- A. The fire alarm system shall comply with requirements of NFPA Standard 72 for Protected Premises Signaling Systems except as modified and supplemented by this specification. The system shall be electrically supervised and monitor the integrity of all conductors.
- B. The facility shall have an emergency voice alarm communication system. Digitally stored message sequences shall notify the building occupants that a fire or life safety condition has been reported. Message generator(s) shall be capable of automatically distributing up to eight (8) simultaneous, unique messages to appropriate audio zones within the facility based on the type and location of the initiating event. The Fire Command Center (FCC) shall also support Emergency manual voice announcement capability for both system wide or selected audio zones, and shall include provisions for the system operator to override automatic messages system wide or in selected zones.
- C. The system shall be support additional, alternate Fire Command Centers, which shall be capable of simultaneous monitoring of all system events. Alternate Fire Command Centers shall also support an approved method of transferring the control functions to an alternate Fire Command Center when necessary. All Fire Command Centers shall be individually capable of assuming Audio Command functions such as Emergency Paging, audio zone control functions, and Firefighter's Telephone communication functions.
- D. Each designated zone shall transmit separate and different alarm, supervisory and trouble signals to the Fire Command Center (FCC) and designated personnel in other buildings at the site via a multiplex communication network.
- E. The fire alarm system shall be manufactured by an ISO 9001:2008 certified company and meet the requirements of BS EN9001: ANSI/ASQC Q9001-1994
- F. The FACP and peripheral devices shall be manufactured 100% by a single U.S. manufacturer (or division thereof). It's acceptable for peripheral devices to be manufactured outside of the U.S. by a division of the U.S. based parent company.
- G. The system and its components shall be Underwriters Laboratories, Inc. listed under the appropriate UL testing standard as listed herein for fire alarm applications and the installation shall be in compliance with the UL listing.
- H. The installing company shall employ NICET (minimum Level II Fire Alarm Technology) technicians on site to guide the final checkout and to ensure the systems integrity.

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1.3 GUARANTY:

- A. The fire alarm control panel, voice panels and any head-end equipment shall have a manufacturer's warranty of a minimum of 3 years.

1.4 POST CONTRACT MAINTENANCE:

- A. Complete maintenance and repair service for the fire and gas detection system shall be available from a factory trained authorized representative of the manufacturer of the major equipment for a period of five (5) years after expiration of the guaranty.
- B. As part of the bid/proposal, include a quote for a maintenance contract to provide all maintenance, required tests, and list pricing for any replacement products included on the bill of materials, along with the list pricing for products not on the bill of materials; if test and inspection rates are different than full service rates the bid/proposal shall include pricing for all levels for a minimum period of five (5) years Rates and costs shall be valid for the period of five (5) years after expiration of the guaranty.
- C. Include also a quote for unscheduled maintenance/repairs, including hourly rates for technicians trained on this equipment, and response travel costs for each year of the maintenance period. Submittals that do not identify all post contract maintenance costs will not be accepted. Rates and costs shall be valid for the period of five (5) years after expiration of the guaranty.

1.5 APPLICABLE STANDARDS AND SPECIFICATIONS:

- A. The specifications and standards listed below form a part of this specification. The system shall fully comply with the latest issue of these standards, if applicable.
- B. National Fire Protection Association (NFPA) - USA:

No. 12	Extinguishing Systems (low and high)
No. 12A	Halon 1301 Extinguishing Systems
No. 13	Sprinkler Systems
No. 15	Water Spray Systems
No. 16	Foam / Water Deluge and Spray Systems
No. 17	Dry Chemical Extinguishing Systems
No. 17A	Wet Chemical Extinguishing Systems
No. 2001	Clean Agent Extinguishing Systems
No. 70	National Electric Code
No. 90A	Air Conditioning Systems
No. 92A	Smoke Control Systems
No. 92B	Smoke Management Systems in Malls, Atria, Large Areas
No. 72	National Fire Alarm Code
No. 101	Life Safety Code

- C. Underwriters Laboratories Inc. (UL) - USA:

No. 268	Smoke Detectors for Fire Protective Signaling Systems
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No. 864	Control Units for Fire Protective Signaling Systems
No. 2572	Mass Notification Systems
No. 217	Smoke Detectors, Single and Multiple Station
No. 228	Door Closers - Holders for Fire Protective Signaling Systems
No. 268A	Smoke Detectors for Duct Applications
No. 521	Heat Detectors for Fire Protective Signaling Systems
No. 464	Audible Signaling Appliances
No. 38	Manually Actuated Signaling Boxes
No. 1481	Power Supplies for Fire Protective Signaling Systems
No. 346	Waterflow Indicators for Fire Protective Signaling Systems
No. 1076	Control Units for Burglar Alarm Proprietary Protective Signaling Systems
No. 1971	Visual Notification Appliances
No. 2017	Standard for General-Purpose Signaling Devices and Systems
No.60950	Safety of Information Technology Equipment

- D. Local and State Building Codes.
- E. All requirements of the Authority Having Jurisdiction (AHJ).

1.6 APPROVALS:

- A. The system shall have proper listing and/or approval from the following nationally recognized agencies:

UL	Underwriters Laboratories, Inc
ULC	Underwriters Laboratories Canada
FM	Factory Mutual
NYFD	New York Fire Department
CSFM	California State Fire Marshal

- B. The system shall be listed by the national agencies as suitable for extinguishing release applications. The system shall support release of low pressure CO2.
- C. The system shall be approved for use in Marine applications by the following agencies.
 - 1. United States Coast Guard
 - 2. Lloyd's Register
 - 3. American Bureau of Shipping
- D. The system shall be certified for seismic applications in accordance with the International Building Code (IBC). For OSHPD applications in California the system shall be Pre-Approved for seismic applications. The basis for qualification of seismic approval shall be via shake table testing.

PART 2 - PRODUCTS

2.1 MAIN FIRE ALARM CONTROL PANEL OR NETWORK NODE:

- A. Main FACP or network node shall be a NOTIFIER Johnson Controls Honeywell Model NFS2-640 and shall contain a microprocessor based Central Processing Unit (CPU) and power supply in an economical space saving single board design. The CPU shall communicate with and control the following types of equipment used to make up the system: intelligent addressable smoke and thermal (heat) detectors, addressable modules, printer, annunciators, and other system controlled devices.

2.2 SYSTEM CAPACITY AND GENERAL OPERATION

- A. The FACP shall be capable of communicating on Noti-Fire-Net over a Local Area Network (LAN) or Wide Area Network (WAN) utilizing a peer-to-peer, inherently regenerative communication format and protocol. The network shall support communication speed up to 100 Mb and support up to 200 panels / nodes per network.
- B. Each network node shall provide, or be capable of 318 intelligent / addressable devices per SLC loop. The Notification Appliance Circuits shall be programmable to Synchronize with System Sensor, Gentex and Wheelock Notification Appliances.
- C. The system shall include a full featured operator interface control and annunciation panel that shall include a backlit Liquid Crystal Display (LCD), individual color coded system status LEDs, and an alphanumeric keypad with easy touch rubber keys for the field programming and control of the fire and gas and gas detection system.
- D. The system shall be programmable, configurable, and expandable in the field without the need for special tools, PROM programmers or PC based programmers. It shall not require replacement of memory ICs to facilitate programming changes.
- E. The system shall allow the programming of any input to activate any output or group of outputs. Systems that have limited programming (such as general alarm), have complicated programming (such as a diode matrix), or require a laptop personal computer are not considered suitable substitutes.
- F. The FACP shall support up to 20 logic equations, including "and," "or," and "not," or time delay equations to be used for advanced programming. Logic equations shall require the use of a PC with a software utility designed for programming.
- G. The FACP or each network node shall provide the following features:
 - 1. Drift compensation to extend detector accuracy over life. Drift compensation shall also include a smoothing feature, allowing transient noise signals to be filtered out.
 - 2. Detector sensitivity test, meeting requirements of NFPA 72.
 - 3. Maintenance alert, with two levels (maintenance alert/maintenance urgent), to warn of excessive smoke detector dirt or dust accumulation.
 - 4. Up to nine sensitivity levels for alarm, selected by detector. The alarm level range shall be 0.5 to 2.35 percent per foot for photoelectric detectors, 0.5 to 2.5 percent per foot for ionization detectors,, 0.5 to 4.0 percent per foot for acclimate detectors and 1.0 to 4.0

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percent per foot for multi-criteria (IntelliQuad and IntelliQuad PLUS) detectors. The system shall also support sensitive advanced detection laser detectors with an alarm level range of .02 percent per foot to 2.0 percent per foot. The system shall also include up to nine levels of Pre-alarm, selected by detector, to indicate impending alarms to maintenance personnel.

5. The ability to display or print system reports.
6. Alarm verification, with counters and a trouble indication to alert maintenance personnel when a detector enters verification 20 times.
7. PAS presignal, meeting NFPA 72 requirements.
8. Self optimizing pre-alarm for advanced fire warning, which allows each detector to learn its particular environment and set its prealarm level to just above normal peaks.
9. Cross zoning with the capability of counting: two detectors in alarm, two software zones in alarm, or one smoke detector and one thermal detector.
10. Control-by-time for non-fire operations, with holiday schedules.
11. Day/night automatic adjustment of detector sensitivity.
12. Device blink control for sleeping areas.
13. The FACP shall be capable of coding main panel node notification circuits in March Time (120 PPM), Temporal (NFPA 72 A-2-2.2.2), and California Code. Panel notification circuits (NAC 1,2,3 and 4) shall also support Two-Stage operation, Canadian Dual Stage (3 minutes) and Canadian Dual Stage (5 minutes). Two stage operation shall allow 20 Pulses Per Minute (PPM) on alarm and 120 PPM after 5 minutes or when a second device activates. Canadian Dual stage is the same as Two-Stage except will only switch to second stage by activation of Drill Switch 3 or 5 minute timer. The panel shall also provide a coding option that will synchronize specific strobe lights designed to accept a specific "sync pulse."
14. Network Communication. The FACP shall be capable of communicating with a Distributed Control System
15. For flexibility and to ensure program validity, an optional Windows(TM) based program utility shall be available. This program shall be used to off-line program the system with batch upload/download, and have the ability to upgrade the manufacturers (FLASH) system code changes. This program shall also have a verification utility, which scans the program files, identifying possible errors. It shall also have the ability to compare old program files to new ones, identifying differences in the two files to allow complete testing of any system operating changes. This shall be in compliance with the NFPA 72 requirements for testing after system modification.
 - a. This utility shall provide the ability to create and print NFPA style Test and Inspection reports
 - b. This utility shall provide the ability to create and print Device Maintenance information
16. The 80-character display keypad shall be an easy to use QWERTY type keypad, similar to a PC keyboard. This shall be part of the standard system and have the capability to command all system functions, entry of any alphabetic or numeric information, and field programming. Two different password levels shall be provided to prevent unauthorized system control or programming.
17. When configured with an optional 640-character display the display shall use 10 "soft" keys for screen navigation or to accomplish dedicated programming functions. Full programming access shall require use of a laptop and the proper programming utility. With the 640 display option the system shall support distributed audio amplifiers on the digital audio loop of the Digital Voice Command.

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H. Signaling Line Circuits (SLC)

1. Each FACP or FACP network node shall support up to two SLCs. Each SLC interface shall provide power to and communicate with up to 159 intelligent detectors (ionization, photoelectric, multi-criteria, thermal, laser, fire/CO) and 159 intelligent modules (monitor, control, relay, releasing) for a loop capacity of 318 devices. The addition of the optional second loop shall double the device capacity, supporting a total of 636 devices. Each SLC shall be capable of NFPA 72 Style 4, Style 6, or Style 7 (Class A or B) wiring.
2. CPU shall receive analog information from all intelligent detectors to be processed to determine whether normal, alarm, prealarm, or trouble conditions exist for each detector. The software shall automatically maintain the detector's desired sensitivity level by adjusting for the effects of environmental factors, including the accumulation of dust in each detector. The analog information shall also be used for automatic detector testing and for the automatic determination of detector maintenance requirements.

I. Serial Interfaces

1. The system shall include two serial EIA-232 interfaces. Each interface shall be a means of connecting UL Listed Information Technology Equipment (ITE) peripherals.
 - a. EIA-232 interface shall be used to connect an UL-Listed 40 or 80 column printer. Printers that are not UL-Listed are not considered acceptable substitutes.
 - b. The system shall include an EIA-485 port for the serial connection of optional annunciators and remote LCD displays.
 - c. The EIA-485 interface may be used for network connection to a proprietary-receiving unit.

J. Digital Voice Command Center

1. The Digital Voice Command Center located with the FACP, shall contain all equipment required for all audio control, emergency telephone system control, signaling and supervisory functions. This shall include speaker zone indication and control, telephone circuit indication and control, digital voice units, microphone and main telephone handset. The DVC shall support up to 8 channels of voice when configured with Digital Audio Amplifiers and 4 channels of voice when employing the optional analog output card. Each DVC shall support up to 32 digital audio amplifiers.
2. Function: The Voice Command Center equipment shall perform the following functions:
 - a. Operate as a supervised multi-channel emergency voice communication system.
 - b. Operate as a two-way emergency telephone system control center.
 - c. Audibly and visually announce the active or trouble condition of every speaker circuit and emergency telephone circuit.
 - d. Audibly and visually announce any trouble condition for digital tone and voice units required for normal operation of the system.
 - e. Provide all-call Emergency Paging activities through activation of a single control switch.
 - f. As required, provide vectored paging control to specific audio zones via dedicated control switches.
 - g. Provide a factory recorded "library" of voice messages and tones in standard WAV. File format, which may be edited and saved on a PC running a current Windows® operating system.
 - h. Provide a software utility capable of off-line programming for the DVC operation and the audio message files. This utility shall support the creation of new programs as well as editing and saving existing program files. Uploading or downloading the DVC shall not inhibit the emergency operation of other nodes on the fire alarm network.

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- i. Support an optional mode of operation with four analog audio outputs capable of being used with UL 864 fire-listed analog audio amplifiers and SLC controlled switching.
 - j. The Digital Voice Command shall be modular in construction, and shall be capable of being field programmable without requiring the return of any components to the manufacturer and without requiring use of any external computers or other programming equipment.
 - k. The Digital Voice Command and associated equipment shall be protected against unusually high voltage surges or line transients.
3. The emergency voice alarm communication system shall incorporate a Two-way emergency telephone communication system.
- a. Two-way emergency telephone communication circuits shall be supervised for open and short circuit conditions.
 - b. Two-way emergency telephone (Fire Fighter Telephone) communication shall be supported between the Digital Voice Audio Command Center and up to seven (7) remote Fire Fighter's Telephone locations simultaneously on a telephone riser.
 - c. Means shall be provided to connect FFT voice communications to the speaker circuits in order to allow voice paging over the speaker circuit from a telephone handset.

K. Audio Amplifiers

1. The Audio Amplifiers will provide Audio Power (@25 Volt RMS or 70 RMS) for distribution to speaker circuits.
2. Multiple audio amplifiers may be mounted in a single enclosure, either to supply incremental audio power, or to function as an automatically switched backup amplifier(s).
3. The audio amplifier shall include an integral power supply, and shall provide built-in LED indicators for the following conditions:
 - a. Earth Fault on DAP A (Digital Audio Port A)
 - b. Earth Fault on DAP B (Digital Audio Port B)
 - c. Audio Amplifier Failure Detected Trouble
 - d. Active Alarm Bus input
 - e. Audio Detected on Aux Input A
 - f. Audio Detected on Aux Input B
 - g. Audio Detected on Firefighter's Telephone Riser
 - h. Receiving Audio from digital audio riser
 - i. Short circuit on speaker circuit 1
 - j. Short circuit on speaker circuit 2
 - k. Short circuit on speaker circuit 3
 - l. Short circuit on speaker circuit 4
 - m. Data Transmitted on DAP A
 - n. Data Received on DAP A
 - o. Data Transmitted on DAP B
 - p. Data Received on DAP B
 - q. Board failure
 - r. Active fiber optic media connection on port A (fiber optic media applications)
 - s. Active fiber optic media connection on port B (fiber optic media applications)
 - t. Power supply Earth Fault
 - u. Power supply 5V present
 - v. Power supply conditions - Brownout, High Battery, Low Battery, Charger Trouble

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4. The audio amplifier shall provide the following built-in controls:
 - a. Amplifier Address Selection Switches
 - b. Signal Silence of communication loss annunciation Reset
 - c. Level adjustment for background music
 - d. Enable/Disable for Earth Fault detection on DAP A
 - e. Enable/Disable for Earth Fault detection on DAP A
 - f. Switch for 2-wire/4-wire FFT riser
 5. Adjustment of the correct audio level for the amplifier shall not require any special tools or test equipment.
 6. Includes audio input and amplified output supervision, back up input, and automatic switch over function, (if primary amplifier should fail).
 7. System shall be capable of backing up digital amplifiers.
 8. One-to-one backup shall be provided by either a plug-in amplifier card or a designated backup amplifier of identical model as the primary amplifier.
 9. One designated backup amplifier shall be capable of backing up multiple primary amplifiers mounted in the same or adjacent cabinets.
 10. Multi-channel operation from a single amplifier shall be supported by the addition of an optional plug-in amplifier card.
- L. Audio Message Generator (Prerecorded Voice)/Speaker Control:
1. Each initiating zone or intelligent device shall interface with an emergency voice communication system capable of transmitting a prerecorded voice message to all speakers in the building.
 2. Actuation of any alarm initiating device shall cause a prerecorded message to sound over the speakers. The message shall be repeated four (4) times. Pre- and post-message tones shall be supported.
 3. A built-in microphone shall be provided to allow paging through speaker circuits.
 4. System paging from emergency telephone circuits shall be supported.
 5. The audio message generator shall have the following indicators and controls to allow for proper operator understanding and control:
 - a. Lamp Test
 - b. Trouble
 - c. Off-Line Trouble
 - d. Microphone Trouble
 - e. Phone Trouble
 - f. Busy/Wait
 - g. Page Inhibited
 - h. Pre/Post Announcement Tone
- M. Controls with associated LED Indicators:
1. Speaker Switches/Indicators
 - a. The speaker circuit control switches/indicators shall include visual indication of active and trouble status for each speaker circuit in the system.
 - b. The speaker circuit control panel shall include switches to manually activate or deactivate each speaker circuit in the system.
 2. Emergency Two-Way Telephone Control Switches/Indicators
 - a. The emergency telephone circuit control panel shall include visual indication of active and trouble status for each telephone circuit in the system.
 - b. The telephone circuit control panel shall include switches to manually activate or deactivate each telephone circuit in the system.

N. Specific System Operations

1. Smoke Detector Sensitivity Adjust: A means shall be provided for adjusting the sensitivity of any or all addressable intelligent detectors in the system from the system keypad. Sensitivity range shall be within the allowed UL window and have a minimum of 9 levels.
2. Alarm Verification: Each of the intelligent addressable smoke detectors in the system may be independently selected and enabled to be an alarm verified detector. The alarm verification delay shall be programmable from 0 to 60 seconds and each detector shall be able to be selected for verification. The FACP shall keep a count of the number of times that each detector has entered the verification cycle. These counters may be displayed and reset by the proper operator commands.
3. Point Disable: Any addressable device in the system may be enabled or disabled through the system keypad.
4. Point Read: The system shall be able to display or print the following point status diagnostic functions:
 - a. Device status
 - b. Device type
 - c. Custom device label
 - d. View analog detector values
 - e. Device zone assignments
5. System History Recording and Reporting: The fire alarm control panel shall contain a history buffer that will be capable of storing up to 800 events. Up to 200 events shall be dedicated to alarm and the remaining events are general purpose. Systems that do not have dedicated alarm storage, where events are overridden by non-alarm type events, are not suitable substitutes. Each of these activations will be stored and time and date stamped with the actual time of the activation. The contents of the history buffer may be manually reviewed, one event at a time, or printed in its entirety. The history buffer shall use non-volatile memory. Systems that use volatile memory for history storage are not acceptable substitutes.
6. Automatic Detector Maintenance Alert: The fire alarm control panel shall automatically interrogate each intelligent detector and shall analyze the detector responses over a period of time. If any intelligent detector in the system responds with a reading that is above or below normal limits, then the system will enter the trouble mode, and the particular detector will be annunciated on the system display, and printed on the optional printer. This feature shall in no way inhibit the receipt of alarm conditions in the system, nor shall it require any special hardware, special tools or computer expertise to perform.
7. Pre-Alarm Function: The system shall provide two levels of pre-alarm warning to give advance notice of a possible fire situation. Both pre-alarm levels shall be fully field adjustable. The first level shall give an audible indication at the panel. The second level shall give an audible indication and may also activate control relays. The system shall also have the ability to activate local detector sounder bases at the pre-alarm level, to assist in avoiding nuisance alarms.
8. Software Zones: The FACP shall support 142 independent programmable software zones
9. The fire alarm control panel shall include a walk test feature. It shall include the ability to test initiating device circuits and notification appliance circuits from the field without returning to the panel to reset the system. Operation shall be as follows:
 - a. Alarming an initiating device shall activate programmed outputs, which are selected to participate in walk test, for 3 seconds.
 - b. Introducing a trouble into the initiating device shall activate the programmed outputs for 8 seconds.
 - c. All devices tested in walk test shall be recorded in the history buffer.

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10. Multiple agent releasing zones: The system shall support up to 10 releasing zones to protect against 10 independent hazards. Releasing zones shall provide up to three cross-zone and four abort options to satisfy any local jurisdiction requirements.
 11. Mass Notification Override: The system shall be UL 2572 listed for Mass Notification and shall be capable, based on the Risk Analysis, of being programmed so that Mass Notification/Emergency Communications events take precedence over fire alarm events.
- O. Conventional Aspirating Detection
1. An optional air aspiration detection system shall be available.
 2. The aspirating system shall support multiple sensitivity settings.
 3. The aspirating system shall operate from 24 VDC.
 4. The aspirating system shall provide alarm and trouble relays used to activate a fire alarm control panel.
- P. Aspiration System Interface:
1. The system shall be capable of supporting Interface Modules for integrating Vesda Aspiration detectors into SLC loop of the fire alarm control panel. The Interface Module shall support up to 19 detectors, each SLC loop shall support one interface module.
- Q. High Level Aspiration System Interface:
1. The system shall be capable of supporting a High Level Interface for Vesda Aspirating Detection Systems. The interface shall support up to 100 detectors and allow the fire alarm network to monitor and control events on the aspiration system.
- R. Portable Emergency Telephone Handset Jack
1. Portable emergency telephone handset jacks shall be flush mounted on stainless steel plates as indicated on the plans. Jacks shall be approved for emergency telephone system application.
 2. Insertion of a portable handset plug into a jack shall send a signal to the fire command center, which shall audibly and visually indicate the on-line condition, and shall sound a "ring" indication in the handset.
 3. The two-way emergency telephone system shall support a minimum of seven (7) handsets on line without degradation of the signal.
- S. Fixed Emergency Telephone Handset
1. The telephone cabinet shall be painted red and clearly labeled as "Emergency Telephone." The cabinets shall be located where shown on drawings.
 2. The handset cradle shall have a switch connection so that lifting the handset off of the cradle shall send a signal to the fire command center, which shall audibly and visually indicate its on-line (off-hook) condition.
 3. On activating the remote phone, the phone earpiece shall sound a telephone ring signal until the master handset is lifted.
 4. The two-way emergency telephone system shall support a minimum of seven (7) handsets on line without degradation of the signal.
- T. All interfaces and associated equipment are to be protected so that they will not be affected by voltage surges or line transients consistent with UL standard 864.
- U. Communicators
1. The UDACT shall be compact in size, mounting in a standard module position of the fire alarm control cabinet. Optionally, the UDACT shall have the ability for remote

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mounting, up to 6,000 feet from the fire alarm control panel. The wire connections between the UDACT and the control panel shall be supervised with one pair for power and one pair for multiplexed communication of overall system status. Systems that utilize relay contact closures are not acceptable.

2. The UDACT shall include connections for dual telephone lines (with voltage detect), per UL/NFPA/FCC requirements. It shall include the ability for split reporting of panel events up to two different telephone numbers.
3. The UDACT shall be capable of transmitting events in 4+2, SIA, and Contact ID.
4. Communication shall include vital system status such as:
 - a. Independent Zone (Alarm, trouble, non-alarm, supervisory)
 - b. Independent Addressable Device Status
 - c. AC (Mains) Power Loss
 - d. Low Battery and Earth Fault
 - e. System Off Normal
 - f. 12 and 24 Hour Test Signal
 - g. Abnormal Test Signal (per UL requirements)
 - h. EIA-485 Communications Failure
 - i. Phone Line Failure
5. The UDACT shall support independent zone/point reporting when used in the Contact ID format. In this format the UDACT shall support transmission of up to 3,064 points. This enables the central station to have exact details concerning the origin of the fire or response emergency.
6. The UDACT shall be capable of being programmed with the same programming utility as the host FACP, and saved, edited and uploaded and downloaded using the utility. UDACT shall be capable of being programmed online or offline. The programming utility shall also support upgrading UDACT operating firmware.
7. The UDACT shall be capable of generating Central Station reports providing detailed programming information for each point along with the central station point address.
8. An IP or IP/GSM Communicator option shall be available to interface to the UDACT and be capable of transmitting signals over the internet/intranet or Cellular (GSM) network to a compatible receiver.

V. Smoke Control Annunciator

1. On/Auto/Off switches and status indicators (LEDS) shall be provided for monitoring and manual control of each fan, damper, HVAC control unit, stairwell pressurization fan, and smoke exhaust fan. To ensure compliance the units supplied shall meet the following UL categories: UUKL, PAZX, UDTZ, QVAX as well as the requirements of NFPA 90A, HVAC, and NFPA 92A & 92B, Smoke Control. The control System shall be field programmable for either 90A operation or 92A/B operation to allow for future use and system expansion.
2. The OFF LED shall be Yellow, the ON LED shall be green, the Trouble/Fault LED shall be Amber/Orange for each switch. The Trouble/Fault indicator shall indicate a trouble in the control and/or monitor points associated with that switch. In addition, each group of eight switches shall have two LEDS and one momentary switch which allow the following functions: An Amber LED to indicate an OFF-NORMAL switch position, in the ON or OFF position; A Green LED to indicate ALL AUTO switch position; A Local Acknowledge/Lamp Test momentary switch.
3. Each switch shall have the capability to monitor and control two addressable inputs and two addressable outputs. In all modes, the ON and OFF indicators shall continuously follow the device status not the switch position. Positive feedback shall be employed to

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verify correct operation of the device being controlled. Systems that indicate on/off/auto by physical switch position only are not acceptable.

4. All HVAC switches (i.e., limit switches, vane switches, etc.) shall be provided and installed by the HVAC contractor.
5. It shall be possible to meet the requirements mentioned above utilizing wall mounted custom graphic.

2.3 Gateway & Webserver Options

- A. Common Alerting Protocol (CAP) Gateway: The system shall support an optional CAP Gateway (Common Alerting Protocol). The CAP Gateway translates fire system messages to industry standard CAP messages for integration with CAP-compliant clients. A CAP gateway shall be available from the fire alarm control panel manufacturer.
- B. LEDSIGN Gateway: The system shall support an optional and proprietary LEDSIGN Gateway to interface to LED signs that will automatically display emergency messages. The signs shall be capable of storing up to 100 messages that can be activated via system programming with the ability to be manually overridden. The Sign Gateway shall support up to 10 independent signs, each sign capable of playing an independent message. Multiple LEDSIGN Gateways can be used in network applications. An LEDSIGN gateway shall be available from the fire alarm control panel manufacturer.
- C. BACnet Interface Gateway: The system shall be capable of being interfaced with BACnet compliant clients. A BACnet interface supporting BACnet/IP communication shall be available from the fire alarm control panel manufacturer.
- D. MODbus Interface Gateway: The system shall be capable of being interfaced with MODbus compliant clients. A MODbus interface supporting MODbus/TCP communication shall be available from the fire alarm control panel manufacturer.
- E. Noti-Fire-Net Gateway: The system shall support an IP based gateway to enable the panel or local Noti-Fire-Net to be connected to an ONYXWorks workstation via the Internet or Intranet. This gateway shall also support the ability to integrate the system to an interactive firefighter's display. The Noti-Fire-Net Gateway shall be available from the fire alarm control manufacturer.
- F. Webserver: The system shall support a webserver allowing remote connection via the Internet or Intranet. Authorized users will have the ability to view panel/network history, event status and device properties. The webserver shall also support sending event information via email or text to up to 50 registered users, the webserver shall be available from the fire alarm control panel manufacturer.
- G. Web Portal Interface: The system shall be capable of being interfaced with a web portal to integrate with Inspection and Service Manager Utilities. The web portal and inspection and service manager utilities shall be available from the fire alarm control panel manufacturer.

2.4 SYSTEM COMPONENTS - ADDRESSABLE DEVICES

- A. Addressable Devices - General

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1. Addressable devices shall use simple to install and maintain decade, decimal address switches. Devices shall be capable of being set to an address in a range of 001 to 159.
 2. Addressable devices, which use a binary-coded address setting method, such as a DIP-switch, are not an allowable substitute. Addressable devices that require the address be programmed using a special tool or programming utility are not an allowable substitute.
 3. Detectors shall be intelligent (analog) and addressable, and shall connect with two wires to the fire alarm control panel Signaling Line Circuits.
 4. Addressable smoke and thermal detectors shall provide dual alarm and power/polling LEDs. Both LEDs shall flash green under normal conditions, indicating that the detector is operational and in regular communication with the control panel, and both LEDs shall be placed into steady red illumination by the control panel, indicating that an alarm condition has been detected. If required, the LED flash shall have the ability to be removed from the system program. An output connection shall also be provided in the base to connect an external remote alarm LED.
 5. The fire alarm control panel shall permit detector sensitivity adjustment through field programming of the system. The panel on a time-of-day basis shall automatically adjust sensitivity.
 6. Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72.
 7. The detectors shall be ceiling-mount and shall include a separate twist-lock base with tamper proof feature. Base options shall include a sounder base with a built-in (local) sounder rated at 85 DBA minimum, a relay base and an isolator base designed for Style 7 applications. The system shall also support an intelligent programmable sounder base, the programmable sounder base shall be capable of providing multiple tones based on programming and at a minimum be capable of providing a Temp-4 tone for CO (Carbon Monoxide) activation and a Temp-3 tone for fire activations and be capable of being synchronized with other programmable sounder bases and common area notification appliances; 85 DBA minimum.
 8. The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel.
 9. Detectors shall also store an internal identifying type code that the control panel shall use to identify the type of device (ION, PHOTO, THERMAL).
 10. Detectors will operate in an analog fashion, where the detector simply measures its designed environment variable and transmits an analog value to the FACP based on real-time measured values. The FACP software, not the detector, shall make the alarm/normal decision, thereby allowing the sensitivity of each detector to be set in the FACP program and allowing the system operator to view the current analog value of each detector.
 11. Addressable devices shall store an internal identifying code that the control panel shall use to identify the type of device.
 12. A magnetic test switch shall be provided to test detectors and modules. Detectors shall report an indication of an analog value reaching 100% of the alarm threshold.
 13. Addressable modules shall mount in a 4-inch square (101.6 mm square), 2-1/8 inch (54 mm) deep electrical box. An optional surface mount Lexan enclosure shall be available.
- B. Addressable Manual Fire Alarm Box (manual station)
1. Addressable manual fire alarm boxes shall, on command from the control panel, send data to the panel representing the state of the manual switch and the addressable

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- communication module status;NOTIFIER model # NBG-12LX. They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.
2. All operated stations shall have a positive, visual indication of operation and utilize a key type reset.
 3. Manual fire alarm boxes shall be constructed of Lexan with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters, 1.75 inches (44 mm) or larger.
- C. Intelligent Photoelectric Smoke Detector: The intelligent photoelectric smoke detector shall be NOTIFIER model # FSP-851 and shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.
- D. Intelligent VIEW® Laser Photo Smoke Detector: The intelligent laser photo smoke detector shall be a spot type detector, NOTIFIER model # FSL-751, that incorporates an extremely bright laser diode and an integral lens that focuses the light beam to a very small volume near a receiving photo sensor. The scattering of smoke particles shall activate the photo sensor.
1. The laser detector shall have conductive plastic so that dust accumulation is reduced significantly.
 2. The intelligent laser photo detector shall have nine sensitivity levels and be sensitive to a minimum obscuration of 0.02 percent per foot.
 3. The laser detector shall not require expensive conduit, special fittings or PVC pipe.
 4. The intelligent laser photo detector shall support standard, relay, isolator and sounder detector bases.
 5. The laser photo detector shall not require other cleaning requirements than those listed in NFPA 72. Replacement, refurbishment or specialized cleaning of the detector head shall not be required.
 6. The laser photo detector shall include two bicolor LEDs that flash green in normal operation and turn on steady red in alarm.
- E. Intelligent Ionization Smoke Detector: The intelligent ionization smoke detector shall be NOTIFIER model # FSI-851 and shall use the dual-chamber ionization principal to measure products of combustion and shall, on command from the control panel, send data to the panel representing the analog level of products of combustion.
- F. Intelligent Multi Criteria Acclimating Detector: The intelligent multi-criteria Acclimate® Plus™ detector shall be an addressable device, NOTIFIER model # FAPT-851, that is designed to monitor a minimum of photoelectric and thermal technologies in a single sensing device. The design shall include the ability to adapt to its environment by utilizing a built-in microprocessor to determine its environment and choose the appropriate sensing settings. The detector design shall allow a wide sensitivity window, no less than 1 to 4% per foot obscuration. This detector shall utilize advanced electronics that react to slow smoldering fires and thermal properties all within a single sensing device.
1. The microprocessor design shall be capable of selecting the appropriate sensitivity levels based on the environment type it is in (office, manufacturing, kitchen etc.) and then have the ability to automatically change the setting as the environment changes (as walls are moved or as the occupancy changes).
 2. The intelligent multi criteria detection device shall include the ability to combine the signal of the thermal sensor with the signal of the photoelectric signal in an effort to react hastily in the event of a fire situation. It shall also include the inherent ability to

distinguish between a fire condition and a false alarm condition by examining the characteristics of the thermal and smoke sensing chambers and comparing them to a database of actual fire and deceptive phenomena.

- G. Intelligent Thermal Detectors: The intelligent thermal detectors shall be NOTIFIER FST-851 series addressable devices rated at 135 degrees Fahrenheit (58 degrees Celsius) and have a rate-of-rise element rated at 15 degrees F (9.4 degrees C) per minute. A high heat thermal detector rated at 190 degrees Fahrenheit shall also be available. The thermal detectors shall connect via two wires to the fire alarm control panel signaling line circuit.
- H. Intelligent Duct Smoke Detector: The smoke detector housing shall accommodate an intelligent photoelectric detector that provides continuous analog monitoring and alarm verification from the panel. When sufficient smoke is sensed, an alarm signal is initiated at the FACP, and appropriate action taken to change over air handling systems to help prevent the rapid distribution of toxic smoke and fire gases throughout the areas served by the duct system. The Intelligent Duct Smoke Detector shall support the installation of addressable Photoelectric detector capable or being tested remotely. The Intelligent Duct Detector housing shall be model # DNR(W) and the remote test capable photoelectric smoke detector shall be NOTIFIER model # FSP-851R.
- I. IntelliQuad™ Advanced Multi-Criteria Intelligent Detector
1. Intelligent multi-criteria fire detector shall be a NOTIFIER model number FSC-851. Smoke detector shall be an addressable intelligent multi-criteria smoke detector. The detector shall be comprised of four sensing elements, including a photoelectric (light-scattering) particulate sensor, an electrochemical carbon monoxide (CO) sensor, a daylight-filtered infrared sensor and solid state thermal sensor(s) rated at 135°F (57.2°C). The device shall be able to indicate distinct smoke and heat alarms.
 2. The intelligent multi-criteria detection device shall include the ability to combine the signal of the photoelectric signal with other sensing elements in an effort to react quickly in the event of a fire situation. It shall also include the inherent ability to distinguish between a fire condition and a nuisance alarm condition. The product design shall be capable of selecting the appropriate sensitivity levels based on the environment type chosen by user in which it is installed (office, manufacturing, kitchen etc.) and then have the ability to automatically change the setting as the environment changes.
 3. The detector shall be capable of automatically adjusting its sensitivity by means of drift compensation and smoothing algorithms. The detector shall be capable of automatically adjusting its sensitivity by means of drift compensation and smoothing algorithms. The device shall provide unique signals to indicate when 20% of the drift range is remaining, when 100% of drift range is used, and when there is a chamber fault to show unit requires maintenance.
 4. The detector shall indicate CO trouble conditions including 6 months of sensor life remaining and sensor life has expired. The detector shall indicate a combined signal for any of the following: low chamber trouble, thermistor trouble, CO self test failure, IR self test failure, and freeze warning.
 5. The detectors shall provide address-setting means on the detector head using rotary switches. Because of the possibility of installation error, systems that use binary jumpers or DIP switches to set the detector address are not acceptable. The detectors shall also store an internal identifying code that the control panel shall use to identify the type of detector. Systems that require a special programmer to set the detector address (including temporary connection at the panel) are labor intensive and not acceptable. Each detector

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- occupies any one of at least 99 possible addresses on the signaling line circuit (SLC) loop. It responds to regular polls from the system and reports its type and status.
6. The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a switch) or initiated remotely on command from the control panel. There are three test methods: functional magnet, smoke entry aerosol, or direct heat method.
 7. The detectors shall provide two LEDs to provide 360° visibility. The LEDs are placed into steady red illumination by the control panel indicating that an alarm condition has been detected. An output connection shall also be provided in the base to connect an external remote alarm LED, sounder base, and / or relay base (optional accessories). The external remote alarm can be interconnected to other sounder or relay bases for activating all devices in a space via a single alarming unit.
 8. Two LEDs on the sensor are controlled by the panel to indicate sensor status. Coded signals, transmitted from the panel, can cause the LEDs to blink, latch on, or latch off. Refer to the control panel technical documentation for sensor LED status operation and expected delay to alarm.
 9. The detectors shall be ceiling-mount and shall be plug-in mounted into a twist-lock base. These detectors shall be constructed of off-white UV resistant polymer and shall be detachable from the mounting base to simplify installation, service and maintenance. Mounting base wiring connections shall be made by means of SEMS screws. The detector shall allow pre-wiring of the base and the head shall be a plug-in type. Mounting base shall be mounted on junction box which is at least 1.5 inches (3.81 cm) deep. Mounting base shall be available to mount to standard junction boxes. Suitable boxes include:
 - a. 4.0" (10.16 cm) square box with and without plaster ring.
 - b. 4.0" (10.16 cm) octagonal box.
 - c. 3.5" (8.89 cm) octagonal box.
 - d. Single-gang box.
 10. Meets Agency Standards
 - a. ANSI/UL 268 -Smoke Detectors for Fire Alarm Signaling Systems
 - b. CAN/ULC-S529- Smoke Detectors for Fire Alarm Systems
 - c. FM 3230-3250- Smoke Actuated Detectors for Automatic Fire Alarm Signaling
- J. IntelliQuad™ PLUS Advanced Multi-Criteria Intelligent Fire/CO Detector
1. Advanced Multi-Criteria Fire/CO detector shall be NOTIFIER model # FCO-851 and shall be an addressable advanced multi-criteria smoke detector with a separate signal for carbon monoxide (CO) detection per UL 2075 standards.
 2. The detector shall be comprised of four sensing elements, including a photoelectric (light-scattering) particulate sensor, an electrochemical CO sensor, a daylight-filtered infrared (IR) sensor and solid state thermal sensor(s) rated at 135°F (57.2°C). The device shall be able to indicate distinct smoke and heat alarms.
 3. The advanced multi-criteria detection device shall include the ability to combine the signal of the photoelectric signal with other sensing elements in order to react quickly in the event of a fire situation. It shall also include the inherent ability to distinguish between a fire condition and a nuisance alarm condition. The detector shall be capable of selecting the appropriate sensitivity levels based on the environment type (office, manufacturing, kitchen, etc.) in which it is installed, and then have the ability to automatically change the setting as the environment changes.
 4. The CO detector component shall be capable of a functional gas test using a canned test agent to test the functionality of the CO sensing cell.

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5. The detector shall be capable of automatically adjusting its sensitivity by means of drift compensation and smoothing algorithms. The device shall provide unique signals to indicate when 20 percent of the drift range is remaining, when 100 percent of drift range is used, and when there is a chamber fault to show the unit requires maintenance.
 6. The detector shall indicate CO trouble conditions, including six months of sensor life remaining and sensor life has expired. The detector shall indicate a combined signal for any of the following: low chamber trouble, thermistor trouble, CO self test failure, IR self test failure, and freeze warning.
 7. The detector shall provide address-setting means on the detector head using rotary switches. Because of the possibility of installation error, systems that use binary jumpers or DIP switches to set the detector address are not acceptable. The detector shall also store an internal identifying code that the control panel shall use to identify the type of detector. Systems that require a special programmer to set the detector address (including temporary connection at the panel) are labor intensive and not acceptable. Each detector occupies any one of at least 159 possible addresses on the signaling line circuit (SLC) loop. It responds to regular polls from the system and reports its type and status.
 8. The detector shall provide a test means whereby it will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a switch) or initiated remotely on command from the control panel. There shall be four test methods: functional magnet, smoke entry aerosol, carbon monoxide aerosol or direct heat method.
 9. The detector shall provide two LEDs to provide 360° visibility. The LEDs shall be placed into steady red illumination by the control panel indicating that an alarm condition has been detected. An output connection shall also be provided in the base to connect an external remote alarm LED. The detector must be capable of connecting to a sounder base that provides both temporal 3 and temporal 4 patterns for fire and CO alarm.
 10. Two LEDs on the sensor shall be controlled by the panel to indicate sensor status. Coded signals, transmitted from the panel, shall cause the LEDs to blink, latch on, or latch off. Refer to the control panel technical documentation for sensor LED status operation and expected delay to alarm.
 11. The detector shall be plug-in mounted into a twist-lock base. The detector shall be constructed of off-white, UV-resistant polymer and shall be detachable from the mounting base to simplify installation, service and maintenance. Mounting base wiring connections shall be made by means of SEMS screws. The detector shall allow pre-wiring of the base and the head shall be a plug-in type. The mounting base shall be mounted on a junction box that is at least 1.5 inches (3.81 cm) deep. The mounting base shall be available to mount to standard junction boxes. Suitable boxes include:
 - a. 4.0" (10.16 cm) square box with and without plaster ring.
 - b. 4.0" (10.16 cm) octagonal box.
 - c. 3.5" (8.89 cm) octagonal box.
 - d. Single-gang box.
 - e. Double-gang box
 12. Meets Agency Standards
 - a. ANSI/UL 268 -Smoke Detectors for Fire Alarm Signaling Systems
 - b. CAN/ULC-S529- Smoke Detectors for Fire Alarm Systems
 - c. FM 3230-3250- Smoke Actuated Detectors for Automatic Fire Alarm Signaling
 - d. UL 2075 – Gas and Vapor Detector and Sensors – Systems Connected
- K. Intelligent Addressable Aspiration Detector: The intelligent aspiration detector shall be NOTIFIER model # FSA-8000 an addressable aspiration detector that communicates directly with the fire alarm control panel via the SLC communication protocol, no modules or high level

interfaces shall be required. The fire alarm control panel shall support up to thirty one intelligent aspiration detectors per SLC loop. The aspiration detector shall have dual source (blue LED and infra-red laser) optical smoke detection for a wide range of fire detection with enhanced immunity to nuisance particulates. The FACP shall be capable of monitoring and annunciating up to five smoke event thresholds and eleven trouble conditions. Each event threshold shall be capable of being assigned a discrete type ID at the FACP

L. Intelligent Addressable Reflected Beam Detector

1. The intelligent single-ended reflected beam smoke detector shall connect with two wires to the fire alarm control panel signaling line circuit (SLC). The detectors shall consist of a transmitter/receiver unit and a reflector and shall send data to the panel representing the analog level of smoke density. The detector shall be capable of being tested remotely via a keyswitch; NOTIFIER model # FSB-200. Model # FSB-200S shall be equipped with an integral sensitivity test feature

M. Addressable Dry Contact Monitor Module

1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional alarm initiating devices (any N.O. dry contact device) to one of the fire alarm control panel SLCs. The addressable monitor module shall be NOTIFIER model # FMM-1 (Class A or B) or FMM-101 (Class B)
2. The IDC zone shall be suitable for Style D/Class A or Style B/Class B operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.
3. For difficult to reach areas, the monitor module shall be available in a miniature package and shall be no larger than 2-3/4 inch (70 mm) x 1-1/4 inch (31.7 mm) x 1/2 inch (12.7 mm). This version need not include Style D or an LED.
4. For multiple dry contact monitoring a module shall be available that provides 10 Style B or 5 Style D input circuits; NOTIFIER model # XP10-M.

N. Two Wire Detector Monitor Module

1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional 2-wire smoke detectors or alarm initiating devices (any N.O. dry contact device); NOTIFIER model # FZM-1.
2. The IDC zone may be wired for Class A or B (Style D or Style B) operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.
3. For multiple 2-wire smoke detector circuit monitoring a module shall be available that provides 6 Style B/Class A or 3 Style D/Class B input circuits; NOTIFIER model # XP6-MA

O. Addressable Control Module

1. Addressable control modules shall be provided to supervise and control the operation of one conventional circuit of compatible Notification Appliances, 24 VDC powered, polarized audio/visual notification appliances; NOTIFIER model # FCM-1
2. The control module NAC may be wired for Style Z or Style Y (Class A/B) with a current rating of 2 Amps for Style Z and 3 Amps for Style Y;
3. Audio/visual power shall be provided by a separate supervised circuit from the main fire alarm control panel or from a supervised UL listed remote supply.
4. For multiple circuit control a module shall be available that provides 6 Style Y (Class B) or 3 Style Z (Class A) control circuits; NOTIFIER model # XP6-C.

- P. Addressable Releasing Control Module
1. An addressable FlashScan releasing module shall be available to supervise and control compatible releasing agent solenoids; NOTIFIER model # FCM-1-REL.
 2. The module shall operate on a redundant protocol for added protection.
 3. The module shall be configurable for Style Z or Style Y (Class A/B) and support one 24 volt or two 12 volt solenoids.
- Q. Addressable Relay Module:
1. Addressable Relay Modules shall be available for HVAC control and other network building functions; NOTIFIER model # FRM-1.
 2. The module shall provide two form C relays rated at up to 3 Amps resistive and up to 2.0 Amps inductive.
 3. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary devices energize at the same time on the same pair of wires.
 4. For multiple relay control a module shall be available that provides 6 programmable Form-C relays; NOTIFIER model # XP6-R.
- R. Addressable Two-In / Two-Out Monitor/Relay Module:
1. An addressable Two-In / Two-Out module shall be available; NOTIFIER model # FDRM-1.
 2. The two-in/two-out module shall provide two Class B/Style B dry-contact input circuits and two independent Form-C relays rated at up to 3 Amps resistive and up to 2.0 Amps inductive.
- S. Isolator Module: Isolator modules shall be provided to automatically isolate wire-to-wire short circuits on an SLC Class A or Class B branch. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC loop segment or branch. At least one isolator module shall be provided for each floor or protected zone of the building; NOTIFIER model # ISO-X.
1. If a wire-to-wire short occurs, the isolator module shall automatically open-circuit (disconnect) the SLC. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section.
 2. The isolator module shall not require address-setting, and its operations shall be totally automatic. It shall not be necessary to replace or reset an isolator module after its normal operation.
 3. The isolator module shall provide a single LED that shall flash to indicate that the isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.
- T. Smoke Control Annunciator
1. On/Auto/Off switches and status indicators (LEDS) shall be provided for monitoring and manual control of each fan, damper, HVAC control unit, stairwell pressurization fan, and smoke exhaust fan. To ensure compliance the units supplied shall meet the following UL categories: UUKL, PAZX, UDTZ, QVAX as well as the requirements of NFPA 90A, HVAC, and NFPA 92A & 92B, Smoke Control. The control System shall be field programmable for either 90A operation or 92A/B operation to allow for future use and system expansion.
 2. The OFF LED shall be Yellow, the ON LED shall be green, the Trouble/Fault LED shall be Amber/Orange for each switch. The Trouble/Fault indicator shall indicate a trouble in the control and/or monitor points associated with that switch. In addition, each group of

eight switches shall have two LEDs and one momentary switch which allow the following functions: An Amber LED to indicate an OFF-NORMAL switch position, in the ON or OFF position; A Green LED to indicate ALL AUTO switch position; A Local Acknowledge/Lamp Test momentary switch.

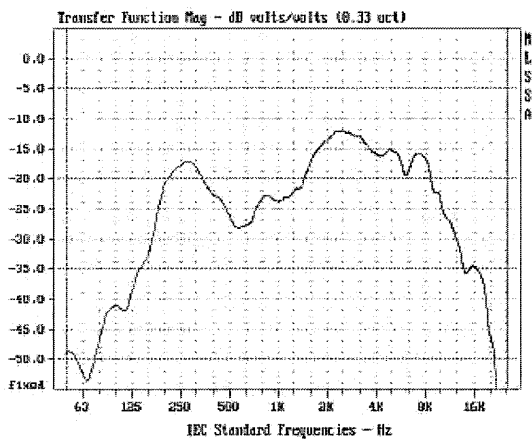
3. Each switch shall have the capability to monitor and control two addressable inputs and two addressable outputs. In all modes, the ON and OFF indicators shall continuously follow the device status not the switch position. Positive feedback shall be employed to verify correct operation of the device being controlled. Systems that indicate on/off/auto by physical switch position only are not acceptable.
4. All HVAC switches (i.e., limit switches, vane switches, etc.) shall be provided and installed by the HVAC contractor.
5. It shall be possible to meet the requirements mentioned above utilizing wall mounted custom graphic.

U. SpectrAlert Advance Speakers

1. The Speaker appliance shall be System Sensor SpectrAlert Advance model _____ Speaker. The speaker shall be listed to UL 1480 for Fire Protective Signaling Systems. It shall be a dual-voltage transformer speaker capable of operation at 25.0 or 70.7 nominal Vrms. The speaker shall have a frequency range of 400 to 4,000 Hz and shall have an operating temperature between 32°F and 120°F. It shall mount to a 4 x 4 x 2 1/8-inch back box.
2. A universal mounting plate shall be used for mounting ceiling and wall speaker products. The notification appliance circuit and amplifier wiring shall terminate at the universal mounting plate.
3. Speakers shall be plug-in and shall have the ability to check wiring continuity via a shorting spring on the universal mounting plate. The shorting spring shall also provide tamper resistance via an open circuit if the device is removed. Speaker design shall isolate speaker components to reduce ground fault incidents.
4. The speaker shall have power taps (from ¼ watt to 2 watts) and voltage that are selected by rotary switches. All models shall have a maximum sound output of 86 dB at 10 feet and shall incorporate an open back construction.
5. All notification appliances shall be backward compatible.

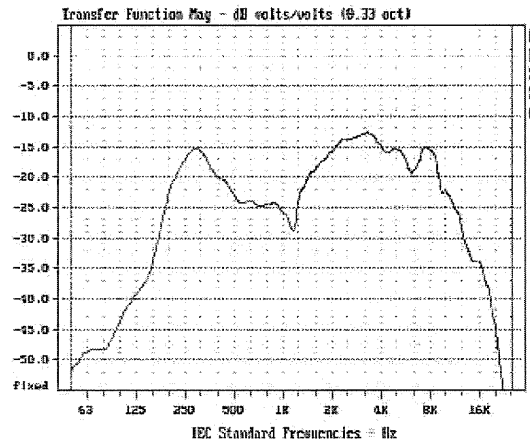
Ceiling Speaker

Wide Band Frequency Response



Wall Speaker

Wide Band Frequency Response



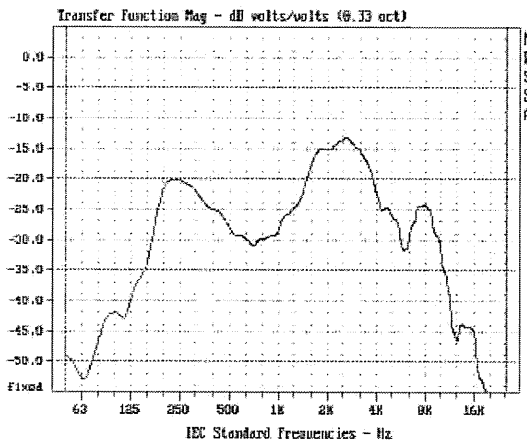
Note: The wide band frequency response is derived using MLS methods

V. SpectrAlert Advance Speaker Strobes

1. The Speaker Strobe appliance shall be System Sensor SpectrAlert Advance model _____ Speaker Strobe. The speaker strobe shall be listed to UL 1971 and UL 1480 and be approved for fire protective signaling systems. It shall be a dual-voltage transformer speaker strobe capable of operation at 25.0 or 70.7 nominal Vrms. The speaker shall have a frequency range of 400 to 4,000 Hz and shall have an operating temperature between 32°F and 120°F. It shall mount to a 4 x 4 x 2 1/8-inch back box.
2. A universal mounting plate shall be used for mounting ceiling and wall speaker strobe products. The notification appliance circuit and amplifier wiring shall terminate at the universal mounting plate. Also, SpectrAlert Advance speaker strobes and the Sync•Circuit™ Module MDL3 accessory, if used, shall be powered from a non-coded notification appliance circuit output and shall operate on a nominal 12 or 24 volts (includes fire alarm panels with built in sync). When used with the Sync•Circuit Module MDL3, 12-volt rated notification appliance circuit outputs shall operate between 8.5 and 17.5 volts; 24-volt rated notification appliance circuit outputs shall operate between 16.5 to 33 volts. If the notification appliances are not UL 9th edition listed with the corresponding panel or power supply being used, then refer to the compatibility listing of the panel to determine maximum devices on a circuit.
3. Speaker strobes shall be plug-in and shall have the ability to check wiring continuity via a shorting spring on the universal mounting plate. The shorting spring shall also provide tamper resistance via an open circuit if the device is removed. Speaker strobe design shall isolate speaker components to reduce ground fault incidents.
4. The speaker strobe shall have power taps (from ¼ watt to 2 watts) and voltage that are selected by rotary switches. All models shall have a maximum sound output of 86 dB at 10 feet and shall incorporate an open back construction. The strobe shall consist of a xenon flash tube with associated lens/reflector system and operate on either 12V or 24V. The strobe shall also feature selectable candela output, providing options for 15 or 15/75 candela when operating on 12V and 15, 15/75, 30, 75, 110, or 115 when operating on 24V. The strobe shall comply with NFPA 72 and the Americans with Disabilities Act requirement for visible signaling appliances, flashing at 1 Hz over the strobe’s entire operating voltage range.
5. All notification appliances shall be backward compatible.

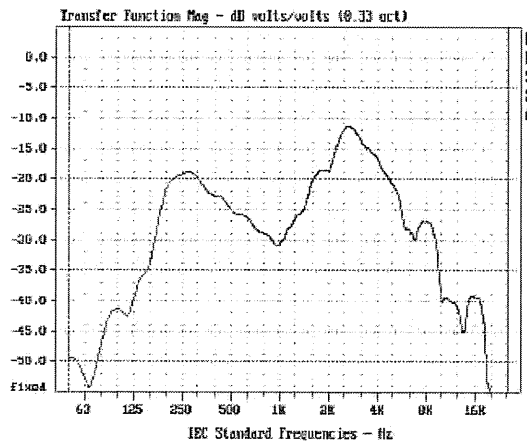
Ceiling Speaker Strobe

Wide Band Frequency Response



Wall Speaker Strobe

Wide Band Frequency Response



Note: The wide band frequency response is derived using MLS methods

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6. Strobe lights shall meet the requirements of the ADA, UL Standard 1971 and be fully synchronized.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Installation shall be in accordance with the NEC, NFPA 72, local and state codes, as shown on the drawings, and as recommended by the major equipment manufacturer.
- B. All conduit, junction boxes, conduit supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas. Smoke detectors shall not be installed prior to the system programming and test period. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage.
- C. All fire detection and alarm system devices, control panels and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas.
- D. Manual fire alarm boxes shall be suitable for surface mounting or semi-flush mounting as shown on the plans, and shall be installed not less than 42 inches (1067 mm), nor more than 48 inches (122 mm) above the finished floor.

3.2 TEST:

The service of a competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment shall be provided to technically supervise and participate during all of the adjustments and tests for the system. All testing shall be in accordance with NFPA 72.

- A. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.
- B. Close each sprinkler system flow valve and verify proper supervisory alarm at the FACP.
- C. Verify activation of all waterflow switches.
- D. Open initiating device circuits and verify that the trouble signal actuates.
- E. Open and short signaling line circuits and verify that the trouble signal actuates.
- F. Open and short notification appliance circuits and verify that trouble signal actuates.
- G. Ground all circuits and verify response of trouble signals.
- H. Check presence and audibility of tone at all alarm notification devices.
- I. Check installation, supervision, and operation of all intelligent smoke detectors using the walk test.

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- J. Each of the alarm conditions that the system is required to detect should be introduced on the system. Verify the proper receipt and the proper processing of the signal at the FACP and the correct activation of the control points.
- K. When the system is equipped with optional features, the manufacturer's manual shall be consulted to determine the proper testing procedures. This is intended to address such items as verifying controls performed by individually addressed or grouped devices, sensitivity monitoring, verification functionality and similar.

3.3 FINAL INSPECTION:

- A. At the final inspection, a factory-trained representative of the manufacturer of the major equipment shall demonstrate that the system functions properly in every respect.

3.4 INSTRUCTION:

- A. Instruction shall be provided as required for operating the system. Hands-on demonstrations of the operation of all system components and the entire system including program changes and functions shall be provided.
- B. The contractor and/or the systems manufacturer's representatives shall provide a typewritten "Sequence of Operation."

END OF SECTION 283100

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SECTION 311000 - SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Disconnecting, capping or sealing site utilities.
7. Temporary erosion- and sedimentation-control measures.
8. Building Structure – Not a part of this section.

1.2 MATERIAL OWNERSHIP

- A. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.3 PROJECT CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
 2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.
- B. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.
- C. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.
- D. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures are in place.
- E. The following practices are prohibited within protection zones:
1. Storage of construction materials, debris, or excavated material.
 2. Parking vehicles or equipment.
 3. Foot traffic.
 4. Erection of sheds or structures.
 5. Impoundment of water.

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6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 312000 Earth Moving.
 1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Locate and clearly identify trees, shrubs, and other vegetation to remain or to be relocated.
- C. Protect existing site improvements to remain from damage during construction.
 1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.
- B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.
- C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
- D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE AND PLANT PROTECTION

- A. General: Protect trees and plants remaining on-site according to requirements in Section 015639 Temporary Tree and Plant Protection.

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- B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Architect.

3.4 EXISTING UTILITIES

- A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.
 - 1. Arrange with utility companies to shut off indicated utilities.
- B. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Architect not less than two days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Architect's written permission.
- C. Removal of underground utilities is included in earthwork sections and with applicable fire suppression, plumbing, HVAC, electrical, communications, electronic safety and security and utilities sections and Section 024116 Structure Demolition and Section 024119 Selective Demolition.

3.5 CLEARING AND GRUBBING

- A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.
 - 1. Grind down stumps and remove roots, obstructions, and debris to a depth of 18 inches below exposed subgrade.
 - 2. Use only hand methods for grubbing within protection zones.
- B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
 - 1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches and compact each layer to a density equal to adjacent original ground.

3.6 TOPSOIL STRIPPING

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil to depth of 6 inches in a manner to prevent intermingling with underlying subsoil or other waste materials.
- C. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

3.7 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

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3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.
- B. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION 311000

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SECTION 311100 - CLEARING AND GRUBBING

1. PART 1 - GENERAL

1.1 SUMMARY

- A. Clearing vegetation, debris, trash and other materials within limits indicated.
- B. Grubbing of vegetation within limits indicated.

1.2 RELATED DOCUMENTS

- A. Caltrans Standard Specifications.
 - 1. Section 16, Clearing and Grubbing.
- B. California Building Code: Chapter 33 – Site Work, Demolition and Construction.

2. PART 2 - PRODUCTS

2.1 NOT USED

3. PART 3 - EXECUTION

3.1 PREPARATION

- A. Locate and clearly flag vegetation to remain or to be relocated.

3.2 RESTORATION

- A. Repair or replace vegetation indicated to remain that is damaged by construction operations, as directed by the Owner.
- B. Employ a qualified arborist, licensed in jurisdiction where the Project is located, to submit details of proposed repairs and to repair damage to shrubs.

3.3 CLEARING AND GRUBBING

- A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction. Removal includes digging out stumps and obstructions and grubbing roots.
- B. Remove trash, debris, logs, concrete, masonry and other waste materials.
- C. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
- D. Completely remove stumps, roots, obstructions, and debris extending to a depth of 18-inches below subgrade.
- E. Use only hand methods for grubbing within drip line of remaining trees.

END OF SECTION 311100

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SECTION 312300 - EXCAVATION AND FILL

1. PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Excavation and/or embankment from existing ground to subgrade, including soil sterilant, for roadways, driveways, parking areas, walks, paths, or trails and any other site improvements called for on the Plans.

1.2 SECTION EXCLUDES

- A. Earthwork related to underground utility installation, see Section 31 23 33 – Trenching and Backfilling.

1.3 RELATED SECTIONS

- A. Section 02 40 00 – Demolition.
- B. Section 31 11 00 – Clearing and Grubbing.
- C. Section 31 23 33 – Trenching and Backfilling.

1.4 RELATED DOCUMENTS

A. ASTM:

- 1. D 1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort.
- 2. D 1586, Method for Penetration Tests and Split-Barrel Sampling of Soils.
- 3. D 2487, Classification of Soils for Engineering Purposes.
- 4. D 3740, Practice for Evaluation of Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
- 5. D 4318. Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
- 6. E 329, Specification for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.
- 7. E 548, Guide for General Criteria Used for Evaluating Laboratory Competence.

B. California Code of Regulation Title 24, Part 2, California Building Code:

- 1. Chapter 11B – Accessibility to Public Buildings.
- 2. Chapter 33 – Site Work, Demolition and Construction.

C. Caltrans Standard Specifications:

- 1. Section 17, Watering.
- 2. Section 19, Earthwork.

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D. CAL/OSHA, Title 8.

1.5 DEFINITIONS

- A. Borrow: Approved soil material imported from off-site for use as Structural Fill or Backfill.
- B. Excavation: Removal of material encountered above subgrade elevations.
 - 1. Authorized Over-Excavation: Excavation below subgrade elevations or beyond indicated horizontal dimensions as shown on plans.
 - 2. Unauthorized Over-Excavation: Excavation below subgrade elevations or beyond indicated horizontal dimensions. Unauthorized excavation shall be without additional compensation.
- C. Structural Backfill: Soil materials used to fill excavations resulting from removal of existing below grade facilities, including trees. See Section 31 23 33 – Trenching and Backfilling.
- D. Structural Fill: Soil materials used to raise existing grades.
- E. Rock: Rock material in beds, ledges, unstratified masses, and conglomerate deposits and boulders of rock material $\frac{3}{4}$ -cubic yards or more in volume that, according to ASTM D 1586, exceeds a standard penetration resistance of 100 blows/2-inches.
- F. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man made stationary features constructed above or below grade.
- G. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, base or topsoil materials.
- H. Unsuitable Material: Any soil material that is not suitable for a specific use on the Project.
- I. Utilities: onsite underground pipes, conduits, ducts and cables.

1.6 SUBMITTALS

- A. Follow submittal procedures outlined in Section 01 33 00 – Submittal Procedures.
- B. Submit material certificates signed by the material producer and the Contractor, certifying that that each material item complies with, or exceeds the specified requirements.

1.7 QUALITY ASSURANCE

- A. Conform all work to the appropriate portion(s) of the California Code of Regulations, Title 24 and Caltrans Standard Specifications, Sections 17 and 19.
- B. Percentage of compaction specified shall be the minimum acceptable. The percentage represents the ratio of the dry density of the compacted material to the maximum dry density of the material as determined by the procedure set forth in ASTM D 1557.
- C. Upon completion of the construction work, certify that all compacted fills and foundations are in place at the correct locations, and have been constructed in accordance with sound construction practice. In addition, certify that the materials used are of the types, quality and quantity required

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by these Technical Specifications. The Contractor shall be responsible for the stability of all fills and backfills constructed by his forces.

- D. Finish soil grade tolerance at completion of grading:
 - 1. Building and paved areas: +0.05
 - 2. Other areas: ±0.10 feet.
- E. The project geotechnical engineer shall be notified of the construction schedule at least one week prior to the beginning of major site construction, and notified at least 48 hours (working days) before being required to perform field observation and testing.

1.8 PROJECT CONDITIONS

- A. Promptly notify the Owner of surface or subsurface conditions differing from those disclosed in the construction documents. First notify the Owner verbally to permit verification and extent of condition and then in writing. No claim for conditions differing from those anticipated in the Contract Documents will be allowed unless the Contractor has notified the Owner in writing of differing conditions prior to the Contractor starting work on affected items.
- B. Protect open excavations, trenches, and the like with fences, covers and railings to maintain safe pedestrian and vehicular traffic passage.
- C. Prevent erosion of freshly graded areas during construction and until such time as permanent drainage and erosion control measures have been installed.
- D. Temporarily stockpile fill material in an orderly and safe manner and in a location approved by the Owner.
- E. Provide dust and noise control in conformance with Division 1 General Requirements for Cleaning and Waste Management.
- F. Environmental Requirements: When unfavorable weather conditions necessitate interrupting earthwork operation, areas shall be prepared by compaction of surface and grading to avoid collection of water. Provide adequate temporary drainage to prevent erosion. After interruption, compaction specified in last layer shall be re-established before resuming work.

2. PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from on-site excavations.
- B. On-Site Structural Fill and Structural Backfill: Soil or soil-rock mixture from on site excavations, free from organic matter or other deleterious substances. On-site structural fill and backfill shall not contain rocks or rock fragments over 4 inches in greatest dimension and not more than 15 percent shall be over 2-1/2 inches in greatest dimension and with an organic content less than 3.0 percent by weight.
- C. Imported Structural Fill and Structural Backfill: Conform to the requirements of on-site structural fill. Material shall also be a non-expansive and predominantly granular soil or soil-rock mixture

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with plasticity index of 15 or less in accordance with ASTM D 4318 and an R-Value of 25 or greater.

2.2 GRAVEL BACKFILL

- A. ¾" crushed rock.

3. PART 3 - EXECUTION

3.1 GENERAL

- A. Conform to Section 19, Earthwork, Caltrans Standard Specifications as modified by the Contract Documents.
- B. Placement and compaction of material by flooding, ponding, or jetting will not be permitted.
- C. The use of explosives will not be permitted.

3.2 CONTROL OF WATER AND DEWATERING

- A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding the site and surrounding area. Provide dewatering equipment necessary to drain and keep excavations and site free from water.
- B. Dewater during backfilling operation so that groundwater is maintained a least one foot below level of compaction effort.
- C. Obtain the Owner's approval for proposed control of water and dewatering methods.
- D. Protect subgrades from softening, undermining, washout and damage by rain or water accumulation.
- E. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations.
- F. Maintain dewatering system in place until dewatering is no longer required.

3.3 WET WEATHER CONDITIONS

- A. Do not prepare subgrade, place or compact soil materials if above optimum moisture content.

3.4 BRACING AND SHORING

- A. Conform to California and Federal OSHA requirements.
- B. Place and maintain such bracing and shoring as may be required to support the sides of the excavations for the proper protection of workmen; to facilitate the work; to prevent damage to the facility being constructed; and to prevent damage to adjacent structures or facilities. Remove all bracing and shoring upon completion of the work.
- C. Be solely responsible for all bracing and shoring and, if requested by the Owner, submit details and calculations to the Owner. The Owner may forward the submittal to the Consulting Engineer and/or the California Division of Industrial Safety for their review. The Contractor's submittal shall include the basic design, assumed soils conditions and estimation of forces to be resisted,

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together with plans and specifications of the materials and methods to be used, and shall be prepared by a civil engineer or structural engineer registered in California. No excavations related to the proposed facility shall precede a response to the submittal by the Owner.

- D. Be solely responsible for installing and extracting the sheathing in a manner which will not disturb the position or operation of the facility being constructed or adjacent utilities and facilities.

3.5 EXCAVATION

- A. Excavate earth and rock to lines and grades shown on drawings and to the neat dimensions indicated on the Plans, required herein or as required to satisfactorily compact backfill.
- B. Remove and dispose of large rocks, pieces of concrete and other obstructions encountered during excavation.
- C. Where forming is required, excavate only as much material as necessary to permit placing and removing forms.
- D. Provide supports, shoring and sheet piles required to support the sides of excavations or for protection of adjacent existing improvements.

3.6 REMOVAL OF EXISTING FILLS AND UNSUITABLE MATERIAL

- A. Over-excavate areas of existing fills and other unsuitable material encountered during mass grading.
- B. Compensation for increased removal widths and depths that are not required will not be considered, except when such increase is necessary for protection of life and property as determined by and approved by the Owner.

3.7 GRADING

- A. Uniformly grade the Project to the elevations shown on plans.
- B. Finish ditches, gutters and swales to the sections, lines and grades indicated and to permit proper surface drainage.
- C. Round tops and bottoms of slopes as indicated or to blend with existing contours.

3.8 SUBGRADE PREPARATION

- A. Install underground utilities and service connections prior to final preparation of subgrade and placement of base materials for final surface facilities. Extend services so that final surface facilities are not disturbed when service connections are made.
- B. Prepare subgrades under paved areas, curbs, gutters, walks, structures, other surface facilities and areas to receive structural fill.
- C. Prepare subgrades for paved areas, curbs and gutters by plowing or scarifying surface at least 6 inches below final subgrade elevations and 5-feet beyond edge of pavement. Uniformly moisture condition to obtain optimum moisture contents. Break clods and condition surface by harrowing or dry rolling. Remove boulders, hard ribs and solid rock. Prepare earth uniform for full depth and width of subgrade.

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- D. Protect utilities from damage during compaction of subgrades and until placement of final pavements or other surface facilities.

3.9 PLACEMENT OF STRUCTURAL FILL

- A. Place structural fill on prepared subgrade.
- B. Spread structural fill material in uniform lifts not more than 8-inches in un-compacted thickness and compact.
- C. Place structural fill material to suitable elevations above grade to provide for anticipated settlement and shrinkage.
- D. Overbuild fill slopes to obtain required compaction. Remove excess material to lines and grades indicated.
- E. Do not drop fill on structures. Do not backfill around, against or upon concrete or masonry structures until structure has attained sufficient strength to withstand loads imposed and the horizontal structural system had been installed.
- F. Backfill in uniform lifts not exceeding 8 inches in uncompacted thickness. Each lift should be brought to a uniform moisture content of at least 1 percent above optimum prior to compacting by either spraying the soil with water if it is too dry or aerating the material if it is too wet.

3.10 COMPACTION AND TESTING

- A. Do not compact by ponding, flooding or jetting.
- B. Compact soils at optimum water content. Aerate material if it is too wet. Add water to material if it is too dry. Thoroughly mix lifts before compaction to ensure uniform moisture distribution.
- C. Perform compaction using rollers, pneumatic or vibratory compactors.
- D. Compaction requirements:
 - 1. Compact structural fills less than 5-feet thick to 90 percent compaction.
 - 2. Compact structural fill 5-feet thick or greater to 95 percent compaction.
 - 3. Compact the upper 6 inches of subgrade soils beneath pavements, curbs and gutters to 95 percent compaction. Extend compaction 5-feet beyond pavement.
 - 4. Compact the upper 6-inches of subgrade soils to the following percentage of compaction: 95 percent under walks and pavements; 93 percent for foundations; and 90 percent for areas to receive structural fill.”

3.11 DISPOSAL

- A. Lawfully dispose of all unsuitable and excess or surplus material off-site at no cost to the Owner.

END OF SECTION 312300

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SECTION 31 23 33 - TRENCHING AND BACKFILLING

1. PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Excavation, bedding, and backfill for underground storm drain, sanitary sewer, and water piping and associated structures.

1.2 SECTION EXCLUDES

- A. Drainage fill material and placement around subdrains.
- B. Trenching and backfill for other utilities such as underground HVAC piping, electrical conduit, telephone conduit, gas piping, cable TV conduit, etc.

1.3 RELATED SECTIONS

- A. Section 31 23 00 – Excavation and Fill.
- B. Section 33 40 00 – Storm Drainage Utilities.

1.4 RELATED DOCUMENTS

A. ASTM:

1. C 33, Specification for Concrete Aggregates.
2. C 150, Specification for Portland Cement.
3. C 260, Specification for Air-Entraining Admixtures for Concrete.
4. C 618, Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.
5. D 1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort.
6. D 2321, Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe.
7. D 2487, Classification of Soils for Engineering Purposes.
8. D 3740, Practice for Evaluation of Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
9. E 329, Specification for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.
10. E 548, Guide for General Criteria Used for Evaluating Laboratory Competence.

B. California Code of Regulation Title 24, Part 2, California Building Code:

1. Chapter 11B – Accessibility to Public Buildings.
2. Chapter 33 – Site Work, Demolition and Construction.

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3. CBC 1809A.14

C. Caltrans Standard Specifications:

1. Section 19, Earthwork.
2. Section 26, Aggregate Bases.
3. Section 68, Subsurface Drains.
4. Section 88, Engineering Fabrics.

D. CAL/OSHA, Title 8.

1.5 DEFINITIONS

- A. AC: Asphalt Concrete.
- B. ASTM: American Society for Testing and Materials.
- C. Bedding: Material from bottom of trench to bottom of pipe.
- D. CDF: Controlled Density Fill.
- E. DIP: Ductile Iron Pipe.
- F. Initial Backfill: Material from bottom of pipe to 12-inches above top of pipe.
- G. PCC: Portland Cement Concrete.
- H. RCP: Reinforced Concrete Pipe.
- I. Springline of Pipe: Imaginary line on surface of pipe at a vertical distance of $\frac{1}{2}$ the outside diameter measured from the top or bottom of the pipe.
- J. Subsequent Backfill: Material from 12-inches above top of pipe to subgrade of surface material or subgrade of surface facility or to finish grade.
- K. Trench Excavation: Removal of material encountered above subgrade elevations and within horizontal trench dimensions.
 1. Authorized Trench Over-Excavation: Excavation below trench subgrade elevations or beyond indicated horizontal trench dimensions as shown on plans.
 2. Unauthorized Trench Over-Excavation: Excavation below trench subgrade elevations or beyond indicated horizontal trench dimensions. Unauthorized excavation shall be without additional compensation.
- L. Utility Structures:
 1. Storm drainage manholes, catch basins, drop inlets, curb inlets, vaults, etc.
 2. Sanitary sewer manholes, vaults, etc.
 3. Water vaults, etc.

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1.6 SUBMITTALS

- A. Follow submittal procedures outlined in Section 01 33 00 – Submittal Procedures.
- B. Product Data:
 - 1. Grading and quality characteristics showing compliance with requirements for the Work.
 - 2. Certify that material meets requirements of the Project.
- C. Samples:
 - 1. If required, provide 40-pound samples of all imported trench bedding and backfill material sealed in airtight containers, tagged with source locations and suppliers of each proposed material.
 - 2. Provide materials from same source throughout work. Change of source requires approval of the Owner.

1.7 QUALITY ASSURANCE

- A. Conform all work to the appropriate portion(s) of the Caltrans Standard Specifications, Section 19.
- B. Percentage of compaction specified shall be the minimum acceptable. The percentage represents the ratio of the dry density of the compacted material to the maximum dry density of the material as determined by the procedure set forth in ASTM D 1557.
- C. Conform work to the requirements of the California Building Code.
 - 1. Section 1806A.11 – Pipe and Trenches.

1.8 PROJECT CONDITIONS

- A. Promptly notify the Owner of surface or subsurface conditions differing from those disclosed in the construction documents. First notify the Owner verbally to permit verification and extent of condition and then in writing. No claim for conditions differing from those anticipated in the Contract Documents will be allowed unless Contractor has notified the Owner in writing of differing conditions prior to contractor starting work on affected items.
- B. Protect open, trenches, and utility structure excavations with fences, covers and railings to maintain safe pedestrian and vehicular traffic passage.
- C. Stockpile on-site and imported backfill material temporarily in an orderly and safe manner.
- D. Provide dust and noise control in conformance with Section 02000, Supplemental General Requirements for Civil Improvements. Also see Division 1 General Requirements for Cleaning and Waste Management.

2. PART 2 - PRODUCTS

2.1 PIPE BEDDING AND INITIAL BACKFILL

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- A. ASTM D 2321, Class IA, IB or II.
 - 1. Clean and free of clay, silt or organic matter.
- B. Permeable Material: Conform to Section 68-1.025 of Caltrans Standard Specifications, Class 2 permeable.
- C. Class 2 Aggregate Base: Conform to Section 26 of Caltrans Standard Specifications, ¾-inch maximum. Material shall also be non-expansive and predominantly granular soil or soil-rock mixture “(percent of passing #200: 50 maximum, 5 minimum)” with plasticity index of 15 or less.
- D. Sand: Conform to Section 19-3.025B of Caltrans Standard Specifications.

2.2 SUBSEQUENT BACKFILL

- A. Conform to on-site or imported structural backfill in Section 31 23 00 – Excavation and Fill.

2.3 CONTROLLED DENSITY FILL (CDF) (IN TRENCHES)

- A. Provide non-structural CDF, from bottom of trench to finish subgrade of subbase or base material, that can be excavated by hand and produce unconfined compressive 28-day strengths from 50-psi to a maximum of 150-psi. Provide aggregate no larger than 3/8-inch top size. The 3/8-inch aggregate shall not comprise more than 30% of the total aggregate content.
- B. Cement: Conform to the standards as set forth in ASTM C-150, Type II Cement.
- C. Fly Ash: Conform to the standards as set forth in ASTM C-618, for Class F pozzolan. Do not inhibit the entrainment of air with the fly ash.
- D. Air Entraining Agent: Conform to the standards as set forth in ASTM C-260.
- E. Aggregates need not meet the standards as set forth in ASTM C-33. Any aggregate, producing performances characteristics described herein will be accepted for consideration. The amount of material passing a #200 sieve shall not exceed 12% and no plastic fines shall be present.
- F. Provide CDF that is a mixture of cement, Class F pozzolan, aggregate, air entraining agent and water. CDF shall be batched by a ready mixed concrete plant and delivered to the job site by means of transit mixing trucks.
- G. The Contractor shall determine the actual mix proportions of the controlled density fill to meet job site conditions, minimum and maximum strengths, and unit weight. Entrained air content shall be a minimum of 4.0%. The actual entrained air content shall be established for each job with the materials and aggregates to be used to meet the placing and unit weight requirements. Entrained air content may be as high as 20% for fluidity requirements.

2.4 CONCRETE STRUCTURE BEDDING AND BACKFILL

- A. Precast Structures: Same materials to the same heights as specified for pipe bedding and backfill.
- B. Poured-in-Place Structures:
 - 1. Bedding: In general, bedding is not required, pour bases against undisturbed native earth in cut areas and against engineered fill compacted to 90% relative compaction in embankment areas.

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2. Side Backfill: On-site or imported structural fill meeting the requirements given in Section 31 23 00 – Excavation and Fill.

2.5 FILTER FABRIC

A. Filter Fabric:

1. Filter Fabric: Section 88-1.03 of Caltrans Standard Specifications.
2. Mirafi 140N (Mirafi Inc., Charlotte, NC) (Tel. 800-438-1855) or equal.

3. PART 3 - EXECUTION

3.1 TRENCHING AND EXCAVATION

- A. Existing PCC or AC Areas: Cut PCC or AC to full depth at a minimum distance of 12-inches beyond the edge of the trench.
- B. Excavate by hand or machine. For gravity systems begin excavation at the outlet end and proceed upstream. Excavate sides of the trench parallel and equal distant from the centerline of the pipe. Hand trim excavation. Remove loose matter.
- C. Excavation Depth for Bedding: Minimum of 4-inches below bottom, except that bedding is not required for nominal pipe diameters of 2-inches or less.
- D. Excavation Width at Springline of Pipe:
 1. Up to a nominal pipe diameter of 24-inches: Minimum of twice the outside pipe diameter.
 2. Nominal pipe diameter of 30-inches through 36-inches: Minimum of the outside pipe diameter plus 2-feet.
 3. Nominal pipe diameter of 42-inches through 60-inches: Minimum of the outside pipe diameter plus 3-feet.
- E. Over-Excavations: Backfill trenches that have been excavated below bedding design subgrade, with approved bedding material.
- F. Comply with the Owner's limitations on the amount of trench that is opened or partially opened at any one time. Do not leave trenches open overnight without the approval of the Owner.
- G. Where forming is required, excavate only as much material as necessary to permit placing and removal of forms.
- H. Grade bottom of trench to provide uniform thickness of bedding material and to provide uniform bearing and support for pipe along entire length. Remove stones to avoid point bearing.

3.2 CONTROL OF WATER AND DEWATERING

- A. Be solely responsible for dewatering trenches and excavations and subsequent control of ground and surface water. Provide and maintain such pumps or other equipment as may be necessary to control ground water.

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- B. Dewater during backfilling operation so that groundwater is maintained a least one foot below level of compaction effort.
- C. Reroute surface water runoff away from open trenches and excavations. Do not allow water to accumulate in trenches and excavations.
- D. Maintain dewatering system in place until dewatering is no longer required.

3.3 BRACING AND SHORING

- A. Conform to California and Federal OSHA requirements.
- B. Place and maintain such bracing and shoring as may be required to support the sides of the excavations for the proper protection of workmen; to facilitate the work; to prevent damage to the pipes and appurtenances being constructed; and to prevent damage to adjacent structures or facilities. Remove all bracing and shoring upon completion of the work.
- C. Be solely responsible for all bracing and shoring and, if requested by the Owner, submit details and calculations to the Owner. The Owner may forward the submittal to the Consulting Engineer and/or the California Division of Industrial Safety for their review. The Contractor's submittal shall include the basic design, assumed soils conditions and estimation of forces to be resisted, together with plans and specifications of the materials and methods to be used, and shall be prepared by a civil engineer or structural engineer registered in California. No excavations in trench section or around structures shall precede a response to the submittal by the Owner.
- D. Be solely responsible for installing and extracting the sheathing in a manner which will not disturb the line, grade, or backfill compaction or operation of the utility being installed or adjacent utilities and facilities.

3.4 PIPE BEDDING

- A. Accurately shape bedding material to the line and grade called for on the Plans. Carefully place and compact bedding material to the elevation of the bottom of the pipe in layers not exceeding 8-inches in loose thickness. Compact bedding material at optimum water content to 95% relative compaction unless specified otherwise on the. Compact by pneumatic tampers or other mechanical means. Jetting or ponding of bedding material will not be permitted.

3.5 BACKFILLING

- A. Bring initial backfill up simultaneously on both sides of the pipe, so as to prevent any displacement of the pipe from its true alignment. Carefully place and compact initial backfill material to an elevation of 12-inches above the top of the pipe in layers not exceeding 8-inches in loose thickness. Compact bedding material at optimum water content to 90% relative compaction unless specified otherwise on the. Compact by pneumatic tampers or other mechanical means. Jetting or ponding of initial backfill material will not be permitted.
- B. Bring subsequent backfill to subgrade or finish grade as indicated. Carefully place and compact subsequent backfill material to the proper elevation in layers not exceeding 8-inches in loose thickness. Compact bedding material at optimum water content to 90% relative compaction, unless specified otherwise on the Plans. Compact by pneumatic tampers or other mechanical means. Jetting or ponding of subsequent backfill material will not be permitted.
- C. Do not use compaction equipment or methods that produce horizontal or vertical earth pressures that may cause excessive pipe displacement or damage the pipe.

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3.6 CLEANUP

- A. Upon completion of utility earthwork all lines, manholes catch basins, inlets, water meter boxes and other structures shall be thoroughly cleaned of dirt, rubbish, debris and obstructions of any kind to the satisfaction of the Owner.
- B. See Section 01 74 00 – Refer to Division 1 General Requirements for Cleaning and Waste Management for further cleanup requirements.

END OF SECTION

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SECTION 320120 - DETECTABLE WARNING SURFACES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes exterior cement concrete pavement for the following:
 - 1. Raised truncated domes.

1.2 SYSTEM DESCRIPTION

- 1. Detectable warning surfaces:
 - a. Detectable warnings surfaces shall comply with CBC Section 11B-705.1.
 - b. Detectable warning surfaces shall be yellow conforming to FS 33538 of Federal Standard 595B, except for locations at curb ramps, islands, or cut-through medians where color used shall contrast visually with that of adjacent walking surfaces, either light-on-dark, or dark-on-light. CBC Sections 11B-705.1.1.3 and 11B-705.1.1.5.
 - c. Detectable warning surfaces shall differ from adjoining surfaces in resiliency or sound-on-cane contact. CBC Section 11B-705.1.1.4.
 - d. Provide minimum 5 year warranty per DSA Bulletin 10/31/02, revised 04/09/08.

1.3 SUBMITTALS

- A. Product Data: For each type of manufactured material and product indicated.
- B. Samples: 5 by 5 inch sample.
- C. Shop Drawings: Show fabrication details, composite structural system, joints, and material to be used as well as outlining installation materials and procedure.
- D. Qualification Data: For manufacturer.
- E. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance requirements indicated, based on comprehensive testing of current materials.
- F. Minutes of preinstallation conference.

1.4 QUALITY ASSURANCE

- A. Reference Standards:
 - 1. 2016 California Building Standards Administrative Code, Part 1, Title 24 CBSC.
 - 2. 2016 California Building Code (CBC), Part 2, Title 24 CBSC. (2015 International Building Code of the International Code Council, with California Amendments).
 - 3. 2016 California Electrical Code (CEC), Part 3, Title 24 CBSC (2014 National Electrical Code, with California Amendments).
 - 4. 2016 California Mechanical Code (CMC), Part 4, Title 24 CBSC (2015 Uniform Mechanical Code, with California Amendments).

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5. 2016 California Plumbing Code (CPC), Part 5, Title 24, CBSC (2015 Uniform Plumbing Code, with California Amendments).
 6. 2016 California Energy Code, Part 6, Title 24 CBSC.
 7. 2016 California Historical Code, Part 8, Title 24 CBSC.
 8. 2016 California Fire Code, Part 9, Title 24 CBSC. (2015 International Fire Code, with California Amendments).
 9. 2016 California Green Building Standards Code (CALGreen Code), Part 11, Title 24 CBSC.
 10. 2016 California Referenced Standards Code, Part 12, Title 24, CBSC.
 11. NFPA 13 - Automatic Sprinkler Systems (California Amended), 2016 Edition.
 12. NFPA 14 - Standpipe Systems (California Amended), 2013 Edition.
 13. NFPA 17 - Dry Chemical Extinguishing Systems, 2013 Edition.
 14. NFPA 17A - Wet Chemical Extinguishing Systems, 2013 Edition.
 15. NFPA 20 - Stationary Pumps, 2016 Edition.
 16. NFPA 24 - Private Fire Service Mains (California Amended), 2016 Edition.
 17. NFPA 72 - National Fire Alarm and Signaling Code (California Amended).
 18. NFPA 80 - Fire Door and Other Opening Protectives, 2016 Edition.
 19. NFPA 253 - Critical Radiant Flux of Floor Covering Systems, 2015 Edition.
 20. NFPA 2001 - Clean Agent Fire Extinguishing Systems (California Amended), 2015 Edition.
 21. Americans with Disabilities Act (ADA), Title II.
- B. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.5 WARRANTY

- A. Duration: 5 years. Such warranty shall indicate compliance with architectural standards as published in the current edition of the California Building Standards Code, and also include durability criteria which indicate that the shape, color fastness, confirmation, sound-on-cane acoustic quality, resilience, and attachment will not degrade significantly for specified years after initial installation.
1. As used in this bulletin, "not degrade significantly" means that the product maintains at least 90 percent of its approved design characteristics, as determined by the enforcing agency.
- B. Installer's Warranty: 2 years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Raised Truncated Domes: Subject to compliance with requirements, provide either the named product or an equal product by one of the other manufacturers specified.
1. Armor-Tile by Engineered Plastics Inc. (Basis of Design)
 2. Armorcast Products Company.
 3. ADA Tactile Systems.
 4. Or equal.

2.2 RAISED TRUNCATED DOMES

- A. Product: Vitrified Polymer Composite (VPC) Cast In Place Detectable/Tactile Warning Surface Tile based on Armor-Tile by Engineered Plastics Inc.
 - 1. Type: Surface applied system.
 - 2. Material: Epoxy polymer composition with ultra violet stabilized coating employing aluminum oxide particles in truncated domes. The tile shall incorporate an in-line pattern of truncated domes measuring nominal 0.2" height, 0.9" base diameter, and 0.45" top diameter, spaced center-to-center 2.35" as measured on a diagonal and 1.67" as measured side by side. For wheelchair safety the field area shall consist of a non-slip surface with a minimum of 40 - 90° raised points 0.045" high, per square inch.
 - 3. Color: Yellow conforming to Federal Color No. 33538. Color shall be homogeneous throughout the tile.
 - 4. Installation: Flush install by pressing into wet concrete per manufacturer's written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine exposed surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.
- B. Proceed with operations only after nonconforming conditions have been corrected and subgrade is ready to receive pavement.

3.2 INSTALLATION

- A. Surface Applied System:
 - 1. During all surface preparation and tile installation procedures, ensure adequate safety guidelines are in place and that they are in accordance with the applicable industry and government standards.
 - 2. The application of all tile, adhesives, mechanical fasteners, and caulking shall be in strict accordance with the guidelines set by their respective manufacturers.
 - 3. Ensure that the surfaces being prepared and fabricated to receive the tiles are constructed correctly and adequately for tile installation. Review design drawings with the Contractor prior to the construction and refer any and all discrepancies to the Architect.
 - 4. Set the tile true and square to the curb ramp area as detailed in the design drawings, so that its location can be marked on the concrete surface. A thin permanent marker works well. Remove tile when done marking its location.
 - 5. The surface to receive the detectable warning surface tile (not recommended for asphalt) is to be mechanically cleaned with a diamond cup grinder or shot blaster to remove any dirt or foreign material. This cleaning and roughening of the concrete surface should include at least 4 inches around the perimeter of the area to receive the tile, and also along the cross pattern established by the corresponding areas on the backside of the tile. Those same areas should then be cleaned with a rag soaked in Acetone.
 - 6. Immediately prior to installing the detectable warning surface tile, the concrete surfaces must be inspected to ensure that they are clean, dry, free of voids, curing compounds,

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- projections, loose material, dust, oil, grease, sealers and determined to be structurally sound and cured for a minimum of 30 days.
7. Using Acetone, wipe the backside of the tile around the perimeter and along the internal cross pattern, to remove any dirt or dust particles from the area to receive the adhesive.
 8. Apply the adhesive on the backside of the tile, following the perimeter and internal cross pattern established by the tile manufacturer. Sufficient adhesive must be placed on the prescribed areas to have full coverage across the 2" width of the adhesive locator. A 3 x 4 foot tile will typically require an entire tube of adhesive.
 9. Set the tile true and square to the curb ramp area as detailed in the design drawings.
 10. Standing with both feet applying pressure around the molded recess provided in the tile, drill a hole true and straight to a depth of 3-1/2 inch using the recommended diameter bit. Drill through the tile without hammer option until the tile has been successfully penetrated, and then with hammer option to drill into the concrete.
 11. Immediately after drilling each hole, and while still applying foot pressure, vacuum, brush or blow away dust and set the mechanical fastener as described below, before moving on to the next hole.
 12. Mechanically fasten tiles to the concrete substrate using a hammer to set the fasteners. Ensure the fastener has been placed to full depth in the dome, straight, and flush to the top of dome. Drive the pin of the fastener with the hammer, taking care to avoid any inadvertent blows to the truncated dome or tile surface. A plastic deadblow or leather hammer is recommended.
 13. Working in a sequence which will prevent buckles in the tile, proceed to drill and install all fasteners in the tile's molded recesses.
 14. Following the installation of the tiles, the perimeter caulking sealant should be applied. Follow the perimeter caulking sealant manufacturer's recommendations when applying. Tape all perimeter edges of the tile and also tape the adjacent concrete back 1/2" from the tile's perimeter edge. Tool the perimeter caulking with a plastic applicator or spatula to create a straight edge in a cove profile between the tile and adjacent concrete. Remove tape immediately after tooling perimeter caulking sealant.
 15. Do not allow foot traffic on installed tiles until the perimeter caulking sealant has cured sufficiently to avoid tracking.

END OF SECTION 320120

SECTION 320523 - CONCRETE FOR EXTERIOR IMPROVEMENTS

1. PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Materials for portland cement concrete.
- B. Aggregate and aggregate grading for portland cement concrete.
- C. Water for portland cement concrete.
- D. Admixtures for portland cement concrete.
- E. Proportioning for portland cement concrete.
- F. Mixing and transporting portland cement concrete.
- G. Formwork for cast in place portland cement concrete.
- H. Embedded materials for portland cement concrete.
- I. Steel reinforcement for portland cement concrete.
- J. Placing and finishing portland cement concrete.
- K. Curing portland cement concrete.
- L. Protecting portland cement concrete.

1.02 RELATED SECTIONS

- A. Section 01 81 13, Sustainable Design Requirements
- B. Section 31 23 00, Excavation and Fill.
- C. Section 32 12 00, Asphalt Concrete Pavement.

1.03 RELATED DOCUMENTS

- A. ASTM Standards
 - 1. A 82, Cold Drawn Steel Wire for Concrete Reinforcement.
 - 2. A 185, Steel Welded Wire Fabric, Plain for Concrete Reinforcement.
 - 3. A 615, Deformed and Plain Billet Steel Bars, for Concrete Reinforcement.
 - 4. C 94, Specification for Ready-mixed Concrete.
 - 5. C 114, Method for Chemical Analysis of Hydraulic Cement.
 - 6. C 150. Portland Cement.
 - 7. C 618, Fly Ash and Raw or Calcined Natural Pozzolan for use as Natural Admixture in Portland Cement.

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8. C 1751, Preformed Expansion Joint Fillers for Concrete. Paving and Structural Construction (Non-extruded and Resilient Bituminous Types).

B. Caltrans Standard Specifications:

1. Section 51: Concrete Structures.
2. Section 73: Concrete Curbs and Sidewalks.
3. Section 90: Portland Cement Concrete.

C. California Building Code:

1. Chapter 11B – Accessibility To Public Buildings.
2. Chapter 19A – Concrete.
3. Chapter 33 – Site Work, Demolition and Construction.
4. Section 1133B – General Accessibility for Entrances, Exits and Paths of Travel.

1.04 DEFINITIONS

- A. ASTM: American Society for Testing and Materials.

1.05 SUBMITTALS

- A. Follow submittal procedures outlined in Section 01 33 00 – Submittal Procedures.

B. LEED Submittals:

1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating cost for each product having recycled content, and LEED Product Submittal Cover Sheet from 018113.
2. Product Data for Credit MR 5: For products having regional content, documentation indicating location and distance from project of material manufacturer and post of extraction with cost, and LEED Product Submittal Cover Sheet from 018113.

- C. Design Mixes: Have all concrete mixes designed by a testing laboratory and approved by the Consulting Engineer. Conform all mixes to the applicable building code requirement, regardless of other minimum requirements listed herein or on the drawings. Submit mix designs for review before use. Show proportions and specific gravities of cement, fine and coarse aggregate, and water and gradation of combined aggregates.

D. Reinforcing Steel Shop-Drawings

1.06 QUALITY ASSURANCE

- A. Concrete shall be subject to quality assurance in accordance with Section 90 of the Standard Specifications.

1. Slump tests: Have available, at job site, equipment required to perform slump tests. Make one slump test for each cylinder sample, from same concrete batch. Allowable maximum slump shall be 4 inches for walls and 3 inches for slabs on grade and other work.

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B. Certifications:

1. Provide Owner's Representative at the time of delivery with certificates of compliance signed by both Contractor and Supplier containing the following statements:
2. Materials contained comply with the requirements of the Contract Documents in all respects.
3. Proportions and mixing comply with the design mix approved by the Consulting Engineer. Design mix shall have been field tested in accordance with the herein requirements of the Caltrans Standard Specifications and produces the required compressive strength under like conditions.
4. Statement of type and amount of any admixtures.
5. Provide Owner's Representative, at time of delivery, with certified delivery ticket stating volume of concrete delivered and time of mixing, or time of load-out in case of transit mixers.

C. Conform to the applicable provisions of Section 51, 73 and 90 of the Caltrans Standard Specification and these Technical Specifications.

1. Conform construction of portland cement concrete surface improvements (including curbs, gutters, medians, valley gutters, walks) to the requirements of Section 73 of the Caltrans Standard Specifications unless otherwise required in these Technical Specifications or shown on the Plans.
2. Construct "V" ditches in accordance with Section 72-4 of the Standard Specifications; except that finishing shall be in accordance with Standard Specification Section 73 instead of 53, or as otherwise required in these Technical Specifications or shown on the Plans.
3. Conform other construction of portland cement concrete items to the requirements of Section 51 of the Caltrans Standard Specifications unless otherwise required in these Technical Specifications or shown on the Plans.

D. Conform to the requirements of the California Building Code section 1929A.2 for testing of reinforcing bars.

1.07 DESIGNATION

- A. General: Whenever the 28-day compressive strength is designated herein or on the plans is greater than 3,600 psi, the concrete shall considered to be designated by compressive strength. The 28-day compressive strength shown herein or on the plans which are 3,600 psi or less are shown for design information only and are not considered a requirement for acceptance of the concrete. Whenever the concrete is designated by class or as minor concrete herein or on the plans, the concrete shall contain the cement per cubic meter shown in section 90-1.01 of the Caltrans Standard Specifications.
- B. Unless specified otherwise herein or on the Plans, Portland Cement Concrete for this Project shall be Class "2" as specified in Section 90-1.01 of the Caltrans Standard Specifications.

2. PART 2 - PRODUCTS

2.01 PORTLAND CEMENT

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- A. General: Type V or type II (modified) cement conforming to the requirements of ASTM C 150, with the following modifications:
1. Cement shall not contain more than 0.60% by weight of alkalis, calculated as the percentage of Na_2O plus 0.658 times the percentage of K_2O when determined by either 4 intensity flame photometry or by the atomic absorption method. The instrument and procedure used shall be qualified as to precision and accuracy in accordance with the requirements of ASTM C 114.
 2. The autoclave expansion shall not exceed 0.50%.
 3. Mortar containing the Portland Cement to be used and the sand, when tested in accordance with Test Method No. Calif. 527, shall not expand in water more than 0.010% and shall have an air content less than .048%.
 4. Allowable tri-calcium Aluminate (C_3A) by weight shall not exceed 5%. Allowable tetracalcium alumino ferrite plus twice the tricalcium aluminate ($\text{C}_4\text{AF}+2\text{C}_3\text{A}$) by weight shall not exceed 25%. The sulfate expansion test (ASTM C 452) may be used in lieu of the above chemical requirements, provided the sulfate expansion does not exceed 0.040% at 14 days (max.).
 5. Contractor may substitute pozzolan for Portland Cement in amounts up to 15% of the required mix unless high early strength concrete is specified. Pozzolan shall consist of Class F Fly Ash meeting the requirements of ASTM C 618.
- B. Cement for Surface Improvements: Provide a coloring equivalent to $\frac{1}{4}$ pound of lampblack per cubic yard. Add to the concrete at the central mixing plant.
- C. Liquiblack, as supplied by Concrete Corporation of Redwood City, California, may be used in lieu of lampblack. One pint of liquiblack shall be considered equal to one pound of lampblack.

2.02 AGGREGATE AND AGGREGATE GRADING

- A. General: Conform to the requirements of Section 90-2.02, 2.02A and 2.02B of the Caltrans Standard Specifications.
- B. Aggregate Size and Gradation: Conform to the requirements of section 90-3 of the Caltrans Standard Specifications for 25-mm (1-inch) maximum combined aggregate.

2.03 WATER

- A. General: Conform to the requirements of section 90-2.03 of the Caltrans Standard Specifications, for mixing and curing portland cement concrete and for washing aggregates.

2.04 CLASSIFICATION OF PORTLAND CEMENT CONCRETE

- A. Concrete for the following items shall be designated by the following classes per Section 90-1.01 of the Caltrans Standard Specifications:
1. Vehicular Pavement: Class 2.
 2. Curbs, Gutters, and Sidewalks: Minor Concrete.
 3. Cast in place Concrete Pipe: The concrete shall consist of a minimum of 564 pounds of Portland cement per cubic yard of concrete.

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4. Thrust Blocks: The concrete shall have a minimum compressive strength of 3,000 psi.
5. Sign and Fence Footings: The concrete shall consist of a minimum of 376 pounds of Portland cement per cubic yard of concrete.
6. Water, Storm, and Sanitary Structures: The concrete shall consist of a minimum of 564 pounds of Portland cement per cubic yard of concrete.

2.05 EXPANSION JOINT MATERIAL

- A. Material for expansion joints in portland cement concrete improvements shall be premolded expansion joint fillers conforming to the requirements of ASTM Designation D 1751. Expansion joint material shall be shaped to fit the cross section of the concrete prior to being placed. Suppliers certificates showing conformance with this specification shall be delivered with each shipment of materials delivered to the job site. Unless noted otherwise herein or on the Plans expansion joint thickness shall be as follows:
 1. Curbs, Curb Ramps, Island Paving, Sidewalks, Driveways and Gutter Depressions: ¼-inch.
 2. Concrete Slope Protection, Gutter Lining, Ditch Lining and Channel Lining: ½-inch.
 3. Structures: As indicated.

2.06 REINFORCEMENT AND DOWELS

- A. Bar reinforcement for concrete improvements shall be deformed steel bars of the size or sizes called for on the plans conforming to the requirements of ASTM Designation A 615 for Grade 60 bars. Size and shape for bar reinforcement shall conform to the details shown or called for on the Plans. Substitution of wire mesh reinforcement for reinforcing bars will not be allowed.
- B. Slip dowels, where noted or called for on the plans or detail drawings shall be smooth billet-steel bars as designated and conforming to the requirements of ASTM Designation A 615 for Grade 60 bars. Ends of bars inserted in new work shall be covered with a cardboard tube sealed with cork; no grease or oil shall be used.
- C. Mesh for reinforcement for concrete improvements shall be cold drawn steel wire mesh of the size and spacing called for on the plans conforming to the requirements of ASTM Designation A 82 for the material and ASTM Designation A 185 for the mesh. Size and extent of mesh reinforcement shall conform to the details shown or called for on the plans.
- D. Tie wire for reinforcement shall be eighteen (18) gauge or heavier, black, annealed conforming to the requirements of ASTM Designation A 82.
- E. Suppliers certificates showing conformance with this specification shall be delivered with each shipment of materials delivered to the job site.

2.07 COLOR AND PATTERN FOR DECORATIVE SURFACES

- A. Colors for decorative surfacing shall be CHROMIX admixtures as manufactured by the L. M. Scofield Company, Schedule A-312.05 or approved equal. The specific color shall be as designated or called for on the Plans.
- B. Patterns for decorative surfacing shall be standard "Bomanite" patterns as copyrighted by the Bomanite Corporation of Palo Alto, California or equal. The specific pattern shall be as designated or called for on the Plans.

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2.08 ACCESSORY MATERIALS

- A. Conform water stops and other items required to be embedded in of Portland Cement Concrete structures to the applicable requirements of Section 51 of the Caltrans Standard Specifications unless otherwise specifically noted or called for on the Plans or detail drawings.
- B. Curing Compounds:
 - 1. Regular Portland Cement Concrete: "Non-Pigmented Curing Compound - chlorinated Rubber Base-Clear" conforming to the requirements contained in Section 90-7.01B, of the Caltrans Standard Specifications.
 - 2. Color Conditioned Decorative Portland Cement Concrete: LITHOCHROME colorwax as manufactured by the L. M. Scofield Company or approved equal.

2.09 FORMS

- A. Conform to the requirements of Section 51-1.05 of the Caltrans Standard Specifications.

2.10 PRECAST CONCRETE STRUCTURES

- A. Conform to the following Sections of Caltrans Standard Specifications:
 - 1. 51-1.02, Minor Structures.
 - 2. 70-1.02C, Flared End Sections.
 - 3. 70-1.02H, Precast Concrete Structures.

2.11 PORTLAND CEMENT CONCRETE VEHICULAR PAVEMENT

- A. General: See Section 32 13 00 – Rigid Paving.

3. PART 3 - EXECUTION

3.01 STRUCTURAL EXCAVATION

- A. Structural excavation may be either by hand, or by machine and shall be neat to the line and dimension shown or called for on the plans. Excavation shall be sufficient width to provide adequate space for working therein, and comply with CAL-OSHA requirements.
- B. Where an excavation has been constructed below the design grade, refill the excavation to the bottom of the excavation grade with approved material and compact in place to 95% of the maximum dry density.
- C. Remove surplus excavation material remaining upon completion of the work from the job site, or condition it to optimum moisture content and compact it as fill or backfill on the site.

3.02 BRACING AND SHORING

- A. Conform to California and Federal OSHA requirements.
- B. Place and maintain such bracing and shoring as may be required to support the sides of the excavations for the proper protection of workmen; to facilitate the work; to prevent damage to the

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facility being constructed; and to prevent damage to adjacent structures or facilities. Remove all bracing and shoring upon completion of the work.

- C. Be solely responsible for all bracing and shoring and, if requested by the Owner's Representative, submit details and calculations to the Owner's Representative. The Owner's Representative may forward the submittal to the Consulting Engineer and/or the California Division of Industrial Safety for their review. The Contractor's submittal shall include the basic design, assumed soils conditions and estimation of forces to be resisted, together with plans and specifications of the materials and methods to be used, and shall be prepared by a civil engineer or structural engineer registered in California. No excavations related to the proposed facility shall precede a response to the submittal by the Owner's Representative.
- D. Be solely responsible for installing and extracting the sheathing in a manner which will not disturb the position or operation of the facility being constructed or adjacent utilities and facilities.

3.03 PLACING CONCRETE FORMS

- A. Form concrete improvements with a smooth and true upper edge. Side of the form with a smooth finish shall be placed next to concrete. Construct forms rigid enough to withstand the pressure of the fresh concrete to be placed without any distortion.
- B. Thoroughly clean all forms prior to placement and coat forms with an approved form oil in sufficient quantity to prevent adherence of concrete prior to placing concrete.
- C. Carefully set forms to the alignment and grade established and conform to the required dimensions. Rigidly hold forms in place by stakes set at satisfactory intervals. Provide sufficient clamps, spreaders and braces to insure the rigidity of the forms.
- D. Provide forms for back and face of curbs, lip of gutters and edge of walks, valley gutters or other surface slabs that are equal to the full depth of the concrete as shown, noted or called for on the Plans. On curves and curb returns provide composite forms made from benders or thin planks of sufficient ply to ensure rigidity of the form.

3.04 PLACING STEEL REINFORCEMENT

- A. Bars shall be free of mortar, oil, dirt, excessive mill scale and scabby rust and other coatings of any character that would destroy or reduce the bond. All bending shall be done cold, to the shapes shown on the plans. The length of lapped splices shall be as follows:
 - 1. Reinforcing bars No. 8, or smaller, shall be lapped at least 45 bar diameters of the smaller bar joined, and reinforced bars Nos. 9, 10, and 11 shall be lapped at least 60 bar diameters of the smaller bars joined, except when otherwise shown on the plans.
 - 2. Splice locations shall be made as indicated on the plans.
- B. Accurately place reinforcement as shown on the plans and hold firmly and securely in position by wiring at intersections and splices, and by providing precast mortar blocks or ferrous metal chairs, spacers, metal hangers, supporting wires, and other approved devices of sufficient strength to resist crushing under applied loads. Provide supports and ties of such strength and density to permit walking on reinforcing without undue displacement.
- C. Place reinforcing to provide the following minimum concrete cover:
 - 1. Surfaces exposed to water: 4-inches.

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2. Surfaces poured against earth: 3-inches.
 3. Formed surfaces exposed to earth or weather: 2-inches.
 4. Slabs, walls, not exposed to weather or earth: 1-inch.
- D. Minimum spacing, center of parallel bars shall be two and one half (2-1/2) times the diameter of the larger sized bar. Accurately tie reinforcing securely in place prior to pouring concrete. Placing of dowels or other reinforcing in the wet concrete is not permitted.

3.05 MIXING AND TRANSPORTING PORTLAND CEMENT CONCRETE

- A. Transit mix concrete in accordance with the requirements of ASTM Designation C 94. Transit mix for not less than ten (10) minutes total, not less than three (3) minutes of which shall be on the site just prior to pouring. Mix continuous with no interruptions from the time the truck is filled until the time it is emptied. Place concrete within one hour of the time water is first added unless authorized otherwise by the Owner's Representative.
- B. Do not hand mix concrete for use in concrete structures.

3.06 PLACING PORTLAND CEMENT CONCRETE

- A. Thoroughly wet subgrade when concrete is placed directly on soil. Remove all standing water prior to placing concrete.
- B. Do not place concrete until the subgrade and the forms have been approved.
- C. Convey concrete from mixer to final location as rapidly as possible by methods that prevent separation of the ingredients. Deposit concrete as nearly as possible in final position to avoid re-handling.
- D. Place and solidify concrete in forms without segregation by means of mechanical vibration or by other means as approved by the Owner's Representative. Continue vibration until the material is sufficiently consolidated and absent of all voids without causing segregation of material. The use of vibrators for extensive shifting of fresh concrete will not be permitted.
- E. Concrete in certain locations may be pumped into place upon prior approval by the Owner's Representative. When this procedure requires redesign of the mix, such redesign shall be submitted for approval in the same manner as herein specified for approval of design mixes.

3.07 PLACING ACCESSORY MATERIALS

- A. Place water stops and other items required to be embedded in of portland cement concrete structures at locations shown or required in accordance with Section 51 of the Caltrans Standard Specifications unless otherwise specifically noted or called for on the Plans.
- B. Curing Compounds:
 1. Regular Portland Cement Concrete: Apply "Non-Pigmented Curing Compound - chlorinated Rubber Base-Clear" in accordance with Section 90-7.01B, 7.01D and 7.03 of the Caltrans Standard Specifications.
 2. Color Conditioned Decorative Portland Cement Concrete: Apply LITHOCHROME colorwax in accordance with the manufactures instructions.

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3.08 EXPANSION JOINTS

- A. Construct expansion joints incorporating premolded joint fillers at twenty (20) foot intervals in all concrete curbs, gutters, sidewalks, median/island paving, valley gutters, driveway approaches and at the ends of all returns. At each expansion joint install one-half inch by twelve inch (1/2" x 12") smooth slip dowels in the positions shown or noted on the detail drawings.
- B. Orient slip dowels at right angles to the expansion joint and hold firmly in place during the construction process by means of appropriate chairs.

3.09 WEAKENED PLANE JOINTS

- A. Construct weakened plane joints in concrete curbs, gutters, sidewalks, median/island paving and valley gutters between expansion joints at ten (10) foot intervals throughout, or as otherwise indicated. Depth of joint score depth to be one-fourth (25%) the thickness of the concrete.
 - 1. Grooved Joints: Form weakened plane joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8-inch. Repeat grooving of weakened plane joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.

3.10 FINISHING CONCRETE

- A. Finish curb and gutter in conformance with the applicable requirements of Section 73-1.04 and 73-1.05A of the Caltrans Standard Specifications as modified herein.
- B. Where monolithic curb, gutter and sidewalk is specified, separate concrete pours will not be allowed.
- C. Provide a medium broom finish to all horizontal surfaces unless otherwise shown.

3.11 FORM REMOVAL

- A. Remove forms without damage to the concrete. Remove all shores and braces below the ground surface, before backfilling.
- B. Do not backfill against concrete until the concrete has developed sufficient strength to prevent damage.
- C. Leave forms for cast-in-place walls in place at least 72 hours after pouring.
- D. Leave edge forms in place at least 24 hours after pouring.

3.12 CONSTRUCTION

- A. Form, place and finish concrete walkways, island paving, valley gutters and driveway approaches in conformance with the applicable requirements of Section 73-1.04 and 73-1.06 of the Caltrans Standard Specifications as modified herein.
- B. Construct new concrete curb, curb and gutter and valley gutters against existing asphalt concrete by removing a minimum of 12-inches of the asphalt concrete to allow placement of curb or gutter forms. Patch pavement with a 6-inch deep lift of asphalt concrete after gutter form is removed.

3.13 CONNECTING TO EXISTING CONCRETE IMPROVEMENTS

- A. New curb, gutter, or sidewalk is to connect to existing improvements to remain by saw cutting to

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existing sound concrete at the nearest score line, expansion joint or control joint. Drill and insert ½-inch diameter by 12-inch long dowels at 24-inches on center into existing improvements. Install pre-molded expansion joint filler at the matching joint.

- B. A cold joint to the existing curb is not acceptable.

3.14 DECORATIVE SURFACING CONSTRUCTION

- A. Decorative surfacing concrete walks, concrete median islands or other installations shall be formed and placed as a concrete slab conforming to the details shown or noted on the Plans.

3.15 FIELD QUALITY CONTROL

- A. Finish subgrade for concrete improvements shall be subject to approval prior to placement of forms.
- B. No concrete shall be placed prior to approval of forms.
- C. Concrete improvements constructed shall not contain "bird baths" or pond water and shall be smooth and ridge free.
- D. Conform the finish grade at top of curb, flow line of gutter, and the finish cross section of concrete improvements to the design grades and cross sections.
- E. Variation of concrete improvements from design grade and cross section as shown or called for on the plans shall not exceed the tolerances established in Sections 73-1.05 and/or 73-1.06 of the Caltrans Standard Specifications.

3.16 RESTORATION OF EXISTING IMPROVEMENTS

- A. Replace in kind all pavement or other improvements removed or damaged due to the installation of concrete improvements.
- B. Remove, landscaping or plantings damaged or disturbed due to the installation of concrete improvements. Replace in kind.

END OF SECTION 320523

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SECTION 321100 - BASE COURSES

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Aggregate subbase.
- B. Aggregate base.
- C. Cement treated base.

1.02 RELATED SECTIONS

- A. Section 31 23 00 – Excavation and Fill
- B. Section 32 05 23 – Concrete for Exterior Improvements
- C. Section 32 12 00 – Asphalt Concrete Pavement

1.03 RELATED DOCUMENTS

- A. ASTM:
 - 1. D 3740, Practice for Evaluation of Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
 - 2. E 329, Specification for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.
 - 3. E 548, Guide for General Criteria Used for Evaluating Laboratory Competence.
- B. Caltrans Standard Specifications:
 - 1. Section 25, Aggregate Subbases.
 - 2. Section 26, Aggregate Bases.
 - 3. Section 27, Cement Treated Bases.

1.04 DEFINITIONS

- A. Geotechnical Testing Agency: An independent testing agency qualified according to ASTM E 329 to conduct soil materials and rock definition testing, as documented according to ASTM D 3740 and ASTM E 548.
- B. Rock: Rock material in beds, ledges, unstratified masses, and conglomerate deposits and boulders of rock material $\frac{3}{4}$ -cubic yards or more in volume that when tested by an independent geotechnical testing agency, according to ASTM D 1586, exceeds a standard penetration resistance of 100 blows/2-inches.

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- C. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, base or topsoil materials.

1.05 SUBMITTALS

- A. Follow submittal procedures outlined in Section 01 33 00 – Submittal Procedures.
- B. Submit material certificates signed by the material producer and the Contractor, certifying that that each material item complies with, or exceeds the specified requirements.

1.06 QUALITY ASSURANCE

- A. Conform all work and materials to the recommendations or requirements of the Geotechnical Report and meet the approval of the Geotechnical Consultant.
- B. Percentage of compaction specified shall be the minimum acceptable. The percentage represents the ratio of the dry density of the compacted material to the maximum dry density of the material as determined by the procedure set forth in ASTM D 1557.
- C. Perform installation of base materials under the observation of the Geotechnical Consultant. Materials placed without approval of the Geotechnical Consultant will be presumed to be defective and, at the discretion of the Geotechnical Consultant, shall be removed and replaced at no cost to the Owner. Notify the Geotechnical Consultant at least 24-hours prior to commencement of base material installation and at least 48 hours prior to testing.
- D. Do not mix or place cement treated base when the temperature is below 36 degrees F or when the ground is frozen.
- E. Finish surface of material to be stabilized as specified in Section 24-1.04 of Caltrans Standard Specifications.
- F. Finish surface of cement treated base shall be as specified in Section 27 of Caltrans Standard Specifications.
- G. Do not project the finish surface of aggregate subbase above the design subgrade.
- H. Finish grade tolerance at completion of base installation: +0.05'.

1.07 PROJECT CONDITIONS

- A. Protect open excavations, trenches, and the like with fences, covers and railings to maintain safe pedestrian and vehicular traffic passage.
- B. Temporarily stockpile material in an orderly and safe manner and in a location approved by the Owner.
- C. Provide dust and noise control in conformance with Division 1 General Requirements.

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PART 2 - PRODUCTS

2.01 AGGREGATE SUBBASE

- A. Material: Caltrans Standard Specification Section 25.
 - 1. Class 1, 2, or 3: Section 25-1.02A.
 - 2. Class 4: Section 25-1.02B.
 - 3. Class 5: Section 25-1.02C.

2.02 AGGREGATE BASE

- A. Material: Caltrans Standard Specification Section 26.
 - 1. Class 2, 1-1/2-inch Maximum: Section 26-1.02A.
 - 2. Class 2, 3/4-inch Maximum: Section 26-1.02A.
 - 3. Class 3: Section 26-1.02B.

2.03 CEMENT TREATED BASE

- A. Materials: Caltrans Standard Specification Section 27-1.02.

PART 3 - EXECUTION

3.01 GENERAL

- A. Placement and compaction of material by flooding, ponding, or jetting will not be permitted.

3.02 Wet Weather Conditions

- A. Do not place or compact subgrade if above optimum moisture content.
- B. If the Geotechnical Consultant allows work to continue during wet weather conditions, conform to supplemental recommendations provided by the Geotechnical Consultant.

3.03 AGGREGATE SUBBASE

- A. Spreading and Compacting: Sections 25-1.04 and 25-1.05 of Caltrans Standard Specifications.

3.04 AGGREGATE BASE

- A. Watering, Spreading and Compacting: Section 26-1.035, 26-1.04 and 26-1.05 of Caltrans Standard Specifications.

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3.05 CEMENT TREATED BASE

- A. Cement treated base shall be as follows: Proportioning and Mixing Plant-Mixed: Section 27-1.05 of Caltrans Standard Specifications.

3.06 DISPOSAL

- A. Lawfully dispose of all unsuitable and excess or surplus material off-site at no cost to the Owner.

END OF SECTION 32 11 00

SECTION 321200 - ASPHALT CONCRETE PAVEMENT

1. PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Prime coat.
- B. Tack coat.
- C. Asphalt concrete paving.
- D. Asphalt concrete overlay.
- E. Speed bumps.
- F. Asphalt curbs.
- G. Pavement grinding.
- H. Adjusting manholes, valves, monument covers and other structures to grade.

1.02 RELATED DOCUMENTS

- A. Geotechnical Report: "Geotechnical Engineering Report" Prepared by Terracon Consultants, Inc., dated October 7, 2016.
- B. ASTM:
 - 1. D 979: Practice for Sampling Bituminous Paving Mixtures.
 - 2. D 1073: Specification for Fine Aggregate for Bituminous Paving Mixtures.
 - 3. D 1188: Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens.
 - 4. D 2041: Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures.
 - 5. D 2726: Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures.
 - 6. D 2950: Test Method for Density of Bituminous Concrete in Place by Nuclear Method.
 - 7. D 3549: Test Method for Thickness or Height of Compacted Bituminous Paving Mixture Specimens.
 - 8. D 3666: Specifications for Minimum Requirements for Agencies Testing and Inspecting Bituminous Paving Mixtures.
- C. Caltrans Standard Specifications.
 - 1. Section 39: Asphalt Concrete.
 - 2. Section 88: Engineering Fabrics.
 - 3. Section 92: Asphalts.
 - 4. Section 93: Liquid Asphalts.
 - 5. Section 94: Asphaltic Emulsions.

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1.03 DEFINITIONS

- A. ASTM: American Society for Testing Materials.

1.04 QUALITY ASSURANCE

- A. Testing Agency: Owner's Representative will engage a qualified independent testing agency to perform field inspections and tests and to prepare test reports.
1. Testing agency will conduct and interpret tests and state in each report whether tested work complies with or deviates from specified requirements.
- B. Additional testing, at Contractor's expense, will be performed to determine compliance of corrected Work with specified requirements.
- C. Thickness of Asphalt Concrete: In-place compacted thickness of asphalt courses will be determined according to ASTM D 3549.
- D. Surface Smoothness: Finished surface of each asphalt course will be tested for compliance with smoothness tolerances.
- E. In-Place Density: Samples of uncompacted paving mixtures and compacted pavement will be secured by testing agency according to ASTM D 979.
1. Reference maximum theoretical density will be determined by averaging results from 4 samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.
 2. In-place density of compacted pavement may be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.
 3. One core sample may be taken for every 1000 sq. yd. or less of installed pavement, but in no case will fewer than 3 cores be taken.
 4. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.

1.05 SUBMITTALS

- A. Follow submittal procedure outlined by the Architect.
- B. LEED Submittals:
1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating cost for each product having recycled content, and LEED Product Submittal Cover Sheet from 018113.
 2. Product Data for Credit MR 5: For products having regional content, documentation indicating location and distance from project of material manufacturer and post of extraction with cost, and LEED Product Submittal Cover Sheet from 018113.
- C. Job-Mix Designs: Certificates signed by manufacturers certifying that each asphalt concrete mix complies with requirements.
- D. Material Certificates: Certificates signed by manufacturers certifying that each material complies with requirements.

1.06 PROJECT CONDITIONS

- A. Environmental Limitations:
1. Prime Coat: Minimum surface temperature of 60 deg F at application.
 2. Tack Coat: Minimum surface temperature of 60 deg F at application.
 3. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at application.
 4. Asphalt Surface Course: Minimum surface temperature of 60 deg F at application.
 5. Reinforcing Fabric: Air temperature is 50 deg F and rising and pavement temperature is 40 deg F and rising.

2. PART 2 - PRODUCTS

2.01 ASPHALT CONCRETE

- A. Caltrans Standard Specifications Section 39, Type B.
- B. Asphalt Materials:
1. Asphalt: Caltrans Standard Specification Section 92, steam refined paving asphalt, PG64-16.
 2. Prime Coat: Caltrans Standard Specification Section 92, SC-70.
 3. Tack Coat: Caltrans Standard Specification Section 93, SS1.
- C. Aggregates: Conform to Caltrans Standard Specification Section 39-2.02.
- D. Storing, Proportioning and Mixing Materials: Caltrans Standard Specification Section 39-3.
- E. Pavement Reinforcing Fabric: Caltrans Standard Specification Section 88.
- F. Sand: ASTM D 1073, Grade No. 2 or 3.

3. PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that subgrade is dry and in suitable condition to support paving and imposed loads.
- B. Proof-roll subbase using heavy, pneumatic-tired rollers to locate areas that are unstable or that require further compaction.
- C. Notify Owner's Representative in writing of any unsatisfactory conditions. Do not begin paving until these conditions have been satisfactorily corrected.

3.02 PAVEMENT GRINDING

- A. Clean existing paving surface of loose or deleterious material immediately before pavement grinding.

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- B. Grind conforms as indicated.

3.03 SOIL STERILANT

- A. Furnish and apply to areas indicated in accordance with Section 312300.

3.04 SURFACE PREPARATION FOR AGGREGATE BASE MATERIALS

- A. General: Immediately before placing asphalt materials remove loose and deleterious material from substrate surfaces and ensure that prepared subgrade is ready to receive paving according to the Caltrans Standard Specification Section 39-4.01.
- B. Prime Coat: Apply uniformly over surface of compacted-aggregate base according to the Caltrans Standard Specification Section 39-4.02. Apply enough material to penetrate and seal, but not flood, surface. Allow prime coat to cure for 24 hours minimum.
 - 1. If prime coat is not entirely absorbed within 8 hours after application, spread excess prime coat with hand tools and broadcast sand over surface to blot excess asphalt. Use just enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.
 - 2. Protect primed substrate from damage until ready to receive paving.
- C. Tack Coat: Apply uniformly to all vertical surfaces against which asphalt concrete is to be placed, including existing surfaces of previously constructed asphalt or Portland cement concrete paving and to surfaces abutting or projecting into new asphalt pavement, according to the Caltrans Standard Specification Section 39-4.02.
 - 1. Allow tack coat to cure undisturbed before paving.
 - 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.05 SURFACE PREPARATION FOR PAVEMENT AT ASPHALT CONCRETE OVERLAYS

- A. Pavement Irregularities: Level with asphalt concrete, Type B, No. 4 maximum.
- B. Pavement Cracks:
 - 1. Less than 1/4-inch wide: Clean of all dirt by compressed air jet, spray and seal with RS-1 asphaltic emulsion.
 - 2. Wider than 1/4-inch: Clean of all dirt by compressed air jet, spray and seal with RS-1 asphaltic emulsion and skin patch.
- C. Clean surface of all material, such as leaves, dirt, sand, gravel, water and vegetation prior to applying binder of paving asphalt to existing surface.

3.06 PAVEMENT REINFORCING FABRIC

- A. Protect from exposure to ultraviolet rays until placed.
- B. Reject rolls with broken or damaged cores, or factory wrinkled fabric that prevents wrinkle free placement.

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- C. Place with binder of paving asphalt in accordance with Section 39-4.03 of Caltrans Standard Specifications.

3.07 ASPHALT CONCRETE SPREADING AND COMPACTING EQUIPMENT

- A. Spreading Equipment: Caltrans Standard Specification Section 39-5.01.
- B. Compaction Equipment: Caltrans Standard Specification Section 39-5.02.

3.08 ASPHALT CONCRETE PLACEMENT

- A. Place, spread and compact asphalt concrete to required grade, cross section, and thickness according to the Caltrans Standard Specification Sections 39-6.01, 39-6.02 and 39-6.03.
- B. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.09 JOINTS

- A. Construct joints to ensure continuous bond between adjoining paving sections according to the Caltrans Standard Specification Sections 39-6.01 and 39-6.02.
 - 1. Construct joints free of depressions with same texture and smoothness as other sections of asphalt course.
 - 2. Clean contact surfaces and apply tack coat.
 - 3. Offset longitudinal joints in successive courses a minimum of 6 inches.
 - 4. Offset transverse joints in successive courses a minimum of 24 inches.
 - 5. Compact joints as soon as asphalt concrete will bear roller weight without excessive displacement.

3.10 COMPACTION

- A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact according to the Caltrans Standard Specification Sections 39-6.01 and 39-6.03.
- B. Compaction Requirements: Average Density to be 95 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent nor greater than 96 percent.
- C. Finish Rolling: Finish roll paved surfaces to remove roller marks while asphalt is still warm.
- D. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while still hot, with back of rake or smooth iron. Compact thoroughly using tamper or other satisfactory method.
- E. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh asphalt. Compact by rolling to specified density and surface smoothness.

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- F. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.11 ASPHALT CURBS

- A. Construction: Place over compacted surfaces according to Caltrans Standard Specification Section 39-7.01 as specified for dikes. Apply a light tack coat prior to construction, unless pavement surface is still tacky and free of dust.
- B. Shape: Place asphalt concrete to curb cross section indicated.

3.12 SPEED BUMPS

- A. Construct speed bumps over compacted pavement surfaces according to Caltrans Standard Specification Section 39-6. Apply a light tack coat prior to construction, unless pavement surface is still tacky and free of dust.
- B. Place asphalt concrete by hand using a template/screed designed to result in speed bump cross-section indicated after compaction.
- C. Compact speed bumps with 8 ton static roller.

3.13 ADJUSTING MANHOLES, VALVES, MONUMENT COVERS AND OTHER STRUCTURES TO GRADE

- A. Remove pavement, using vertical cuts, as needed to remove frame and provide for concrete collar. Do not damage adjacent pavement.
 - 1. Circular Covers: Cut circle with radius 6 inches larger than cover and concentric with cover.
 - 2. Rectangular Covers: Cut rectangle 6 inches larger than cover on all sides.
- B. Install grade rings or blocking as needed to raise cover to finish grade.
- C. Pour concrete collar:
 - 1. Bottom of Collar: Top of existing collar or 6 inches below top of proposed collar, whichever is at a higher elevation.
 - 2. Top of Collar: Bottom of existing asphalt pavement.
 - 3. Apply tack coat to all exposed surfaces.
 - 4. Fill excavation with asphalt concrete and, while still hot, compact flush with adjacent surface.

3.14 INSTALLATION TOLERANCES

- A. Asphalt Pavement:
 - 1. Course thickness and surface smoothness within the tolerances Caltrans in the Caltrans Standard Specification Sections 39-6.01, 39-6.02 and 39-6.03.
 - 2. Total Thickness: Not less than indicated.

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- B. Trench Patch:
 - 1. Compacted surface: Within 0.01 foot of adjacent pavement.
 - 2. Do not create ponding.

- C. Adjust Covers:
 - 1. Compacted surface: Up to 0.01 foot higher, and no lower, than adjacent pavement.
 - 2. Do not create ponding.

END OF SECTION 321200

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SECTION 321313 - CONCRETE PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concrete paving, bands, curbs, mow strips, steps and walls.
2. Reinforcement.
3. Surface finish.
4. Special curing.

B. Related sections:

1. Section 312000 - Earth Moving, for backfilling and compacted fill for paving.
2. Section 321373 - Joint Sealants, for paving contraction joint sealing.
3. Section 018113 Sustainable Design Requirements

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. LEED Submittals:

1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating cost for each product having recycled content. Include LEED Product Submittal Cover Sheet.
2. Product Data for Credit MR 5: For products having regional content, documentation indicating location and distance from project of material manufacturer and post of extraction with cost, and LEED Product Submittal Cover Sheet from 018113.

C. Samples: Provide a 4 x 4 foot job site sample of each paving finish specified, for review and approval by Owner's Representative prior to installation. Sample shall represent final appearance of paving, including any stain, sealer or other surface applications. Provide additional samples until finish is considered acceptable by the Owner's Representative, at no additional cost to the Owner. The approved sample shall serve as a standard of appearance for the final work to be produced and shall remain on site until all site concrete has been reviewed and approved by the Owner's Representative.

D. Other Action Submittals:

1. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.3 QUALITY ASSURANCE

- A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
- B. ACI Publications: Comply with ACI 301 unless otherwise indicated.

1.4 TESTS

- A. Testing and analysis will be performed under provisions of Section 014000 - Quality Requirements.
- B. Make available proposed mix design of each class of concrete to appointed firm for review prior to commencement of work.
- C. Testing firm will take cylinders and perform slump and air entrainment tests in accordance with ACI 301.
- D. Tests of cement and aggregates will be performed to ensure conformance with specified requirements.
- E. Three concrete test cylinders will be taken for every 75 or less cubic yards of each class of concrete placed each day.
- F. One additional test cylinder will be taken and be cured on site under same conditions as concrete it represents.
- G. One slump test will be taken for each set of test cylinders taken.

PART 2 - PRODUCTS

2.1 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of same type, brand, and source throughout Project:
 - 1. Cement: ASTM C 150 Normal-Type I, gray Portland cement.
 - 2. Blended Hydraulic Cement: ASTM C 595, cement.
- B. Normal-Weight Aggregates: ASTM C 33, Class 4S, uniformly graded. Provide aggregates from a single source.
- C. Water: Clean, potable and complying with ASTM C 94/C 94M.
- D. Air-Entraining Admixture: ASTM C 260.
- E. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain no more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

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- F. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, nonfading, and resistant to lime and other alkalis.
 - 1. Color: As indicated.

2.2 FORM MATERIALS

- A. Conform to ACI 301.
- B. Wood or Steel form material, profiled to suit conditions.

2.3 STEEL REINFORCEMENT

- A. Recycled Content: Postconsumer recycled content plus one-half of pre-consumer recycled content not less than 25 percent.
- B. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, uncoated finish, fabricated from as-drawn steel wire into flat sheets.
- C. Reinforcing Bars: ASTM A 615/A 615M; deformed, uncoated finish.
- D. Plain-Steel Wire: ASTM A 82/A 82M, as drawn.
- E. Tie Wire: Annealed steel, minimum 16 gage size.
- F. Dowel Bars: ASTM A 615/A 615M, plain-steel bars. Cut bars true to length with ends square and free of burrs, uncoated finish.
- G. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's Manual of Standard Practice from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified.

2.4 ACCESSORIES

- A. Pre-emergent Herbicide: Surflan.
- B. Curing Compound: FS TT-C-800, Type 1, 30 percent solids; ASTM C309, Ashford Formula.
- C. Integral Color (Non-immersion Conditions): L.M. Scofield Chromix, or approved equal.
- D. Chemical Surface Retarder: 'Top-cast' by Grace Construction Products.
- E. Liquid Surface Sealer: 'HLQ-125' by SINAK Corporation.
- F. Patch Bond: Weld-Crete.

2.5 RELATED MATERIALS

- A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber in preformed strips.

2.6 PAVEMENT MARKINGS

- A. Pavement-Marking Paint: Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952, Type II, with drying time of less than 45 minutes.
1. Color: As indicated.
- B. Pavement-Marking Paint: MPI #97 Latex Traffic Marking Paint.
1. Color: As indicated.

2.7 WHEEL STOPS

- A. Wheel Stops: Precast, air-entrained concrete.
1. Color: Gray.
 2. Dowels: Galvanized steel, 3/4 inch in diameter, 18-inch minimum length.
 3. Adhesive: As recommended by wheel stop manufacturer for application to concrete pavement.

2.8 CONCRETE MIXTURES

- A. Mix concrete in accordance with ASTM C94.
- B. Prepare design mixtures, proportioned according to ACI 301, with the following properties:
1. Compressive Strength (28 Days): 3000 psi.
 2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.50.
 3. Slump Limit: 4 inches, plus or minus 1 inch.
 4. Air Content: 6 percent plus or minus 1.5 percent.
- C. Chemical Admixtures:
1. Use accelerating admixtures in cold weather only when approved by Owner's Representative. Use of admixtures will not relax cold weather placement requirements.
 2. Use set-retarding admixtures during hot weather only when approved by Owner's Representative.
- D. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 1.0 pound/cu. yd.
- E. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions.
- F. Add air entraining agent to concrete mix for concrete work as necessary.

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- D. Provide dowelled joints at interruptions of concrete with one end of dowel set in capped sleeve to allow longitudinal movement.

3.4 JOINTS

- A. General: Form construction, isolation, and expansion joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct control joints at maximum 5 foot intervals of paving and at right angles to centerline unless otherwise indicated. Align curb, gutter and sidewalk joints when possible.
- B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.
- C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.
- D. Expansion Joints: Place expansion joints at 20 foot intervals unless otherwise shown to correct elevation and profile. Place expansion joints between paving components and building or other appurtenances.
- E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/8-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

3.5 CONCRETE PLACEMENT

- A. Comply with ACI 301 requirements for measuring, mixing, transporting, placing, and consolidating concrete.
- B. Ensure reinforcement, inserts, embedded parts and formed joints are not disturbed during concrete placement.
- C. Deposit and spread concrete in a continuous operation between predetermined construction joints. Do not push or drag concrete into place or use vibrators to move concrete into place. Do not break or interrupt successive pours such that cold joints occur.
- D. Place concrete to pattern indicated.
- E. Coordinate pours of integral color concrete to ensure consistency of color throughout. Color inconsistency will not be accepted.
- F. For steps, walls or other cast-in-place elements, settle concrete by vibration to eliminate honeycombs. Concrete with visible honeycombs will be rejected.
- G. Screed paving surface with a straightedge and strike off.

2.9 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Furnish batch certificates for each batch discharged and used in the Work.

PART 3 - EXECUTION

3.1 EXAMINATION AND PREPARATION

- A. Verify compacted subgrade and/or base is ready to support paving and imposed loads.
- B. Verify gradients and elevations of base are correct.
- C. Beginning of installation means acceptance of existing conditions.
- D. Moisten base to minimize absorption of water from fresh concrete.
- E. Notify Owner's Representative minimum 24 hours prior to commencement of concreting operations.
- F. Proof-roll prepared sub-base surface below concrete paving to identify soft pockets and areas of excess yielding.
- G. Remove loose material from compacted sub-base surface immediately before placing concrete.

3.2 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement. Obtain layout approval prior to pour.
- B. Assemble formwork to permit easy stripping and dismantling without damaging concrete. Use of permanent concrete screed is permissible. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.
- C. Place joint fillers vertical in position, in straight lines. Secure to formwork during concrete placement.

3.3 REINFORCEMENT

- A. Place reinforcement. Comply with CRSI's Manual of Standard Practice for fabricating, placing, and supporting reinforcement.
- B. Interrupt reinforcement at expansion joints.
- C. Place reinforcement to achieve slab and curb alignment as detailed.

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- H. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.
- I. Tolerances in horizontal alignment of hardscape elements such as paving edges, joints, walls and steps shall not exceed 1/4 inch in 10 feet, or 1/2 inch in 50 feet.

3.6 FINISHING

- A. See plan for finishes and finish locations. Portland cement concrete paving shall be stable, firm, and slip resistant and shall comply with CBC Section 11B-302 and 11B-403.
- B. Curbs, mow strips and gutters: Light broom, unless otherwise specified.
- C. Finishes:
 - 1. General: Do not add water to concrete surfaces during finishing operations. Compact and tamp concrete (unless Retardant Finish is specified), to bring 3/8 inch of mortar to surface, float with wood screeds and floats only, and apply following finishes after surface floating. Do not use steel or any plastic screeds, floats or "Fresno" for initial floating and screeding operations. For Retardant Finish, the concrete shall be placed and consolidated so as to completely fill all spaces in the forms; however, tamping will not be permitted because the aggregate must remain near the surface for later exposure.
 - 2. All concrete finishes shall be as listed on the Drawings. Finishes are as follows:
 - a. Fine-to-Medium-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.
 - b. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.
 - c. Rough Trowel Swirl Finish: Provide rough trowel finish to slab surfaces. After placing slabs, consolidate surface by floating to a uniform, smooth, granular texture.
 - d. Scratch Finish: Provide scratch finish to slab surfaces that are to receive mortar setting beds for precast tile pavers as noted on Drawings.
 - e. Steel Trowel Finish: After surface water disappears and floated surface is sufficiently hardened, steel trowel and re-trowel to smooth, dense, hard finish. After concrete has set sufficiently, re-trowel to a smooth, uniform finish free of trowel marks or other blemishes. Avoid excessive troweling that produces burned areas.
 - f. Sandblast Finish (Dry Sand Method):
 - 1) Contractor shall schedule this work to be executed with as little conflict with other trades as possible. Contractor shall be responsible for the protection or masking of adjacent surfaces, if necessary.
 - 2) Test areas for sample of blasting will be established where surfaces will not be left exposed. Owner's Representative shall be present at time of sample blasting and approve the desired finish.
 - 3) Care shall be taken to protect all adjacent surfaces from damage which are not receiving sandblasting.
 - 4) Sandblasting shall be accomplished using qualified workmen familiar with the proper technique.

- 5) Sandblasting work shall be by the dry sane method, utilizing appropriate equipment and adequate air pressure. Abrasives shall be washed silica sand free from salt, clay or other foreign materials. Nozzle position during the operation shall be as determined in the making of the approved samples.
 - 6) All concrete areas requiring patching shall be patched, with all rough spots and unevenness in the concrete surface ground smooth before the sandblasting operation is begun.
- g. Etched or Retardant Finish (with Surface Retarder):
- 1) All work shall conform to applicable OSHA and EPA standards.
 - 2) Contractor shall schedule this work to be executed with as little conflict with other trades as possible. If necessary, Contractor shall be responsible for the protection of adjacent masonry and concrete surfaces with a film-forming protective coating, 'Face-off' by Grace Construction Products, or approved equal, allowing time for coating to dry prior to pouring concrete.
 - 3) Preparatory Work: The concrete should be placed and consolidated so as to completely fill all spaces in the forms. Tamping will not be permitted for Top-cast finish #25 or higher because the aggregate must remain near the surface for later exposure.
 - 4) Application of Retarder: Surface retarder shall be applied by qualified workmen familiar with the proper technique. After concrete has been floated or trowel finished and initial bleed water has risen to the surface, apply film-forming top surface retarder, 'Top-cast' by Grace Construction Products or approved equal, at specified gradient, using a low-pressure sprayer with a 0.5 gpm tip at a rate of 200-350 square feet per gallon until surface has a complete hiding coat. Once surface retarder has cured adequately, dependent on weather and site conditions, remove by pressure washing. Remove rinse water and cement matrix from site in accordance with local codes.

3.7 CONCRETE PROTECTION, CURING AND SEALING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
- B. Comply with ACI 306.1 for cold-weather protection.
- C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 pound/square feet x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.
- D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- E. Curing Methods: Cure concrete by moisture-retaining-cover curing, curing compound or a combination of these.
- F. Concrete Surface Sealer: All concrete paving shall be sealed with a clear, penetrating concrete sealer. If efflorescence or alkali-staining is evident after the concrete has cured, lightly wash

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the surface with a mild muriatic acid solution (usually a 10:1 dilution) that has been thoroughly rinsed with water and cleaned with diluted Lithochrome Floor Cleaner by L.M. Scofield, or approved equal. Rinse again and dry thoroughly. After concrete mix has cured for at least one month, the concrete surface shall be thoroughly washed with fresh, clean water. After surface is thoroughly dried, apply 'HLQ-125' as manufactured by SINAK Corporation, or approved equal, per manufacturer's specifications.

3.8 PAVING TOLERANCES

- A. Comply with tolerances in ACI 117 and as follows:
 - 1. Elevation: 3/4 inch.
 - 2. Thickness: Plus 3/8 inch, minus 1/4 inch.
 - 3. Surface: Gap below 10-foot- long, unleveled straightedge not to exceed 1/2 inch.
 - 4. Joint Spacing: 3 inches.
 - 5. Contraction Joint Depth: Plus 1/4 inch, no minus.
 - 6. Joint Width: Plus 1/8 inch, no minus.

3.9 PAVEMENT MARKING

- A. Allow concrete paving to cure for a minimum of 28 days and be dry before starting pavement marking.
- B. Sweep and clean surface to eliminate loose material and dust.
- C. Apply paint with mechanical equipment to produce markings of dimensions indicated with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 millimeters.

3.10 WHEEL STOPS

- A. Install wheel stops in bed of adhesive applied as recommended by manufacturer.
- B. Securely attach wheel stops to paving with not less than two steel dowels located at one-quarter to one-third points. Install dowels in drilled holes in the paving and bond dowels to wheel stop. Recess head of dowel beneath top of wheel stop.

3.11 REPAIRS AND PROTECTION

- A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Owner's Representative.
- B. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

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- C. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 321313

SECTION 321373 - CONCRETE PAVING JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Cold-applied joint sealants.
 - 2. Hot-applied joint sealants.

1.2 PRECONSTRUCTION TESTING

- A. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, eight samples of materials that will contact or affect joint sealants. Use manufacturer's standard test method to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.

1.3 ACTION SUBMITTALS

- A. Product Data: For each joint-sealant product indicated.
- B. Samples: For each kind and color of joint sealant required.
- C. Pavement-Joint-Sealant Schedule: Include the following information:
 - 1. Joint-sealant application, joint location, and designation.
 - 2. Joint-sealant manufacturer and product name.
 - 3. Joint-sealant formulation.
 - 4. Joint-sealant color.

1.4 INFORMATIONAL SUBMITTALS

- A. Product certificates.
- B. Product test reports.
- C. Preconstruction compatibility and adhesion test reports.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021.
- B. Preinstallation Conference: Conduct conference at project site.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer based on testing and field experience.
- B. Colors of Exposed Joint Sealants: As indicated by manufacturer's designations.

2.2 COLD-APPLIED JOINT SEALANTS

- A. Single-Component, Nonsag, Silicone Joint Sealant for Concrete: ASTM D 5893, Type NS.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Crafcoc Inc., an ERGON company; RoadSaver Silicone.
 - b. Dow Corning Corporation; 888.
 - c. Pecora Corporation; 301 NS.
- B. Single-Component, Self-Leveling, Silicone Joint Sealant for Concrete: ASTM D 5893, Type SL.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Crafcoc Inc., an ERGON company; RoadSaver Silicone SL.
 - b. Dow Corning Corporation; 890-SL.
 - c. Pecora Corporation; 300 SL.
- C. Multicomponent, Pourable, Traffic-Grade, Urethane Joint Sealant for Concrete: ASTM C 920, Type M, Grade P, Class 25, for Use T.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Pecora Corporation; Urexpan NR-200.

2.3 HOT-APPLIED JOINT SEALANTS

- A. Hot-Applied, Single-Component Joint Sealant for Concrete: ASTM D 3406.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Crafcoc Inc., an ERGON company; Superseal 444/777.
- B. Hot-Applied, Single-Component Joint Sealant for Concrete and Asphalt: ASTM D 6690, Types I, II, and III.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Meadows, W. R., Inc.; Sealtight Hi-Spec.
 - b. Right Pointe; D-3405 Hot Applied Sealant.

2.4 JOINT-SEALANT BACKER MATERIALS

- A. Round Backer Rods for Cold- and Hot-Applied Joint Sealants: ASTM D 5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.
- B. Round Backer Rods for Cold-Applied Joint Sealants: ASTM D 5249, Type 3, of diameter and density required to control joint-sealant depth and prevent bottom-side adhesion of sealant.
- C. Backer Strips for Cold- and Hot-Applied Joint Sealants: ASTM D 5249; Type 2; of thickness and width required to control joint-sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

2.5 PRIMERS

- A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.
- B. Cleaning of Joints: Clean out joints immediately before installing joint sealants.
- C. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- D. Install joint-sealant backings of kind indicated to support joint sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 - 1. Do not leave gaps between ends of joint-sealant backings.
 - 2. Do not stretch, twist, puncture, or tear joint-sealant backings.
 - 3. Remove absorbent joint-sealant backings that have become wet before sealant application and replace them with dry materials.
- E. Install joint sealants using proven techniques that comply with the following and at the same time backings are installed:
 - 1. Place joint sealants so they directly contact and fully wet joint substrates.
 - 2. Completely fill recesses in each joint configuration.
 - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- F. Tooling of Nonsag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants according to the following requirements to form

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smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint:

1. Remove excess joint sealant from surfaces adjacent to joints.
 2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.
- G. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.
- H. Clean off excess joint sealant or sealant smears adjacent to joints as the Work progresses, by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

END OF SECTION 321373

SECTION 321400 - UNIT PAVERS – MORTAR SET

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Brick pavers set in aggregate and mortar setting beds.
 - 2. Concrete pavers set in aggregate and mortar setting beds.
 - 3. Stone pavers set in aggregate and mortar setting beds.
 - 4. Steel edge restraints.

1.2 ACTION SUBMITTALS

- A. Product Data: For materials other than water and aggregates.
- B. LEED Submittals:
 - 1. Product Certificates for Credit MR 5: For products and materials required to comply with requirements for regional materials, certificates indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating distance to Project, cost for each regional material, and fraction by weight that is considered regional.
- C. Samples for unit pavers and edge restraints.

1.3 PROJECT CONDITIONS

- A. Cold-Weather Protection: Do not use frozen materials or build on frozen subgrade or setting beds.
- B. Weather Limitations for Mortar and Grout:
 - 1. Cold-Weather Requirements: Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
 - 2. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602. Do not apply mortar to substrates with temperatures of 100 degrees F and higher.

1.4 INFORMATIONAL SUBMITTALS

- A. Material Certificates: For unit pavers. Include statements of material properties indicating compliance with requirements, including compliance with standards. Provide for each type and size of unit.
- B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for unit pavers, indicating compliance with requirements.

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1. For grid paving units, include durability test data based on testing according to proven field performance requirements of ASTM C 1319 performed on units subjected to three years' exposure to same general type of environment, temperature range, and traffic volume as Project.
 2. For solid interlocking paving units, include test data for freezing and thawing according to ASTM C 67.
- C. Paver Installation ICPI certified Subcontractor.
1. A copy of Subcontractor's current certificate from the Interlocking Concrete Pavement Institute Concrete Permeable Paver Installer Certification program.
 2. Job references from projects of a similar size and complexity. Provide Owner/Client/General Contractor names, postal address, phone, fax, and email address.
 3. Written Method Statement and Quality Control Plan that describes material staging and flow, paving direction and installation procedures, including representative reporting forms that ensure conformance to the project specifications.
 4. Subcontractor must supply ICPI permeable certificate at time of bidding and must have completed at least two permeable paver projects of similar magnitude in past three years.

PART 2 - PRODUCTS

2.1 CONCRETE PAVERS

- A. Regional Materials: Provide concrete pavers that have been manufactured within 500 miles of Project site from aggregates and cement that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.
- B. Concrete Pavers: Solid interlocking paving units complying with ASTM C 936 and resistant to freezing and thawing when tested according to ASTM C 67, made from normal-weight aggregates. Use concrete paver units of type, quality, size, color and finish indicated on the drawings.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acker-Stone Industries.
 - b. Angelus Block Company, Inc.
 - c. Belgard Commercial.
 - d. Olsen Pavingstone, Inc.
 2. Color: As indicated on drawings.
 3. Finish: As indicated on drawings.

2.2 EDGE RESTRAINTS

- A. Steel Edge Restraints: Manufacturer's standard painted steel edging 3/16 inch thick by 4 inches high with loops pressed from or welded to face to receive stakes at 36 inches o.c., and steel stakes 15 inches long for each loop.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Border Concepts, Inc.

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- b. Collier Metal Specialties, Inc.
 - c. J. D. Russell Company (The).
 - d. Sure-loc Edging Corporation.
2. Color: As indicated on drawings.

2.3 AGGREGATE SETTING-BED MATERIALS

- A. Graded Aggregate for Base: Sound, crushed stone or gravel complying with ASTM D 2940, base material.
- B. Sand for Leveling Course: Sound, sharp, washed natural sand or crushed stone complying with gradation requirements in ASTM C 33 for fine aggregate.
- C. Sand for Joints: Fine, sharp, washed, masonry sand with 100 percent passing No. 16 sieve and no more than 10 percent passing No. 200 sieve.
- D. Paver Bond©: SB-10 quick curing, high strength, structural grade adhesive complying with ASTM 2339-70.
 - 1. Acceptable Manufacturer: SUREBOND; (800) 424-9300.
- E. Drainage Geotextile: Nonwoven needle-punched geotextile fabric, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
 - 1. Apparent Opening Size: No. 40 sieve, maximum; ASTM D 4751.
 - 2. Permittivity: 0.5 per second, minimum; ASTM D 4491.
- F. Herbicide: Commercial chemical for weed control, registered with the EPA. Provide in granular, liquid, or wettable powder form.

2.4 MORTAR SETTING-BED MATERIALS

- A. Regional Materials: Provide aggregate, cement, and lime for mortar that has been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.
- B. Portland Cement: ASTM C 150, Type I or Type II.
- C. Hydrated Lime: ASTM C 207, Type S.
- D. Sand: ASTM C 144.
- E. Latex Additive: Manufacturer's standard water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed Portland cement and aggregate mortar bed, and not containing a retarder.
- F. Water: Potable.

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2.5 GROUT MATERIALS

- A. Regional Materials: Provide aggregate and cement for grout that has been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.
- B. Polymer-Modified Tile Grout: ANSI A118.7, sanded.
- C. Grout Colors: As specified on drawings.
- D. Water: Potable.

2.6 MORTAR AND GROUT MIXES

- A. General: Comply with referenced standards and with manufacturers' written instructions. Discard mortars and grout if they have reached their initial set before being used.
- B. Mortar-Bed Bond Coat: Mix neat cement and water to a creamy consistency.
- C. Portland Cement-Lime Setting-Bed Mortar: Type M complying with ASTM C 270, Proportion Specification.
- D. Latex-Modified, Portland Cement Setting-Bed Mortar: Comply with written instructions of latex-additive manufacturer and as necessary to produce stiff mixture with a moist surface when bed is ready to receive pavers.
- E. Latex-Modified, Portland Cement Bond Coat: Proportion and mix Portland cement, aggregate, and liquid latex for bond coat to comply with written instructions of liquid-latex manufacturer.
- F. Packaged Grout Mix: Proportion and mix grout ingredients according to grout manufacturer's written instructions.

2.7 SEALER AND JOINT SAND STABILIZER

- A. Sealer and joint sand stabilizer: Enhanced Stabilizing Seal, as produced by B.P. PRO, commercial grade, water-based, single component, epoxy-modified, penetrating sealer and joint sand stabilizer, complying with applicable air quality regulations.
 - 1. Base: Epoxy-reinforced exterior polymer.
 - 2. Appearance: Water-white solution that dries crystal clear, enhancing paver color without darkening.
 - 3. Waterproof quality: 0 gallons per hour on treated masonry wall, tested according to ASTM E 154 – Water Permeance of Masonry.
 - 4. Water vapor transmission: Rated “Excellent” when tested according to ASTM D 1653 Test Methods for Water Vapor Transmission of Organic Coating Films.
 - 5. Skid resistance: 0.6 to 0.7 when tested according to ASTM E 303 – Test Method for Measuring Surface Frictional Properties Using the British Pendulum.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.
- B. Cut unit pavers with motor-driven masonry saw equipment to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible.
 - 1. For concrete pavers, a block splitter may be used.
- C. Joint Pattern: Indicated on drawings.
- D. Pavers over Waterproofing: Exercise care in placing pavers and setting materials over waterproofing so protection materials are not displaced and waterproofing is not punctured or otherwise damaged.
 - 1. Provide joint filler at waterproofing that is turned up on vertical surfaces unless otherwise indicated; where unfilled joints are indicated, provide temporary filler or protection until paver installation is complete.
- E. Tolerances: Do not exceed 1/16-inch unit-to-unit offset from flush (lippage) nor 1/8 inch in 24 inches (3 mm in 600 mm) and 1/4 inch in 10 feet from level, or indicated slope, for finished surface of paving.
- F. Expansion and Control Joints: Provide for sealant-filled joints at locations and of widths indicated. Provide compressible foam filler as backing for sealant-filled joints unless otherwise indicated. Install joint filler before setting pavers. Sealant materials and installation are specified in Section 079200 "Joint Sealants."
- G. Expansion and Control Joints: Provide cork joint filler at locations and of widths indicated. Install joint filler before setting pavers. Make top of joint filler flush with top of pavers.
- H. Provide edge restraints as indicated. Install edge restraints before placing unit pavers.
- I. For installation of paver units smaller than 3 inches square, use construction adhesive as follows:

Apply a 1/4" to 3/8" bead of SB-10 Paver Bond to form an "S" shape on the bottom surface of the paver or stone. Run a bead around the edge a minimum of 1/2 inch from the edge. Set the stone in place and tamp the stone down gently with a rubber mallet to compress the adhesive.

3.2 AGGREGATE SETTING-BED APPLICATIONS

- A. Compact soil subgrade uniformly to at least 95 percent of ASTM D 698 laboratory density.
- B. Place aggregate base, compact by tamping with plate vibrator, and screed to depth indicated.
- C. Place drainage geotextile over compacted base course, overlapping ends and edges at least 12 inches.

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- D. Place leveling course and screed to a thickness of 1 to 1-1/2 inches, taking care that moisture content remains constant and density is loose and uniform until pavers are set and compacted.
- E. Treat leveling course with herbicide to inhibit growth of grass and weeds.
- F. Set pavers with a minimum joint width of 1/16 inch and a maximum of 1/8 inch, being careful not to disturb leveling base. If pavers have spacer bars, place pavers hand tight against spacer bars. Use string lines to keep straight lines. Fill gaps between units that exceed 3/8 inch with pieces cut to fit from full-size unit pavers.
- G. Vibrate pavers into leveling course. Perform at least 3 pass across paving with vibrator. Vibrate under the following conditions:
 - 1. After edge pavers are installed and there is a completed surface or before surface is exposed to rain.
 - 2. Before ending each day's work, fully compact installed concrete pavers. Cover the open layers with nonstaining plastic sheets to protect it from rain.
- H. Spread dry sand and fill joints immediately after vibrating pavers into leveling course. Vibrate pavers and add sand until joints are completely filled, then remove excess sand. Leave a slight surplus of sand on the surface for joint filling.
- I. Do not allow traffic on installed pavers until sand has been vibrated into joints.
- J. Repeat joint-filling process 30 days later.

3.3 MORTAR SETTING-BED APPLICATIONS

- A. Saturate concrete subbase with clean water several hours before placing setting bed. Remove surface water about one hour before placing setting bed.
- B. Apply mortar-bed bond coat over surface of concrete subbase about 15 minutes before placing mortar bed. Limit area of bond coat to avoid its drying out before placing setting bed. Do not exceed 1/16-inch thickness for bond coat.
- C. Apply mortar bed over bond coat; spread and screed mortar bed to uniform thickness at subgrade elevations required for accurate setting of pavers to finished grades indicated.
- D. Mix and place only that amount of mortar bed that can be covered with pavers before initial set. Before placing pavers, cut back, bevel edge, and remove and discard setting-bed material that has reached initial set.
- E. Wet brick pavers before laying if the initial rate of absorption exceeds 30 g/30 square inch per minute when tested according to ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.
- F. Place pavers before initial set of cement occurs. Immediately before placing pavers on mortar bed, apply uniform 1/16-inch- thick bond coat to mortar bed or to back of each paver with a flat trowel.

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- G. Tamp or beat pavers with a wooden block or rubber mallet to obtain full contact with setting bed and to bring finished surfaces within indicated tolerances. Set each paver in a single operation before initial set of mortar; do not return to areas already set or disturb pavers for purposes of realigning finished surfaces or adjusting joints.
- H. Spaced Joint Widths: Provide 1/2-inch nominal joint width with variations not exceeding plus or minus 1/16 inch.
- I. Grouted Joints: Grout paver joints complying with ANSI A108.10.
- J. Grout joints as soon as possible after initial set of setting bed.
 - 1. Force grout into joints, taking care not to smear grout on adjoining surfaces.
 - 2. Tool exposed joints slightly concave when thumbprint hard.
- K. Cure grout by maintaining in a damp condition for seven days unless otherwise recommended by grout or liquid-latex manufacturer.
- L. Cleaning: Remove excess grout from exposed paver surfaces; wash and scrub clean.
 - 1. Remove temporary protective coating as recommended by coating manufacturer and as acceptable to paver and grout manufacturers.

END OF SECTION 321400

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SECTION 321723 - PAVEMENT MARKINGS

1. PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Removal of existing traffic stripes and pavement markers.
- B. Removal of existing signs.
- C. Cleaning and sweeping of streets before application of traffic stripes and pavement markings.
- D. Materials and application for traffic stripes and pavement markings.
- E. Traffic control signs.

1.02 RELATED SECTIONS

- A. Section 32 05 23 – Cement and Concrete for Exterior Improvements

1.03 RELATED DOCUMENTS

A. Caltrans Standard Specifications:

- 1. Section 56, Signs.
- 2. Section 81, Monuments.
- 3. Section 82, Markers and Delineators.
- 4. Section 84, Traffic Stripes and Pavement Markings.
- 5. Section 85, Pavement Markers.

B. Caltrans Standard Plans:

- 1. Plan A20A through A20D: Pavement Markers and Traffic Lines, Typical Details.
- 2. Plan A24A and A24B: Pavement Markings Arrows.
- 3. Plan A24C: Pavement Markings, Symbols and Numerals.
- 4. Plan A24D: Pavement Markings, Words.
- 5. Plan A24E: Pavement Markings, Words and Crosswalks.
- 6. Plan A73A: Object Markers.
- 7. Plan A73B: Markers.
- 8. Plan A74: Survey Monuments.
- 9. Plan RS1: Roadside Sign, Typical Installation Details No. 1.

C. The Manual of Uniform Traffic Control Devices (MUTCD), and the California Supplement to the MUTCD, the editions in effect at time of date on plans.

D. The regulations, standards, and tests of the State of California Department of Transportation Materials and Research Division, edition in effect at time of date on plans.

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- E. California Code of Regulation Title 24, Part 2, California Building Code:
 - 1. Chapter 11B – Accessibility to Public Buildings.

1.04 QUALITY ASSURANCE

- A. Deliver certificates showing conformance with this specification to the Owner with each shipment of materials and equipment to the Project site.

1.05 PROJECT CONDITIONS

- A. Do not apply traffic striping or pavement markings to the pavement until after approval to proceed has been given by the Owner.
- B. Thoroughly cure new asphalt concrete and portland cement concrete before application of stripes, markings or markers.

2. PART 2 - PRODUCTS

2.01 THERMOPLASTIC STRIPES AND MARKING

- A. Conform thermoplastic striping and marking materials to Section 84-2.02 of Caltrans Standard Specifications, unless noted otherwise herein or on the Plans.

2.02 PAINTED STRIPES AND MARKINGS

- A. Conform painted striping and marking materials to Section 84-3.02 of Caltrans Standard Specifications, unless noted otherwise herein or on the Plans.

2.03 TRAFFIC CONTROL SIGNS

- A. General: Section 56-2 of the Caltrans Standard Specifications.
- B. Sign Panels: Conform type (regulatory or warning), size, shape and pattern to the State of California, Department of Transportation, Traffic Manual, edition in effect at the date of the Plans. Sign faces to be of reflectorized porcelain enamel.
- C. Posts:
 - 1. Metal: Two (2) inch inside diameter steel pipe. Conform to Section 56-2.02A of Caltrans Standard Specifications, unless otherwise specified.
 - 2. Wood: Conform to Section 56-2.02B.
- D. Mounting Hardware: Section 56-2.02D of Caltrans Standard Specifications, unless otherwise specified.

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- E. Post Foundations: Portland cement concrete conforming to Section 32 05 23 – Cement and Concrete for Exterior Improvements.

3. PART 3 - EXECUTION

3.01 REMOVAL OF TRAFFIC STRIPES, PAVEMENT MARKINGS AND PAVEMENT MARKERS

- A. Where blast cleaning is used for the removal of painted traffic stripes and pavement markings, or for removal of objectionable material, remove the residue, including dust and water, immediately after contact with the surface being treated. Remove by a vacuum attachment operating concurrently with the blast cleaning operation.
- B. Where grinding is used for the removal of thermoplastic traffic stripes and pavement markings; remove the residue by means of a vacuum attachment to the grinding machine. Do not allow the residue to flow across or be left on, the pavement.
- C. Where markings are to be removed by blast cleaning or by grinding, the removed area shall be approximately rectangular so that no imprint of the removed marking remains on the pavement.
- D. Contractor will be responsible for repairing any damage to the pavement during removal of pavement markers. Damage to the pavement, resulting from removal of pavement markers, shall be considered as any depression more than 1/4-inch deep.

3.02 THERMOPLASTIC TRAFFIC STRIPES AND PAVEMENT MARKINGS

- A. Apply in conformance with the manufacturer's instructions and the applicable requirements of Section 84-2.04 of Caltrans Standard Specifications and Caltrans Standard Plans A20A through A20D, and A24A through A24E.

3.03 PAINTED TRAFFIC STRIPES AND PAVEMENT MARKINGS

- A. Apply in conformance with the manufacturer's instructions and the applicable requirements of Section 84-3.03, 3.04 and 3.05 of Caltrans Standard Specifications and Caltrans Standard Plans A20A through A20D, and A24A through A24E.

3.04 TRAFFIC CONTROL SIGNS

- A. Install in conformance with Sections 56-2.03 and 2.04 of Caltrans Standard Specifications, Caltrans Standard Plan RS1, the applicable requirements of the State of California Department of Transportation Maintenance Manual and the details shown on the Plans. The horizontal locations shown on Caltrans Standard Plan RS1 shall not be applicable, the horizontal location shall be as shown on the Plans.
- B. Portland cement concrete for post foundations shall be of the configuration shown on the Plans.
- C. After erection, damage to traffic sign faces shall be touched up or the sign replaced.

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3.05 PROTECTION

- A. Protect the newly installed and traffic stripes and pavement markings from damage until the material has cured.
- B. Replace any traffic stripes or pavement markings or markers broken, misaligned or otherwise disturbed prior to opening roadway to traffic.

3.06 RESTORATION OF EXISTING IMPROVEMENTS

- A. Existing signs striping or other markings removed or damaged due to the installation of new facilities shall be replaced in kind.
- B. Existing landscaping or planting removed, damaged or disturbed due to the installation of traffic control signs or street name signs shall be replaced in kind.

END OF SECTION 321723

SECTION 323118 - METAL FENCES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Metallic-coated steel fences and gates.
 - 2. Swing gates.
- B. Related Sections:
 - 1. Division 5 Section "Decorative Metal Railing" for wire-mesh infill and frame work.

1.2 PERFORMANCE REQUIREMENTS

- A. Lightning-Protection System: Maximum grounding-resistance value of 25 ohms under normal dry conditions.
- A. Accessibility Requirements for Door Hardware: (all requirements below shall apply to gates as well)
 - 1. Doors/doorways as part of an accessible route shall comply with CBC Sections 11B-404.
 - 2. The clear opening width for a door shall be 32" minimum. For a swinging door it shall be measured between the face of the door and the stop, with the door open 90 degrees. There shall be no projections into it below 34" and 4" maximum projections into it between 34" and 80" above the finish floor or ground. Door closers and stops shall be permitted to be 78" minimum above the finish floor or ground. CBC Section 11B-404.2.3
 - 3. Handles, pulls, latches, locks, and other operable parts on accessible doors shall comply with CBC Section 11B-309.4 and shall be operable with one hand and shall not require tight grasping, pinching, or twisting of the wrist. Operable parts of such hardware shall be 34" minimum and 44" maximum above finish floor or ground. Where sliding doors are in the fully open position, operating hardware shall be exposed and usable from both side.
 - 4. CBC Section 11B-404.2.7
 - 5. The force for pushing or pulling open a door shall be as follows: CBC Section 11B-404.2.9.
 - a. Interior hinged doors, sliding or folding doors, and exterior hinged doors: 5 pounds (22.2 N) maximum.
 - b. Required fire doors: the minimum opening force allowable by the DSA authority, not to exceed 15 pounds (67N).
 - c. These forces do not apply to the force required to retract latch bolts or disengage other devices that hold the door in a closed position.
 - d. The force required to activate any operable parts, such as retracting latch bolts or disengaging other devices, shall be 5 pounds (22.2N) maximum to comply with CBC Section 11B-309.4.
 - 6. Door closing speed shall be as follows: CBC Section 11B-404.2.8.
 - a. Closer shall be adjusted so that the required time to move a door from an open position of 90 degrees to a position of 12 degrees from the latch is 5 seconds min.
 - b. Spring hinges shall be adjusted so that the required time to move a door from an open position of 70 degrees to the closed position is 1.5 seconds minimum.

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7. Thresholds shall comply with CBC Section 11B-404.2.5.
8. Floor stops shall not be located in the path of travel and 4" maximum from walls.
9. Hardware (including panic hardware) shall not be provided with "Night Latch" (NL) function for any accessible doors or gates unless the following conditions are met per DSA Interpretation 10-08 DSA /AC (External), latest revision. Such conditions must be clearly demonstrated and indicated in the specifications:
 - a. Such hardware has a 'dogging' feature.
 - b. It is dogged during the time the facility is open.
 - c. Such 'dogging' operation is performed only by employees as their job function (non-public use).
10. Pair of doors: limit swing of one leaf to 90 degrees so that a clear floor space is provided beyond the arc of the swing for the wall-mounted tactile sign. CBC Section 11B-703.4.2.1.

B. Fences, gates and hardware:

1. Gates that are part of the accessible route shall meet all the requirements of an accessible door in compliance with CBC Section 11B-404.
2. The lever of lever actuated latches or locks for an accessible gate shall be curved with a return to within 1/2" of the (face of) gate to prevent catching on the clothing or persons. California Referenced Standards code. T-24 Part 12, Section 12-10-202, Item (F).
3. Swing doors and gate surfaces within 10" of the finish floor or ground shall have a smooth surface on the push side extending the full width of the door or gate. Parts creating horizontal or vertical joints in these surfaces shall be within 1/16" of the same plane as the other and be free of sharp or abrasive edges. Cavities created by added kick plates shall be capped. CBC Section 11B-404.2.10.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For gates. Include plans, elevations, sections, details, and attachments to other work.
- C. Samples: For each fence material and for each color specified.
 1. Provide Samples 12 inches in length for linear materials.
 2. Provide Samples 12 inches square for wire mesh.
- D. Maintenance Data: For gate operators to include in maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Reference Standards:
 1. 2016 California Building Standards Administrative Code, Part 1, Title 24 CBSC.
 2. 2016 California Building Code (CBC), Part 2, Title 24 CBSC. (2015 International Building Code of the International Code Council, with California Amendments).
 3. 2016 California Electrical Code (CEC), Part 3, Title 24 CBSC (2014 National Electrical Code, with California Amendments).
 4. 2016 California Mechanical Code (CMC), Part 4, Title 24 CBSC (2015 Uniform Mechanical Code, with California Amendments).

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5. 2016 California Plumbing Code (CPC), Part 5, Title 24, CBSC (2015 Uniform Plumbing Code, with California Amendments).
 6. 2016 California Energy Code, Part 6, Title 24 CBSC.
 7. 2016 California Historical Code, Part 8, Title 24 CBSC.
 8. 2016 California Fire Code, Part 9, Title 24 CBSC. (2015 International Fire Code, with California Amendments).
 9. 2016 California Green Building Standards Code (CALGreen Code), Part 11, Title 24 CBSC.
 10. 2016 California Referenced Standards Code, Part 12, Title 24, CBSC.
 11. NFPA 13 - Automatic Sprinkler Systems (California Amended), 2016 Edition.
 12. NFPA 14 - Standpipe Systems (California Amended), 2013 Edition.
 13. NFPA 17 - Dry Chemical Extinguishing Systems, 2013 Edition.
 14. NFPA 17A - Wet Chemical Extinguishing Systems, 2013 Edition.
 15. NFPA 20 - Stationary Pumps, 2016 Edition.
 16. NFPA 24 - Private Fire Service Mains (California Amended), 2016 Edition.
 17. NFPA 72 - National Fire Alarm and Signaling Code (California Amended).
 18. NFPA 80 - Fire Door and Other Opening Protectives, 2016 Edition.
 19. NFPA 253 - Critical Radiant Flux of Floor Covering Systems, 2015 Edition.
 20. NFPA 2001 - Clean Agent Fire Extinguishing Systems (California Amended), 2015 Edition.
 21. Americans with Disabilities Act (ADA), Title II.
- B. Emergency Access Requirements: Comply with requirements of authorities having jurisdiction for automatic gate operators on gates that must provide emergency access.
- C. Preinstallation Conference: Conduct conference at Project site.

1.5 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal fences and gates that fails in materials or workmanship within specified warranty period.
1. Warranty Period: 2 years.
- B. Installer's Warranty: 2 years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Metallic-Coated Steel Fences and Gates:
1. Ameristar Fence Products.
 2. Master Halco.
 3. Merchants Metals; a division of MMI Products, Inc.
 4. Xcel Fence.
 5. Or equal.

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2.2 STEEL AND IRON

- A. Plates, Shapes, and Bars: ASTM A 36.
- B. Bars (Pickets): Hot-rolled, carbon steel complying with ASTM A 29, Grade 1010.
- C. Tubing: ASTM A 500, cold formed steel tubing.

2.3 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- B. Nonshrink Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107 and specifically recommended by manufacturer for exterior applications.
- C. Galvanizing: For components indicated to be galvanized and for which galvanized coating is not specified in ASTM F 2408, hot-dip galvanize to comply with ASTM A 123/A 123M. For hardware items, hot-dip galvanize to comply with ASTM A 153/A 153M.

2.4 DECORATIVE STEEL FENCES

- A. Decorative Steel Fences: As indicated Drawings.
- B. Infill panel frame work: As indicated on Drawings.
- C. Infill panel: Wire-mesh infill as specified in Division 5 Section "Decorative Metal Railing".

2.5 SWING GATES

- A. Gate Configuration: As indicated.
- B. Gate Frame Height: As indicated.
- C. Gate Opening Width: As indicated.
- D. Infill: Comply with requirements for adjacent fence.

A. Hardware:

2 ea	Hinges 1600 series, single acting	Silver	DAC Industries 800/888-9768
1 ea	Panic Device 6003	Silver	DAC Industries
1 ea	Lock Box	Silver	DAC Industries
1 ea	Receiver Bracket 6020	Silver	DAC Industries
1 ea	Guard 24"	Silver	DAC Industries
1 ea	2 piece Mounting Plate	Silver	DAC Industries
1 ea	6100 ADA lever (outside)	Silver	DAC Industries

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1 ea	Rim Cylinder 63-34 LF key-way, 111113 bitted	626	Sargent
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PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, construction layout, and other conditions affecting performance of the Work.
- B. Do not begin installation before final grading is completed unless otherwise permitted by Architect.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.
 - 1. Construction layout and field engineering are specified in Division 1 Section "Execution Requirements."

3.3 DECORATIVE FENCE INSTALLATION

- A. Install fences by setting posts as indicated and fastening rails and infill panels to posts.
- B. Post Setting: Set posts in concrete at indicated spacing.
 - 1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
 - 2. Concrete Fill: Place concrete around posts and sleeves and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
 - a. Exposed Concrete: Extend 2 inches above grade. Finish and slope top surface to drain water away from post.
 - 3. Posts Set in Concrete: Extend post to within 6 inches of specified excavation depth, but not closer than 3 inches to bottom of concrete.
 - 4. Posts Set into Concrete in Sleeves: Use galvanized-steel pipe sleeves with inside diameter at least 3/4 inch larger than outside diagonal dimension of post, preset and anchored into concrete for installing posts.
 - a. Extend posts at least 5 inches into sleeve.
 - b. After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink grout, mixed and placed to comply with grout manufacturer's written instructions; shape and smooth to shed water. Finish and slope top surface of grout to drain water away from post.

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3.4 GATE INSTALLATION

- A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.5 ADJUSTING

- A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.
- B. Lubricate hardware and other moving parts.

END OF SECTION 323118

SECTION 323119 - DECORATIVE METAL FENCES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Decorative steel fences.
 - 2. Swing gates.
 - 3. Gate operators, including controls.
- B. Related Sections:
 - 1. Division 1 Section "Sustainable Design Requirements" for additional LEED requirements.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For gates. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Wiring Diagrams: For power, signal, and control wiring.
- C. Samples: For each fence material and for each color specified.
- D. LEED Submittals:
 - 1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.

1.3 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For gate operators to include in maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. UL Standard: Provide gate operators that comply with UL 325.
- C. Emergency Access Requirements: Comply with requirements of authorities having jurisdiction for automatic gate operators on gates that must provide emergency access.

PART 2 - PRODUCTS

2.1 STEEL AND IRON

- A. Plates, Shapes, and Bars: ASTM A 36/A 36M.
- B. Bars (Pickets): Hot-rolled, carbon steel complying with ASTM A 29/A 29M, Grade 1010.
- C. Tubing: ASTM A 500, cold formed steel tubing.
- D. Bar Grating: NAAMM MBG 531.
 - 1. Bars: Hot-rolled steel strip, ASTM A 1011/A 1011M, Commercial Steel, Type B.
 - 2. Wire Rods: ASTM A 510.
- E. Uncoated Steel Sheet: Hot-rolled steel sheet, ASTM A 1011/A 1011M, Structural Steel, Grade 45.
- F. Galvanized-Steel Sheet: ASTM A 653/A 653M, structural quality, Grade 50, with G90 coating.
- G. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, structural quality, Grade 50, with AZ60 coating.
- H. Recycled Content:
 - 1. Steel produced by electric arc furnace (EAF): Recycled content not less than 90 percent.
 - 2. Steel produced by basic oxygen furnace (BOF): Recycled content not less than 25 percent.

2.2 COATING MATERIALS

- A. Epoxy Zinc-Rich Primer for Steel: Complying with MPI #20 and compatible with coating specified to be applied over it.
- B. Epoxy Primer for Galvanized Steel: Complying with MPI #101 and compatible with coating specified to be applied over it.
- C. Epoxy Intermediate Coat: Complying with MPI #77 and compatible with primer and topcoat.
- D. Polyurethane Topcoat: Complying with MPI #72 and compatible with undercoat.

2.3 MISCELLANEOUS MATERIALS

- A. Concrete: Normal-weight concrete complying with requirements in Section 033000 "Cast-in-Place Concrete" with a minimum 28-day compressive strength of 3000 psi, 3-inch slump, and 1-inch maximum aggregate size.
- B. Nonshrink Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107 and specifically recommended by manufacturer for exterior applications.

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2.4 GROUNDING MATERIALS

- A. Grounding Conductors: Bare, solid wire for No. 6 AWG and smaller; stranded wire for No. 4 AWG and larger.
 - 1. Material above Finished Grade: Copper.
 - 2. Material on or below Finished Grade: Copper.
- B. Grounding Connectors and Grounding Rods: Comply with UL 467.

2.5 DECORATIVE STEEL FENCES

- A. Decorative Steel Fences: Fences made from steel tubing and shapes.
 - 1. 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:
 - a. A & T Iron Works, Inc.
 - b. Ametco Manufacturing Corporation.
 - c. BarnettBates Corporation.
 - d. Golden State.
- B. Posts: Square steel tubing, with 1/8-inch wall thickness.
- C. Post Caps: Formed from steel sheet.
- D. Rails:
 - 1. Steel Tube Rails: Square steel tubing with 1/8-inch wall thickness.
- E. Pickets: Decorative steel bars of pattern and size indicated.
 - 1. Picket Spacing: 4 inches clear, maximum.
- F. Fasteners: Stainless-steel carriage bolts and tamperproof nuts.
- G. Fabrication:
 - 1. Fit and shop assemble in largest practical sections, for delivery to site.
 - 2. Fabricate items with joints tightly fitted and secured.
 - 3. Continuously seal joined members by continuous welds.
 - 4. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.
 - 5. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.
 - 6. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.
- H. Galvanizing: Hot-dip galvanize to comply with ASTM A 123/A 123M.
 - 1. Hot-dip galvanize posts and rails.
 - 2. Hot-dip galvanize rail and picket assemblies after fabrication.
- I. Finish for Steel Items: Primed with two coats and shop-painted.

2.6 SWING GATES

- A. Galvanized-Steel Frames and Bracing: Fabricate members from square tubes formed from 0.108-inch nominal-thickness, metallic-coated steel sheet or formed from 0.105-inch nominal-thickness steel sheet and hot-dip galvanized after fabrication.
- B. Steel Frames and Bracing: Fabricate members from square steel tubing with 1/8-inch wall thickness.
- C. Hardware: Latches permitting operation from both sides of gate, hinges, and keepers for each gate leaf more than 5 feet wide. Provide center gate stops and cane bolts for pairs of gates.
- D. Galvanizing: For items that are indicated to be galvanized, hot-dip galvanize to comply with ASTM A 123/A 123M unless otherwise indicated.
- E. Steel Finish: Primed with two coats and shop-painted.

2.7 GATE OPERATORS

- A. General: Provide factory-assembled automatic operating system designed for gate size, type, weight, and operation frequency. Provide operation control system with characteristics suitable for Project conditions, with remote-control stations, safety devices, and weatherproof enclosures; coordinate electrical requirements with building electrical system.
 - 1. Provide operator with UL-approved components.
 - 2. Provide controllers, electrical devices, and wiring.
- B. Motors: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 110513 "Common Motor Requirements for Equipment."
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
- C. Gate Operators: Concrete base mounted and as follows:
 - 1. Hydraulic Swing Gate Operators:
 - a. Duty: Heavy duty, commercial/industrial.
 - 2. Mechanical Swing Gate Operators:
 - a. Duty: Heavy duty, commercial/industrial.
- D. Remote Controls: Electric controls separated from gate and motor and drive mechanism, with NEMA ICS 6, Type enclosure for concrete base mounting, and with space for additional optional equipment. Provide the following remote-control device(s):
 - 1. Card Reader: Programmable, multiple-code system.
 - 2. Digital Keypad Entry Unit: Multiple-programmable, code capability.
 - 3. Vehicle Detector: Loop system including automatic closing timer with adjustable time delay before closing, and timer cutoff switch,] designed to hold gate open until traffic clears.
- E. Obstruction Detection Devices: Provide each motorized gate with automatic safety sensor(s). Activation of sensor(s) causes operator to immediately reverse gate in both opening and closing cycles and hold until clear of obstruction.

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2.8 Accessories:

- A. Battery Backup System: Battery-powered drive and access-control system.
- B. Instructional, Safety, and Warning Labels and Signs: According to UL 325.

2.9 STEEL FINISHES

- A. Surface Preparation: Clean surfaces according to SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 - 1. After cleaning, apply a conversion coating suited to the organic coating to be applied over it.
- B. Powder Coating: 2-coat finish consisting of epoxy primer and TGIC polyester topcoat, with a minimum total dry film thickness of not less than 8 mils.
- C. Primer Application: Apply zinc-rich epoxy primer immediately after cleaning, to provide a minimum dry film thickness of 2 mils.
- D. High-Performance Coating: Apply epoxy intermediate and polyurethane topcoats to prime-coated surfaces. Apply at spreading rates recommended by coating manufacturer.
 - 1. Match approved Samples for color, texture, and coverage.

PART 3 - EXECUTION

3.1 DECORATIVE FENCE INSTALLATION

- A. Install fences according to manufacturer's written instructions.
- B. Post Excavation: Excavate holes to a diameter of not less than 4 times post size and a depth of not less than 24 inches plus 3 inches for each foot or fraction of a foot that fence height exceeds 4 feet.
- C. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.
 - 1. Hold posts in position during setting with concrete or mechanical devices.
 - 2. Concrete Fill: Place concrete around posts and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
 - 3. Posts Set in Concrete: Extend post to within 6 inches of specified excavation depth, but not closer than 3 inches to bottom of concrete. Crown top of concrete for positive drainage.
 - 4. Space posts uniformly at 6 feet o.c., maximum.

3.2 GATE INSTALLATION

- A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach hardware using tamper-resistant or concealed means.

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Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.3 GATE OPERATOR INSTALLATION

- A. General: Install gate operators according to manufacturer's written instructions, aligned and true to fence line and grade.
- B. Concrete Bases: Cast-in-place or precast concrete, dimensioned and reinforced according to gate operator component manufacturer's written instructions and as indicated on Drawings.
- C. Vehicle Loop Detector System: Cut grooves in pavement and bury and seal wire loop according to manufacturer's written instructions. Connect to equipment operated by detector.
- D. Comply with NFPA 70 and manufacturer's written instructions for grounding of electric-powered motors, controls, and other devices.

3.4 GROUNDING AND BONDING

- A. Fence Grounding: Install at maximum intervals of 1500 feet except as follows:
 - 1. Fences within 100 Feet of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 750 feet.
 - a. Gates and Other Fence Openings: Ground fence on each side of opening. Bond metal gates to gate posts.
- B. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at the grounding location.
- C. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.
- D. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
- E. Bonding to Lightning-Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning-protection down conductor or lightning-protection grounding conductor, complying with NFPA 780.

3.5 FIELD QUALITY CONTROL

- A. Grounding-Resistance Testing: Engage a qualified testing agency to perform tests and inspections.

END OF SECTION 323119

SECTION 328400 – IRRIGATION SYSTEMS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. It is the intent of the specifications and drawings that the finished system is complete in every respect and shall be ready for operation satisfactory to the Owner.
- B. The work shall include all materials, labor, services, transportation, and equipment necessary to perform the work as in these specifications, and as necessary to complete the contract.

1.2 CONSTRUCTION DRAWINGS

- A. Due to the scale of the drawings, it is not possible to indicate all offsets, fittings, sleeves, etc., which may be required. The Contractor shall carefully investigate the structural and finished conditions affecting all of his work and plan his work accordingly, furnishing such fittings, etc. as may be required to meet such conditions. Drawings are generally diagrammatic and indicative of the work to be installed. The work shall be installed in such a manner as to avoid conflicts between irrigation systems, planting, and architectural features.
- B. All work called for on the drawings by notes or details shall be furnished and installed whether or not specifically mentioned in the specifications. When an item is shown on the plans but not shown on the specifications or vice versa, it shall be deemed to be as shown on both. The Architect shall have final authority for clarification. When a conflict occurs between an item shown on the plan and as shown on the specifications, the Architect shall have final authority for clarification.
- C. The Contractor shall not willfully install the irrigation system as shown on the drawings when it is obvious in the field that obstructions, grade differences or discrepancies in area dimensions exist that might not have been considered in engineering. Such obstructions or differences should be brought to the attention of the Architect as soon as detected. In the event this notification is not performed, the Irrigation Contractor shall assume full responsibility for any revisions necessary.

1.3 QUALITY ASSURANCE

- A. Provide at least one English speaking 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 manufacturer's recommended methods of installation and who shall direct all work performed under this section.
- B. Manufacturer's directions and detailed drawings shall be followed in all cases where the manufacturer of articles used in this contract furnishes directions covering points now shown in the drawings and specifications.

- C. All local, municipal and state laws, rules and regulations governing or relating to any portion of this work are hereby incorporated into and made a part of these specifications, and their provisions shall be carried out by the Contractor. Anything contained in these specifications shall not be construed to conflict with any of the above rules and regulations of the same. However, when these specifications and drawings call for or describe materials, workmanship, or construction of a better quality, higher standard, or larger size than is required by the above rules and regulations, the provisions of these specifications and drawings shall take precedence.
- D. All materials supplied for this project shall be new and free from any defects. All defective materials shall be replaced immediately.

1.4 SUBMITTALS

- A. Materials List:
 - 1. After award of contract and before any irrigation system materials are delivered to the job site, submit to the Owner a complete list of all irrigation systems, materials, or processes proposed to be furnished and installed as part of this contract.
 - 2. Show manufacturer's name and catalog number for each item, furnish complete catalog cuts and technical data, and furnish the manufacturer's recommendations as to the method of installation.
 - 3. No substitutions will be allowed without prior written acceptance by the Architect or Owner's authorized representative.
 - 4. Manufacturer's warranties shall not relieve the Contractor of his liability under the guarantee. Such warranties shall only supplement the guarantee.

1.5 EXISTING CONDITIONS

- A. The Contractor shall verify and be familiar with the locations, size and detail of points of connection provided as the source of water, electrical supply, and telephone line connection to the irrigation system.
- B. Irrigation design is based on the available static pressure shown on the drawings. Contractor shall verify static water on the project prior to the start of construction. Should a discrepancy exist, notify the Architect and Owner's authorized representative prior to beginning construction.
- C. Prior to cutting into the soil, the Contractor shall locate all cables, conduits, sewer septic tanks, and other utilities as are commonly encountered underground and he shall take proper precautions not to damage or disturb such improvements. If a conflict exists between such obstacles and the proposed work, the Contractor shall promptly notify the Architect and Owner who will arrange for relocations. The Irrigation Contractor will proceed in the same manner if a rock layer or any other such conditions are encountered.
- D. The Contractor shall protect all existing utilities and features to remain on and adjacent to the project site during construction. Contractor shall repair, at his own cost, all damage resulting from his operations or negligence.
- E. The Irrigation Contractor shall coordinate with the General Contractor for installation of required sleeving as shown on the plans.

1.6 INSPECTIONS

- A. The Contractor shall permit the Architect and Owner's authorized representative to visit and inspect at all times any part of the work and shall provide safe access for such visits.
- B. Where the specifications require work to be tested by the Contractor, it shall not be covered over until accepted by the Architect, Owner's authorized representative, and/or governing agencies. The Irrigation Contractor shall be solely responsible for notifying the Architect, Owner, and governing agencies, a minimum of 48 hours in advance, where and when the work is ready for testing. Should any work be covered without testing or acceptance, it shall be, if so ordered, uncovered at the Irrigation Contractor's expense.
- C. Inspections will be required for the following at a minimum:
 - 1. System layout
 - 2. Pressure test of irrigation main line (Three hours at 150 PSI)
 - 3. Coverage test of irrigation sprinkler system.
 - 4. Sample layout of dripline irrigation.
 - 5. Final inspection prior to start of maintenance period
 - 6. Final acceptance
- D. Site observations and testing will not commence without the record drawings a prepared by the Irrigation Contractor. Record drawings must be complete and up to date for each site visit.
- E. Work which fails testing and is not accepted will be retested.

1.7 STORAGE AND HANDLING

- A. Use all means necessary to protect irrigation system materials before, during, and after installation and to protect the installation work and materials of all other trades. In the event of damage, immediately make all repairs and replacements necessary to the acceptance of the Architect and Owner.
- B. Exercise care in handling, loading, unloading, and storing plastic pipe and fittings under cover until ready to install. Transport plastic pipe only on a vehicle with a bed long enough to allow the pipe to lay flat to avoid undue bending and concentrated external load.

1.8 CLEANUP AND DISPOSAL

- A. Dispose of waste, trash, and debris in accordance with applicable laws and ordinances and as prescribed by authorities having jurisdiction. Bury no such waste material and debris on the site. Burning of trash and debris will not be permitted. The Contractor shall remove and dispose of rubbish and debris generated by his work and workmen at frequent intervals or when ordered to do so by the Owner's authorized representative.
- B. At the time of completion the entire site will be cleared of tools, equipment, rubbish and debris which shall be disposed of off-site in a legal disposal area.

1.9 TURNOVER ITEMS

A. Record Drawings:

1. Record accurately on one set of contract drawings all changes in the work constituting departures from the original contract drawings.
2. The changes and dimensions shall be recorded in a legible and workmanlike manner to the satisfaction of the Architect or Owner's authorized representative. Prior to final inspection of work, submit record drawings to the Architect or Owner's authorized representative.
3. Dimensions from/to permanent points of reference such as buildings, sidewalks, curbs, etc. shall be shown. Data on record drawings shall be recorded on a day to day basis as the project is being installed. All lettering on drawings shall be minimum 1/8 inch in size.
4. Show locations and depths of the following items:
 - a. Point of connection (including water meters, backflow preventors, master control valves, etc.)
 - b. Routing of sprinkler pressure lines (dimensions shown at a maximum of 100 feet along routing and at all changes in direction)
 - c. Gate valves
 - d. Automatic remote control valves
 - e. Quick coupling valves
 - f. Routing of control wires
 - g. Irrigation controllers
 - h. Related equipment (as may be directed)
5. Maintain record drawings on site at all times. Upon completion of work, transfer all as-built information and dimensions to a clean set of bond prints, using red, waterproof ink.

B. Controller Charts:

1. Record drawings must be approved by Architect and/or Owner's authorized representative before charts are prepared.
2. Provide one controller chart for each automatic controller. Chart shall show the area covered by the particular controller.
3. The chart is to be a reduced copy of the actual "record" drawing. In the event the controller sequence is not legible, when the drawing is reduced, it shall be enlarged to a readable size.
4. When completed and approved, the chart shall be hermetically sealed between two pieces of plastic, each piece being a minimum 5 millimeters in thickness.

C. Operation and Maintenance Manuals:

1. Two individually bound copies of operation and maintenance manuals shall be delivered to the Architect or Owner's authorized representative at least 10 calendar days prior to final inspection. The manuals shall describe the material installed and the proper operation of the system.
2. Each complete, bound manual shall include the following information:
 - a. Index sheet stating Contractor's address and telephone number, duration of guarantee period, list of equipment including names and addresses of local manufacturer representatives.
 - b. Operating and maintenance instructions for all equipment.
 - c. Spare parts list and related manufacturer information for all equipment.
 - d. Guarantee Statement.

- D. Equipment:
1. Supply as a part of this contract the following items:
 - a. Two (2) wrenches for disassembly and adjustment of each type of sprinkler head used in the irrigation system.
 - b. Three 30-inch sprinkler keys for manual operation of control valves.
 - c. Two keys for each automatic controller.
 - d. Two quick coupler keys with a 3/4 inch bronze hose bib, bent nose type with hand wheel and two coupler lid keys.
 - e. One valve box cover key or wrench.
 - f. One 5-foot tee wrench for operating butterfly valves (if used).
 - g. Six extra sprinkler heads of each size and type.
 2. The above equipment shall be turned over to Owner's authorized representative at the final inspection.

1.10 COMPLETION

- A. At the time of the pre-maintenance period inspection, the Architect, Owner's authorized representative, and governing agencies will inspect the work, and if not accepted, will prepare a list of items to be completed by the Contractor. At the time of the post-maintenance period or final inspection, the work will be reinspected and final acceptance will be in writing by the Architect, Owner's authorized representative, and governing agencies.
- B. The Owner's authorized representative shall have final authority on all portions of the work.
- C. After the system has been completed, the Contractor shall instruct Owner's authorized representative in the operation and maintenance of the irrigation system and shall furnish a complete set of operating and maintenance instructions.
- D. Any settling of trenches which may occur during the one-year period following acceptance shall be repaired. Repairs shall include the complete restoration of all damage to planting, paving or other improvements of any kind as a result of the work.

1.11 GUARANTEE

- A. The entire sprinkler system, including all work done under this contract, shall be unconditionally guaranteed against all defects and fault of material and workmanship, including settling of backfilled areas below grade, for a period of two (2) years in accordance with the contract documents.

Should any problem with the irrigation system be discovered within the guarantee period, it shall be corrected by the Contractor at no additional expense to owner within ten (10) calendar days of receipt of written notice from Owner. When the nature of the repairs, as determined by the Owner, constitutes an emergency (i.e. broken pressure line) the Owner may proceed to make repairs at the Contractor's expense. Any and all damages to existing improvement resulting either from faulty materials or workmanship.

PART 2 - PRODUCTS

2.1 SUMMARY

Use only new materials of the manufacturer, size and type shown on the drawings and specifications. Materials or equipment installed or furnished that do not meet Architect's, Owner's, or governing agencies standards will be rejected and shall be removed from the site at no expense to the Owner.

2.2 PIPING

- A. Pressure supply line from point of connection through basket strainer unit shall be Type "K" copper or brass pipe.
- B. Pressure supply lines 2 inches in diameter and up to 3 inches in diameter shall be Class 315 solvent weld PVC. Piping shall conform to ASTM D1784.
- C. Pressure supply lines 1-1/2 inches and smaller in diameter shall be Schedule 40 solvent weld PVC. Piping shall conform to ASTM D1784.
- D. Non-pressure lines 3/4 inches in diameter and larger downstream of the remote control valve shall be Schedule 40 PVC. Non-pressure lines 1 inch and larger to conform to ASTM D1784.

2.3 METAL PIPE AND FITTINGS

- A. Brass pipe shall be 85 percent red brass, ANSI, IPS Standard 125 pounds, Schedule 40 screwed pipe.
- B. Fittings shall be medium brass, screwed 125-pound class.
- C. Copper pipe and fittings shall be Type "K" sweat soldered.

2.4 PLASTIC PIPE AND FITTINGS

- A. Pipe shall be marked continuously with manufacturer's name, nominal pipe size, schedule or class, PVC type and grade, National Sanitation Foundation approval, Commercial Standards designation, and date of extrusion.
- B. All plastic pipe shall be extruded of an improved PVC virgin pipe compound in accordance with ASATM D2241 or ASTM D1784.
- C. All PVC fittings shall be standard weight Schedule 80 for constant-pressure mainline fittings and Schedule 40 for non-pressure lateral fittings and shall be injection molded of an improved virgin PVC fitting compound. Slip PVC fittings shall be the "deep socket" bracketed type. Threaded plastic fittings shall be injection molded. All tees and ells shall be side gated. All fittings shall conform to ASTM D2466 and D2467.

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- D. All threaded nipples shall be standard weight Schedule 80 with molded threads and shall conform to ASTM D1785.
- E. All solvent cementing of plastic pipe and fittings shall be a two-step process, using primer and solvent cement applied per the manufacturer's recommendations. Cement shall be of a fluid consistency, not gel-like or ropy. Solvent cementing shall be in conformance with ASTM D2564 and ASTM D2855.
- F. When connection is plastic to metal, female adapters shall be hand tightened, plus one turn with a strap wrench. Joint compound shall be non-lead base Teflon paste, tape, or equal.

2.5 VALVES

A. Gate Valves:

- 1. Gate valves shall be of the manufacturer, size, and type indicated on the drawings.
- 2. Gate valves shall have threaded ASTM B-62 bronze body, bonnet and wedge, silicon bronze stem, and malleable iron handwheel.
- 3. All Gate valves shall have a minimum working pressure of not less than 150 psi and shall conform to AWWA standards.

B. Quick Coupler Valves:

- 1. Quick coupler valves shall be of the manufacturer, size, and type indicated on the drawings.
- 2. Quick coupler valves shall be brass with a wall thickness guaranteed to withstand normal working pressure of 150 psi without leakage. Valves shall have $\frac{3}{4}$ female threads opening at base, with two-piece body. Valves to be operated only with a coupler key, designed for that purpose. Coupler key is inserted into valve and a positive, watertight connection shall be made between the coupler key and valve. Hinge cover shall be the locking type constructed of brass with a rubber-like vinyl cover.

C. Automatic Control Valves:

- 1. Automatic control valves shall be of the manufacturer, size, and type indicated on the drawings.
- 2. Automatic control valves shall be electrically operated.

D. Anti-drain Valves:

- 1. Anti-drain valves shall be of the manufacturer, size and type indicated on the drawings.
- 2. Anti-drain valves shall have 18-8 stainless steel springs and valve stems with Buna-N seals.
- 3. Anti-drain valves will have threaded connections the size of the riser or pipe they are to be installed onto, or the next available size. No slip connection anti-drain valves are allowed.

2.6 VALVE BOXES

- A. Valve boxes shall be fabricated from a durable, weather-resistant plastic material resistant to sunlight and chemical action of soils.

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- B. The valve box cover shall be green in color and secured with a hidden latch mechanism or bolts.
- C. The cover and box shall be capable of sustaining a load of 1,500 pounds.
- D. Valve box extensions shall be by the same manufacturer as the valve box.
- E. Automatic control valve boxes shall be 16 inch x11 inch x12 inch rectangular size. Valve box covers shall be marked "RCV" with the valve identification number "heat branded" onto the cover in 2-inch high letters/numbers.

2.7 AUTOMATIC CONTROLLER

- A. Automatic controller shall be of the manufacturer, size, and type indicated on the drawings.
- B. Automatic controller enclosures shall be of the manufacturer, size, and type indicated on the drawings. Enclosure shall be vandal-resistant, ventilated and waterproof.

2.8 ELECTRICAL

- A. All electrical equipment shall be NEMA Type 3, waterproofed for exterior installations.
- B. All electrical work shall conform to local codes and ordinances.

2.9 LOW VOLTAGE CONTROL WIRING

- A. Remote control wire shall be direct-burial AWG-UF type, size in no case smaller than 14 gauge.
- B. Connections shall be either epoxy-sealed packet type or Penn-Tite connectors.
- C. Ground wires shall be white in color. Control wires shall be red (where two or more controllers are used, the control wires shall be a different color for each controller. These colors shall be noted on the "Record Drawings" plans located on controller door).

2.10 IRRIGATION HEADS

- A. Sprinkler heads shall be of the manufacturer, size, type, with radius of throw, operating pressure and discharge rate indicated on the drawings.
- B. Pop-up heads and riser heads shall be used.

2.11 DRIP IRRIGATION COMPONENTS

- A. Dripline tubing shall be of the manufacturer, model number and distribution (emitter flow and spacing) indicated on the drawings.
- B. Drip emitters, bubblers and micro-sprays shall be of the manufacturer and model number indicated on the drawings.

- C. Distribution tubing, connectors and insert or compression fittings shall be of the manufacturer and type indicated on the drawings.

2.12 RAIN SENSOR

Rain sensor shall be of the manufacturer, size and type indicated on the drawings.

PART 3 - EXECUTION

3.1 SITE CONDITIONS

- A. Inspections:
 - 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 irrigation system may be installed in accordance with all pertinent codes and regulations, the original design, the referenced standards, and the manufacturer's recommendations.
- B. Discrepancies:
 - 1. In the event of discrepancy, immediately notify the Architect or Owner's authorized representative.
 - 2. Do not proceed with installation in areas of discrepancy until all discrepancies have been resolved.
- C. Grades:
 - 1. Before starting work, carefully check all grades to determine that work may safely proceed, keeping within the specified material depths with respect to finish grade.
 - 2. Final grades shall be accepted by the Engineer before work on this section will be allowed to begin.
- D. Field Measurements:
 - 1. Make all necessary measurements in the field to ensure precise fit of items in accordance with the original design. Contractor shall coordinate the installation of all irrigation materials with all other work.
 - 2. All scaled dimensions are approximate. The Contractor shall check and verify all size dimensions prior to proceeding with work under this section.
 - 3. Exercise extreme care in excavating and working near existing utilities. Contractor shall be responsible for damages to utilities which are caused by his operations or neglect.
- E. Diagrammatic Intent:

The drawings are essentially diagrammatic. The size and location of equipment and fixtures are drawn to scale where possible. Provide offsets in piping and changes in equipment locations as necessary to conform to structures and to avoid obstructions or conflicts with other work.
- F. Layout:

1. Prior to installation, the Contractor shall stake out all pressure supply lines, routing and location of sprinkler heads, valves, backflow preventor, and automatic controller.
2. Layout irrigation system and make minor adjustments required due to differences between site and drawings. Where piping is shown on drawings under paved areas, but running parallel and adjacent to planted areas, install the piping in the planted areas.

G. Water Supply

Connections to, or the installation of, the water supply shall be at the locations shown on the drawings. Minor changes caused by actual site conditions shall be made.

H. Electrical Service:

1. Connections to the electrical supply shall be at the locations shown on the drawings. Minor changes caused by actual site conditions shall be made.
2. Contractor shall make 120 volt connection to the irrigation controllers. Electrical power source to controller locations shall be provided by others.

3.2 TRENCHING

- A. Excavations shall be straight with vertical sides, even grade, and support pipe continuously on bottom of trench. Trenching excavation shall follow layout indicated on drawings to the depths below finished grade and as noted. Where lines occur under paved area, these dimensions shall be considered below subgrade.
- B. Provide minimum cover of 24 inches on pressure supply lines 2 ½ inches and smaller.
- C. Provide minimum cover of 18 inches for control wires.
- D. Provide minimum cover of 12 inches for non-pressure lines.
- E. Pipes installed in a common trench shall have a 6-inch minimum space between pipes.

3.3 BACKFILLING

- A. Backfill material on all lines shall be the same as adjacent soil free of debris, litter, and rocks over 1/2 -inch in diameter
- B. Backfill shall be tamped in 4-inch layers under the pipe and uniformly on both sides for the full width of the trench and the full length of the pipe. Backfill materials shall be sufficiently damp to permit thorough compaction, free of voids. Backfill shall be compacted to dry density equal to adjacent undisturbed soil and shall conform to adjacent grades.
- C. Flooding in lieu of tamping is not allowed.
- D. Under no circumstances shall truck wheels be used to compact backfill.
- E. Provide sand backfill a minimum of 6 inches over and under all piping under paved areas.

3.4 PIPING

- A. Piping under existing pavement may be installed by jacking, boring, or hydraulic driving. No hydraulic driving is permitted under asphalt pavement.
- B. Cutting or breaking of existing pavement is not permitted.
- C. Carefully inspect all pipe and fittings before installation, removing dirt, scale, burrs and reaming. Install pipe with all markings up for visual inspection and verification.
- D. Remove all dented and damaged pipe sections.
- E. All lines shall have a minimum clearance of 6 inches from each other and 12 inches from lines of other trades.
- F. Parallel lines shall not be installed directly over each other.
- G. In solvent welding, use only the specified primer and solvent cement and make all joints in accordance with the manufacturer's recommended methods including wiping all excess solvent from each weld. Allow solvent welds at least 15 minutes setup time before moving or handling and 24 hours curing time before billing.
- H. PVC pipe shall be installed in a manner which will provide for expansion and contraction as recommended by the pipe manufacturer.
- I. Centerload all plastic pipe prior to pressure testing.
- J. All threaded plastic-to-plastic connections shall be assembled using Teflon tape.
- K. For plastic-to-metal connections, work the metal connections first. Use a non-hardening pipe dope on all threaded plastic-to-metal connections shall be made with plastic female adapters.
- L. All solvent weld mainline piping is to be secured with minimum one cubic foot thrust blocks at all directional changes. Bell and gasket pipe to have a Leemco joint restraint system installed on all fittings in lieu of thrust blocks.

3.5 CONTROLLER

- A. The exact location of the controller shall be approved by the Architect or Owner's authorized representative before installation. The electrical service shall be coordinated with this location.
- B. The Irrigation Contractor shall be responsible for the final electrical hook up to the irrigation controller.
- C. The irrigation system shall be programmed to operate during the periods of minimal use of the design area or in accordance with the irrigation schedule provided.

3.6 CONTROL WIRING

- A. Low voltage control wiring shall occupy the same trench and shall be installed along the same route as the pressure supply lines whenever possible.
- B. Where more than one wire is placed in a trench, the wiring shall be taped together in a bundle at intervals of 10 feet. Bundle shall be secured to the mainline with tape at intervals of 20 feet.
- C. All connections shall be of an approved type and shall occur in a valve box. Provide an 18-inch service loop at each connection.
- D. An expansion loop of 12 inches shall be provided at each wire connection and/or directional change, and one of 24 inches shall be provided at each remote control valve.
- E. A continuous run of wire shall be used between a controller and each remote control valve. Under no circumstances shall splices be used without prior approval.
- F. Pull boxes for the low voltage control wires shall be provided at a spacing of 480 feet on center along the wire route. An expansion loop of 24 inches shall be provided at each control wire pull box.

3.7 VALVES

- A. Automatic control valves, manual valves, gate valves, and ball valves are to be installed in the approximate locations indicated on the drawings.
- B. Valve shall be installed in shrub areas whenever possible.
- C. Install all valves.
- D. Valves to be installed in valve boxes shall be installed one valve per box.

3.8 VALVE BOXES

- A. Valve boxes shall be installed in shrub areas whenever possible.
- B. Each valve box shall be installed on a foundation of 3/4 inch gravel backfill, 3 cubic feet minimum. Valve boxes shall be installed with their tops 1/2 inch above the surface of surrounding finish grade in lawn areas and 2 inches above finish grade in ground cover areas.

3.9 SPRINKLER HEADS

- A. Sprinkler heads shall be installed.
- B. Spacing of heads shall not exceed maximum indicated on the drawings.
- C. Riser nipples shall be of the same size as the riser opening in the sprinkler body.
- D. Pop-up sprinkler heads shall not be installed using side outlet openings.

3.10 DRIP IRRIGATION

- A. Provide sample layout for one complete drip valve control zone, including all components, dripline and/or emitter spacing and, for review and approval by Landscape Architect.
- B. Thoroughly flush all driplines and distribution tubing prior to installing drip emitters, air relief valves, flush valves and similar components.
- C. All drip irrigation shall be installed prior to installation of plant material.

3.11 MISCELLANEOUS EQUIPMENT

- A. Install all assemblies specified herein according to the respective detail drawings or specifications, using best standard practices.
- B. Quick coupler valves shall be set approximately 12 inches from walks, curbs, header boards, or paved areas where applicable.
- C. Unless designed as an integral part of the irrigation head, anti-drain valves will be installed under every head. The anti-drain valve will be the same diameter as the riser and be integral to the riser assembly.
- D. Install rain sensors as recommended by the manufacturer.

3.12 FLUSHING THE SYSTEM

- A. Prior to installation of sprinkler nozzles, the valves shall be opened and a full head of water used to flush out the lines and risers.
- B. Sprinkler nozzles shall be installed after flushing the system has been completed.

3.13 ADJUSTING THE SYSTEM

- A. Contractor shall adjust valves, align heads, and check coverage of each system prior to coverage test.
- B. If it is determined by the Architect or Owner's authorized representative that additional adjustments or nozzle changes will be required to provide proper coverage, all necessary changes or adjustments shall be made prior to any planting.
- C. The entire system shall be operating properly before any planting operations commence.
- D. Automatic control valves are to be adjusted so that the sprinkler heads operate at the pressure recommended by the manufacturer.

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3.14 TESTING AND OBSERVATION

- A. Do not allow or cause any of the work of this section to be covered up or enclosed until it has been observed, tested and accepted by the Architect, Owner, and governing agencies.
- B. The Contractor shall be solely responsible for notifying the Architect, Owner, and governing agencies, a minimum of 48 hours in advance, where and when the work is ready for testing.
- C. When the sprinkler system is completed, the Contractor shall perform a coverage test of each system in its entirety to determine if the water coverage for the planted areas is complete and adequate in the presence of the Architect.
- D. The Contractor shall furnish all materials and perform all work required to correct any inadequacies of coverage due to deviations from the plans, or where the system has been willfully installed when it is obviously inadequate, without bringing this to the attention of the Architect. This test shall be accepted by the Architect and accomplished before starting any planting.
- E. Final inspection will not commence without record drawings as prepared by the Irrigation Contractor.

3.15 MAINTENANCE

During the maintenance period the Contractor shall adjust and maintain the irrigation system in a fully operation condition providing complete irrigation coverage to all intended plantings.

3.16 COMPLETION CLEANING

Clean-up shall be made as each portion of the work progresses. Refuse and excess dirt shall be removed from the site, all walks and paving shall be broomed, and any damage sustained on the work of others shall be repaired to original conditions.

END OF SECTION 328400

SECTION 329000 - PLANTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Soil Preparation.
 - 2. Planting.
 - 3. Staking.
 - 4. Hydroseeding.
 - 5. Clean up.

- B. Related Sections:
 - 1. Section 328400 – Irrigation Systems

1.2 DEFINITIONS

- A. Backfill: The earth used to replace or the act of replacing earth in an excavation.
- B. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.
- C. Finish Grade: Elevation of finished surface of planting soil.
- D. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
- E. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- F. Pests: Living organisms that occur where they are not desired, or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- G. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
- H. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.
- I. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

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- J. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.
- K. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.3 ACTION SUBMITTALS

- A. Product Data: Prior to installation submit for review and approval specifications and product information on items being used on project. Submit bound with list of items as cover sheet. Conform to Section 01300. For each type of product indicated, including soils.
 - 1. Plant Materials: Include quantities, sizes, quality, and sources for plant materials.
 - 2. Pesticide and Herbicides: Include product label and manufacturer's application instructions specific to the Project.
 - 3. Plant Photographs: Include color photographs in digital format of each required species and size of plant material as it will be furnished to the Project. Take photographs from an angle depicting true size and condition of the typical plant to be furnished. Include a scale rod or other measuring device in each photograph. For species where more than 20 plants are required, include a minimum of three photographs showing the average plant, the best quality plant, and the worst quality plant to be furnished. Identify each photograph with the full scientific name of the plant, plant size, and name of the growing nursery
- B. Samples of mineral and / or organic mulch.

1.4 INFORMATIONAL SUBMITTALS

- A. Product certificates.
- B. Material test reports.
- C. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of plants during a calendar year.

1.5 OBSERVATION SCHEDULE

- A. Notify Architect in advance for the following inspections, according to the time specified:
 - 1. Pre-Job conference – 7 days
 - 2. Final grade review – 48 hours
 - 3. Plant material review – 48 hours
 - 4. Plant layout review – 48 hours
 - 5. Soil preparation and planting operations review – 48 hours
 - 6. Pre-maintenance – 7 days
 - 7. Final inspection – 7 days
- B. No site visits shall commence without all items noted in previous observation reports either completed or remedied unless such compliance has been waived by the Architect.

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1.6 QUALITY ASSURANCE

- A. Soil Analysis: For each un-amended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory.
 - 1. The soil-testing laboratory shall oversee soil sampling.
 - 2. Report suitability of tested soil for plant growth.
 - a. State recommendations for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
 - b. Report presence of problem salts, minerals, or heavy metals; if present, provide additional recommendations for corrective action.
- B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.
- C. Source Quality:
 - 1. At least 60 days prior to planting submit documentation that all plant materials are available. Materials are subject to inspection after confirmation of ordering.
 - 2. Materials are subject to inspection at place of growth and upon delivery for conformity to specifications. Inspection, approval and rejection can also take place at other times during progress of work.
 - 3. Request, in writing, inspection of plant materials at place of growth. Identify place of growth and quantity of plants to be inspected.
 - 4. As described in the planting notes for tree tagging, the Architect may opt to either visit the tree nursery or review photographs submitted by the Contractor. In either case, visit the nursery and select trees conforming to specifications prior to review by the Architect.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.
- B. Handle planting stock by root ball.
- C. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.
- D. Deliver fertilizer to site in original unopened containers bearing manufacturer's guaranteed chemical analysis, name, trade mark, and conformance to State law.
- E. Provide copies of receipts for all amendments specified in these specifications or in the agronomic Soils Report.
- F. Deliver plants with legible identification labels. Label trees, evergreens, bundles of containers of like shrubs and groundcover plants. State correct plant name and size indicated on plant list.

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Use durable waterproof labels with water-resistant ink which will remain legible for at least 60 days.

- G. Protect plant material during delivery to prevent damage to root ball or desiccation of leaves.
- H. Notify Architect 7 days in advance of delivery of plant materials and submit itemization of plants in each delivery.
- I. Store plants in shade and protect from weather.
- J. Maintain and protect plant material in a healthy, vigorous condition.
- K. Exercise care in handling, loading, unloading and storing of plant materials. Replace damaged materials.

1.8 WARRANTY

- A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.
 - 1. Warranty Periods from date of end of 90-day maintenance period:
 - a. Trees: 12 months.
 - b. Shrubs, Vines, Ornamental Grasses, Ground Covers, Biennials, and Perennials: 90 days.
 - c. Annuals: 90 days.

1.9 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Provide maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established but for not less than maintenance period below.
 - 1. Maintenance Period for Trees and Shrubs: 90 days from date of Substantial Completion.
 - 2. Maintenance Period for Ground Cover and Other Plants: 90 days from date of Substantial Completion.
- B. Continuously maintain all site areas involved in this contract during the progress of work and during the maintenance period until final acceptance of the work by City. Improper maintenance or possible poor condition of the project at the termination of the scheduled maintenance period may cause postponement of the final completion date of the Contract. Continue maintenance until acceptable to the Owner.
- C. Provide sufficient numbers of workers and adequate equipment to perform work during maintenance period.
- D. Maintenance period does not start until all elements of construction, planting, and irrigation for the complete project are in accordance with the contract documents for this project.

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- E. Request an inspection to begin maintenance period after all planting and related work has been completed in accordance with other contract documents. Maintenance period commences as described in written notification by the Owner.
- F. Prior to commencement of maintenance period, ensure that all ground cover and lawn areas have been planted and that all lawn areas show an even, healthy stand of grass seedlings or sod, grass having been mown twice.
- G. Any day or days that there is failure to properly maintain plantings, replace suitable plants, perform weed control or maintain hardscape areas will not be credited as part of the 90 days maintenance. The project will not be segmented into maintenance phases.
- H. Keep paved areas free of silt, dirt, leaves and other planting area debris. Maintain these areas at least broom clean through the duration of the maintenance period, cleaning no less often than once per week.
- I. Guarantee: Guarantee plant material against any and all poor, inadequate or inferior materials and workmanship for one year. Replace plants found to be dead or in poor condition due to faulty materials or workmanship, at no extra cost to owner.
- J. Replacement: Replace materials found to be dead, missing or in poor condition during the maintenance period immediately. The Architect is the sole judge of the acceptability of condition. Make replacements of materials within 15 days after condition develops or written notification from Architect has been sent. Architect has the right to make emergency repairs without releasing Contractor's guarantee and warranty to Architect.
- K. Prior to date of final inspection, acquire approved reproducible prints and finally record from the job record set, all changes made during construction and deliver them to Architect.
- L. Deliver guarantees to Architect.

PART 2 - PRODUCTS

2.1 PLANT MATERIAL

- A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant Legend shown on Drawings and complying with ANSI Z60.1. Provide plant materials in accordance with the State Department of Agriculture's regulation for nursery inspections, rules and ratings. Provide plants with a normal habit of growth, sound, healthy, vigorous and free from insect infestations, plant diseases, sunscalds, and other disfigurements. Ensure tree trunks are sturdy and have well-hardened systems and vigorous and fibrous root systems which are not root or pot-bound. In the event of disagreement as to condition of root system, the root conditions of the furnished plants in containers will be determined by removal of earth from the roots of not less than two plants, or more than 2 percent of the total number of plants of each species or variety. Where container grown plants are from several sources, roots of not less than two plants of each species or variety from each source will be inspected. In the event that the sample plants inspected are found to be defective, the entire lot or lots of plants represented by the defective samples may

- be rejected. Plants rendered unsuitable for planting due to this inspection will be considered samples and will be provided at no cost to the Owner.
- B. Size of plants will comply with ANSIZ60.1 and correspond with that normally expected for species and variety of commercially available nursery stock or as specified on drawings. The minimum acceptable size of plants measured before pruning with the branches in normal position, must conform to the measurements specified in the plant list. If approved by the Owner, larger sized plants may be used. If larger plants are approved for use, the ball of earth or spread of roots for each plant will be increased proportionately.
 - C. Plants not meeting requirements of these specifications are considered to be defective whether in place or not. They must be immediately removed and replaced with new acceptable and approved plants of the required size, species and variety.
 - D. Pruning: Do not prune, trim, top or alter the shape of trees or plants except as approved.
 - E. Provide plant material true to botanical and common name and variety as specified in Annotated Checklist of Woody Ornamental Plants in California, Oregon and Washington, published by University of California School of Agriculture (latest edition).
 - F. Nursery Grown and Collected Stock: Grow under climatic conditions similar to those in locality of project; container-grown stock in vigorous, healthy condition, not root-bound or with root system hardened off. Use only liner stock plant material which is well established in removable containers or formed homogenous soil sections.
 - G. Select trees which are aesthetically desirable and are good examples of the species. Trees with gashes, misshapen trunks or branches, topped leaders, structural defects, badly crossed branches, or other visual defects will not be accepted. If formal arrangements or consecutive order of plants is shown on Drawings, select stock for uniform height and spread to assure symmetry in planting.
 - H. Seed: Label seed and provide in sealed containers with signed copies from vendor certifying that each container is fully labeled in compliance with State Agricultural Code and is in compliance with minimum requirements of these specifications. Wet, moldy or damaged seed will not be permitted. Provide seed mix per plan.

2.2 INORGANIC SOIL AMENDMENTS

- A. The following soil amendments are to be used for bid purposes only. Specific amendments and fertilizer will be selected and specified after rough grading operations are complete and Contractor has had soil samples tested.
- B. Soil Sulfur: Agricultural grad sulfur containing minimum of 99 percent sulfur expressed as elemental.
- C. Iron Sulfate: 20 percent iron expressed as metallic iron, derived from ferric and ferrous sulfate, 10 percent sulfur expressed as elemental.
- D. Agricultural Gypsum: Minimum 98 percent calcium sulfate, Calcium Carbonate: 95 percent lime as derived from oyster shells.

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2.3 ORGANIC SOIL AMENDMENTS

- A. The following soil amendments are to be used for bid purposes only. Specific amendments and fertilizer will be selected and specified after rough grading operations are complete and Contractor has had soil samples tested.
- B. Nitrogen Stabilized: 0.56 to 0.84 percent N based on dry weight for wood residual or rice hulls.
- C. Particle Size: 95 to 100 percent passing 6.35 mm standard sieve; 80 to 100 percent passing 2.33 mm standard sieve.
- D. Salinity: Ensure that saturation extract conductivity does not exceed 3.5 millimohs per centimeter at 25 degrees C. as determined by saturation extract method.
- E. Iron Content: Minimum 0.08 percent dilute acid soluble Fe on dry weight basis.
- F. Ash: 0 to 6 percent dry weight.

2.4 FERTILIZERS

- A. The following soil amendments are to be used for bid purposes only. Specific amendments and fertilizer will be selected and specified after rough grading operations are complete and Contractor has had soil samples tested.
- B. Planting Fertilizer: Granular or pelleted fertilizer consisting of the following percents by weight and mixed by commercial fertilizer supplier:
 - 1. Composition: 6 percent nitrogen, 20 percent phosphorous, and 20 percent potash, by weight.
- C. Planting Tablets: Provide slow-release type with potential acidity of not more than 5 percent by weight containing the following percent by weight of nutrients listed:
 - 1. Size: 21 gram tablets manufactured by Agriform, or approved equal.
 - 2. Nutrient Composition: 20 percent nitrogen, 10 percent phosphoric acid, and 5 percent potash, 2.6-combined calcium, 1.6 combined sulfur, 0.35-iron elemental from ferrous sulfate, by weight plus micronutrients.
- D. Hydroseeding Fertilizer: Provide ammonium phosphate which consists of the following percent by weight and mixed by a commercial fertilizer supplier: 16-nitrogen, 20-phosphoric acid, 0-potash.
- E. Sulfate of potash: 0-0-50.
- F. Single super-phosphate: Commercial product containing 18 to 20 percent available Phosphoric Pentoxide, or other approved.
- G. Urea formaldehyde: 38-0-0.

2.5 PLANTING SOILS

- A. Planting Soil (Import or Amended Top Soil) Ensure silt plus clay content of top soil does not exceed 20 percent by weight, with a minimum 95 percent passing the 2.0 mm sieve. Do not allow the sodium absorption ratio SAR to exceed 6. The electrical conductivity (ECE) of the saturation extract cannot exceed 3.0 millimohs per centimeter at 25 degrees C. Ensure boron content is less than 1 part per million as measured on the saturation extract. To ensure compliance with these requirements submit samples of soil for analysis prior to and following backfilling.

2.6 PLANTER MIX

- A. Planter Mix for all on-structure planters and plant container: provide custom topsoil (“Disney”) Mix by EarthWorks Soil Amendments, Inc., (951) 782-0260, to include the following pre-blended items:

- 85 percent sandy loam topsoil
- 15 percent peat moss
- 0.5 pounds / cy Triple Super Phosphate (0-45-0)
- 0.25 pounds/ cy Potassium Sulfate (0-0-50)
- 1.0 pound/cy Agricultural Gypsum
- 0.2 pounds/cy P.A.M. (soil aggregating polymer)

- B. Roofdeck Soil Mix

1. On-structure Planter Soil (Mix “A”) – (bottom of planter to 8-inches below finish grade) – per cubic yard of mix.
 - a. 80% Over-structure Planter Sand (optional – 100% sand if weight is not a consideration).
 - b. 20% pumice (optional no pumice).
 - c. 2 lbs. Nitroform (38-0-0, 27% WIN).
 - d. 2 lbs. 12-12-12 General Planting Fertilizer.
 - e. 1 lb. iron sulfate.
 - f. 2 lbs. dolomite lime.
 - g. 2 lbs. calcium carbonate limestone.
 - h. Thoroughly blend mix before placing soil in 12” lightly compacted lifts.
2. On-structure Planter Soil (Mix “B”) – (8-inch layer – place on top of On-structure Planter Soil (Mix “A”) up to finish grade) – per cubic yard of mix:
 - a. 70% Over-structure Planter Sand.
 - b. 30% Organic Amendment.
 - c. 2 lbs. Nitroform (38-0-0, 27% WIN).
 - d. 1 lb. iron sulfate.
 - e. 2 lbs. dolomite lime.
 - f. 2 lbs. calcium carbonate limestone.
 - g. Thoroughly blend soil mix before placing soil in one lightly compacted lift.
3. Over-structure Planter Sand:
 - a. Washed nursery sand which meets following U.S. Standard Sieve criteria:

<u>Sieve No. (U.S. Standard)</u>	<u>Weight Percent Passing</u>
10	100
18	100
35	92
60	16

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100	2.1
140	1.3
270	0.1

2.7 MULCHES

- A. Organic Mulch: Provide medium grind bark, consisting of organic, fibrous, woody bark mixture of varied particle size such that 90 to 100 percent passes 1 inch sieve, 80 to 100 percent passes 1/2 inch sieve, and 20 to 60 percent passes 1/4 inch sieve, or approved equal. Mulch shall be free of contaminants and weed seed and shall have a pleasant musty or moldy soil-like odor. Putrid, ammonia and sour-smelling materials will be deemed unacceptable. Recycled construction materials will not be permitted.

2.8 HYDROSEEDING FIBER MULCH

- A. Provide Hydro-mulch as manufactured by Conwed, or other approved equal, composed of wood cellulose fiber and containing no germination or growth inhibiting factors. Ensure a consistent texture which disperses evenly and remains suspended in agitated water. Provide with a temporary green dye and the following percentage property analysis: moisture content 9 plus or minus 0.8; 3 o.d. basis, organic matter 99.2 plus or minus 0.8; ash content 0.8 plus or minus 0.2; pH 4.8 plus or minus 0.5; water holding capacity (grams of H2O per 100 grams of fiber) 1150 minimum.

HYDROSEEDING ADDITIVE (BINDER)

- B. Provide Ecology Control-M-Binder organic seeding additive.

2.9 GUYING AND STAKING MATERIALS

- A. Wood Tree Stakes: lodge pole pine, full treated with Coppernaphthanate Wood Preservative in strict accordance with FS TT-W-572 Type I, Composition B, 2-inch minimal normal size diameter by 10 feet long, no split stakes.
- B. Ties: Provide cinch ties, size corresponding to tree box size as manufactured by VIT Company or other approved.

2.10 LANDSCAPE EDGINGS

- A. Wood Edging:
 - 1. Provide 2-inch by 4-inch pressure treated Douglas Fir or Redwood construction grade headerboards. Make splices with 1-inch by 4-inch pieces no less than 12 inches long. Place 1-inch by 3-inch by 16-inch stakes at intervals of not more than 5 feet. Cut stakes level and set below top of headerboards.
 - 2. On sharp turns and curves, four 1/2 inch by 4-inch laminated boards, or two 1-inch by 4-inch laminated boards may be permitted.
 - 3. Nail stakes and splices with galvanized common nails. Nail as required for solid installation.

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4. Provide header as shown on drawings, laid true to line and grade, protect in-place adjacent improvements, shrubbery and other properties. Place stakes on ground cover side of header.
- B. Steel Edging: Standard commercial-steel edging, rolled edge, fabricated in sections of standard lengths, with loops stamped from or welded to face of sections to receive stakes.
- C. Aluminum Edging: Standard-profile extruded-aluminum edging, ASTM B221, Alloy 6063-T6, fabricated in standard lengths with interlocking sections with loops stamped from face of sections to receive stakes.
- D. Plastic Edging: Standard black polyethylene or vinyl edging, horizontally grooved, extruded in standard lengths, with 9-inch steel stakes.
- E. Concrete Mowstrip: 6 inch wide by 6 inch thick concrete mowstrip with 1/2 inch tooled edging and #3 continuous rebar.

2.11 MISCELLANEOUS PRODUCTS

- A. Sand: Provide washed silica sand.
- B. Tree Paint: Provide Morrison Tree Seal, Cabot Tree Paint or other approved.
- C. Water: Provide clean, potable water.
- D. Root Barrier: Provide UB24-2 by Deep Root Corporation, (800) 458-7668. Install at all trees within 5 feet of concrete paving, curbs or mow strips or as shown on plans. Install barrier with vertical ribs facing toward the tree and with the top edge 1/2 inch above finish grade. Provide linear root barrier adjacent to paving or curbing; root barrier shall not circle the rootball.

2.12 QUALITY CONTROL

- A. Provide standard, approved and first-grade quality materials, in prime condition when installed and accepted. Deliver commercially processed and packaged materials in manufacturer's unopened containers bearing the manufacturer's guaranteed analysis. Supply a sample of all supplied materials accompanied by analytical data from an approved laboratory source illustrating compliance, or bearing the manufacturer's guaranteed analysis.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Obtain certification that final grades to 1/10 foot have been established prior to commencing landscaping operations. Provide for inclusion of all amendments, settling, etc. Be responsible for shaping all planting areas as indicated on drawings or as required.
- B. Inspect trees, shrubs and liner stock plant material for injury, insect infestation and trees and shrubs for improper pruning.

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- C. Do not begin planting of trees until deficiencies are corrected or plants replaced.

3.2 PLANTING AREA ESTABLISHMENT

- A. Soil Preparation: After proper finish grades have been verified or established, cross-rip all planting areas to a depth of 12 inches, condition and fertilize soil in accordance with recommendations of soil testing laboratory and as approved by Owner. The following is for bid purposes only. Uniformly spread and cultivate amendments thoroughly by means of mechanical tiller into top 6 inches of soil. Application rates per 1,000 square feet:
 - 1. Nitrogen stabilized organic amendment: 4 cubic yards
 - 2. 16-16-16 Commercial Fertilizer: 15 lbs.
 - 3. Agricultural Gypsum: 100 lbs.
 - 4. Soil Sulfur: 20 lbs.
- B. At time of planting, ensure that top 2 inches of all areas to be planted or seeded are free of stones, stumps and other deleterious matter 1 inch in diameter or larger, and free from wire, plaster, concrete, wood and similar materials which would cause hindrance to planting or maintenance.
- C. Finish Grading: Make minor modifications to grade as may be necessary to establish required final grade. Ensure that finish grade provides proper drainage of the site and surface drainage is away from building. Final grades are to be 1-inch below adjacent paved areas, sidewalks, valve boxes, headers, clean-outs, drains, manholes, etc., or as shown on drawings or required by City. Eliminate erosion scars prior to commencing maintenance period.
- D. Pre-Plant Weed Control:
 - 1. After irrigation system is operational, use a non-selective systemic contact herbicide as recommended and applied by an approved licensed landscape pest control advisor and applicator. Leave sprayed plants intact for at least 15 days.
 - 2. Clear and remove these existing weeds by mowing or grubbing off all plant parts at least 2 inches below surface of soil over entire areas to be planted.
 - 3. After irrigation system is operational, apply water for 10 days as needed to achieve weed germination. Apply contact herbicides and wait as needed before planting. Repeat as required.
 - 4. Maintain weed free site until acceptance by Owner.

3.3 PLANTING INSTALLATION

- A. General:
 - 1. The irrigation system shall be operational and approved prior to planting.
 - 2. Perform actual planting only during those periods when weather and soil conditions are suitable and in accordance with locally accepted practice, as approved.
 - 3. Distribute in planting areas only as many plants as can be planted and watered that same day.
 - 4. Ensure that containers which are opened and plants removed are handled with care such that ball of earth surrounding roots is not broken and that plants are planted and watered immediately. Do not open containers prior to placing plants in planting areas.

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- B. Layout: Mark locations for plants and outlines of areas to be planted before any plant pits are dug. Gain City approval. If underground construction or utility lines are encountered in the excavation of planting areas, other locations for planting may be selected by Owner. Accomplish layout with flagged grade stakes indicating plant names and specified container size on each stake. Confirm location and depth of underground utilities and obstructions.

3.4 EXCAVATION FOR TREES AND SHRUBS

- A. Planting Pits and Trenches: Excavate circular planting pits with sides sloping inward at a 45-degree angle. Trim perimeter of bottom leaving center area of bottom raised slightly to support rootball and assist in drainage away from center. Do not further disturb base. Ensure that rootball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.
 - 1. Excavate approximately two times as wide as rootball diameter.
 - 2. Do not excavate deeper than depth of the rootball, measured from the root flare to the bottom of the rootball.
- B. Subsoil and topsoil removed from excavations may be used as planting soil backfill.
- C. Strip and stack approved excavation for planting which is encountered within areas for trenches, tree holes, plant pits and planting beds.
- D. Remove from site excess soil generated from planting holes and not used for backfilling.
- E. Protect areas from excessive compaction when trucking plants or other materials to planting areas.

3.5 TREE, SHRUB, AND VINE PLANTING

- A. Before planting, verify that root flare is visible at top of root ball according to ANSI Z60.1.
- B. Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.
- C. Set stock plumb and in center of planting pit or trench with root flare 1 inch above adjacent finish grades.
 - 1. Use planting soil for backfill.
 - 2. Container Grown: Cut cans on two sides with acceptable can cutter only. Carefully remove rootball from container without damaging rootball or plant. Superficially loosen edge roots on three sides after removing from can.
 - 3. Boxed Trees: Remove bottom of plant boxes before planting. Remove sides without damage to rootball after positioning plant and partially backfilling.
 - 4. Face plants with fullest growth into prevailing wind.
 - 5. Backfill plants with: 6 parts by volume on-site soil, 4 parts by volume organic amendment, 1 pound 6-20-20 fertilizer mix per cubic yard of mix, 2 pounds iron sulfate per cubic yard of mix. Note: This is for bid purposed only. Specific backfill recommendations are made as a result of the soils testing described on the planting plan.
 - 6. Backfill around rootball in layers, tamping to settle soil and eliminate voids and air pockets. Hold plant rigidly and plumb until soil has been firmed around ball or roots.

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Raise all plants which settle deeper than the surrounding grade. When planting pit is approximately one-half filled, add water to the top of the planting pit and thoroughly saturate rootball and adjacent soil.

7. Set planting tablets with each plant on top of rootball while plants are still in their containers so the required number of tablets can be verified. After water has completely drained, place planting tablets as follows or in amounts recommended in soil reports from soil-testing laboratory.
 - 1 tablet per 1-gallon container
 - 2 tablets per 5-gallon container
 - 3 tablets per 15-gallon container
 - 4 tablets per 24-inch box
 - 6 tablets per 36-inch box
 - 8 tablets per 48-inch boxPlace tablets beside the rootball about 1-inch from root tips; do not place tablets in bottom of the hole.
8. Continue backfilling process. Construct an earthen basin around each plant after backfilling. Provide basin of depth sufficient to hold at least 2 inches of water. Construct basins with amended backfill. Remove basin in all turf areas after initial watering. Water again after placing and tamping final layer of soil.
9. Limit pruning to minimum necessary. Remove injured twigs and branches. Pruning may not be done prior to delivery of plants. Paint cuts over 3/4 inch in diameter with tree paint.
10. Stake or guy trees immediately after planting. Install stakes plumb. Locate stakes so that a straight line drawn between the stakes is perpendicular to the prevailing wind direction.
11. Do not bring iron sulfate into contact with concrete surfaces due to potential staining. Contractor is responsible for cleaning and replacing stained surfaces.

- D. When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the rootball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the rootball.

3.6 TREE, SHRUB, AND VINE PRUNING

- A. Remove only dead, dying, or broken twigs or branches. Do not prune for shape. Pruning may not be done prior to delivery of plants. Paint cuts over 3/4 inch in diameter with tree paint.
- B. Prune, thin, and shape trees, shrubs, and vines according to standard professional horticultural and arboricultural practices. Unless otherwise indicated by Architect, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character.

3.7 GROUND COVER AND OTHER SMALL CONTAINER PLANTING

- A. Set out and space ground cover and plants from flats or containers smaller than 1-gallon as indicated on planting plan in even rows with triangular spacing.
- B. Ensure that groundcover remains in the flats until transplanting. Flats' soil must contain sufficient moisture so it will not fall apart when lifting plants.

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- C. Use planting soil for backfill. Plant each rooted plant with its proportionate amount of flat soil.
- D. Dig holes large enough to allow spreading of roots.
- E. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.
- F. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.
- G. Protect plants for damage and trampling.

3.8 HYDROSEEDING:

- A. Install large trees and shrubs (5 gallon and larger) if they occur in hydroseeded areas.
- B. Install trees and shrubs (1 gallon) and groundcovers from flats if they occur in hydroseeded areas.
- C. Provide seed mixes as shown on plan.
- D. Apply hydroseed by an approved hydro-mulch company.
- E. Apply in a form of slurry consisting of cellulose fiber, see, chemical additives, commercial fertilizer and water. When hydraulically sprayed on soil, ensure that hydro-mulch forms a blotter like groundcover impregnated uniformly with seed and fertilizer and allows the absorption of moisture and rainfall to percolate to the underlying soil.
- F. Prepare the slurry at the site by first adding water to the tank when the engine is at half throttle. When water level has reached height of agitator shaft, provide full circulation, then add seed, followed by fertilizer, then mulch. Only add the mulch to the mixture after the seed and the tank is at least 1/3 filled with water. By the time the tank is 2/3 to 3/4 full, all mulch shall be in. Commence spraying immediately when tank is full.
- G. Spray uniform visible coat by using the green color as a guide. Apply the slurry in a sweeping motion, in an arched stream so as to fall like rain allowing the wood fibers to build on each other until a good coat is achieved and the material is spread at the required rates.
- H. Remove slurry not used within two hours from the site.
- I. Fill out the daily worksheets by the nozzle man with the following information: Seed type and amount, mulch type and amount, number of loads and amount of water, seeding additive type and amount, area covered and equipment used, capacity and license number.
- J. Do not allow any slurry to be sprayed into any reservoir basin or drainage ditches and channels which may impede the flow of rain or irrigation water. Clean up any spilled slurry.
- K. After application of hydro-mulch, wash excess material from previously planted materials and architectural features. Avoid washing or eroding mulch materials.

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- L. Ensure that application equipment has a built-in agitation system and operating capacity sufficient to agitate, suspend and mix a slurry containing not less than 40 pounds of fiber mulch plus a combined total of 7 pounds fertilizer solids for each 100 gallons of water.
- M. Slurry distribution lines shall be large enough to prevent stoppage and shall be equipped with a set of hydraulic spray nozzles which will provide a continuous non-fluctuating discharge. Capacity requirements is 1,500 gallons, mounted on a traveling unit, either self-propelled or drawing by a separate unit which will place slurry tank and nozzles within sufficient proximity of areas to be seeded.
- N. Hydraulic equipment used for pesticide applications shall consist of a clean 150 gallon capacity fiberglass tank, complete with mechanical agitation. Pump volume shall be 10 gallons per minute, while operating at a pressure of 100 pounds per square inch. Distribution lines shall be large enough to carry the volume of water necessary for even chemical distribution. Spray nozzle must cover a 15-foot swath, with a minimum output of 5 gallons per minute at 80 pounds per square inch.

3.9 PLANTING AREA MULCHING

- A. Mulch backfilled surfaces of planting areas with 2 inch layer of mulch except 2:1 slopes, hydroseeded and turf areas.

3.10 CLEAN-UP

- A. After all planting operations are complete; remove all trash, excess soil, empty plant containers, and rubbish from the property. Repair scars, ruts and other marks in the ground and leave ground in a neat and orderly condition.
- B. Leave the site in a broom-clean condition and wash down all paved areas within the project site. Leave walks in a clean and safe condition.

3.11 LANDSCAPE MAINTENANCE

- A. Weed and cultivate all areas at intervals of not more than 10 days.
- B. Perform watering, mowing, rolling, edging, trimming, fertilization, spraying, pest control, and cleaning as may be required.
- C. Street gutters and curbs are to be included.
- D. Maintain adequate protection for people and property, and be financially responsible for damages and injuries. Notify the Architect immediately should damage occur as a result of maintenance operations and provide repair or remuneration.
- E. Between the 15th and 20th calendar day of the maintenance period, reseed or resod all spots or areas within the lawn where normal turf growth is not evident.

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3.12 TREE AND SHRUB CARE

- A. Watering: Maintain a large enough water basin around plants so that enough water can be applied to establish moisture through the major root zone. When hand watering, use a water wand to break force of water.
- B. Pruning:
 - 1. Prior to any pruning, obtain written approval from the Architect to proceed.
 - 2. Trees:
 - a. Propose tree pruning to the Architect should there be health or structural reasons for doing so, including the need to eliminate diseased or damaged growth, eliminate structurally unsound growth, reduce potential for wind toppling or wind damage, or maintain growth within limited space.
 - b. Tree pruning that is required during the Maintenance Period for tree health or structural reasons, or as directed by the City, shall be performed in accordance with ANSI A-300 ISA standards.
 - c. Major pruning of deciduous trees shall be during their dormant season.
 - 3. Shrubs:
 - a. The objectives of shrub pruning are the same as for trees. Do not clip shrubs into balled or boxed forms unless such is required by the design.
 - b. Make pruning cuts to lateral branches or buds or flush with trunk. Stubbing will not be permitted.
- C. Staking and guying: Ensure that stakes and guys remain in place through acceptance and monitor to prevent girdling of trunks or branches and to prevent rubbing that causes bark wounds. All nursery stakes shall be removed.
- D. Weed control: Keep all areas free of weeds. Use recommended legally approved herbicides. Avoid frequent soil cultivation that destroys shallow roots. Use mulches per specifications to help prevent weed seed germination.
- E. Insect and disease control: Maintain a reasonable control with approve materials.
- F. Fertilize as specified by the agronomic soils testing recommendations and as follows for bid purposes:
 - 1. Commencement of maintenance period – 6 pounds per 1,000 square feet with top dress fertilizer.
 - 2. At the end of first 30 days of maintenance period – 6 pounds per 1,000 square feet with top dress fertilizer.
 - 3. At end of maintenance period and at 30 day intervals should maintenance period by extended for any reason – 6 pounds per 1,000 square feet with fertilizer mix.
 - 4. Avoid applying fertilizer to the rootball and base of main stem; rather, spread evenly under plant to dripline. Rates will vary from about a cup of nitrate fertilizer (depending upon nitrogen percentage) around a newly installed small plant to about 1/2 pound of actual nitrogen per inch of truck diameter measured four feet from the ground for mature trees.
- G. Replacement of plants: Replace dead, dying and missing plants with plants of a size, condition and variety acceptable to the Architect.

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3.13 GROUND COVER CARE

- A. Weed control: Control weeds, preferably with pre-emergent herbicides, but also by hand or with selective systemic herbicides. Hoe weeds as little as possible since this may result in plant damage.
- B. Watering: Water enough that moisture penetrates throughout root zone and only as frequently as is necessary to maintain healthy growth.
- C. Trash: Remove as it accumulates, but no less often than weekly.
- D. Edging and trimming: Edge groundcover to keep in bounds.
- E. Replace dead and missing plants.

3.14 LAWN AND TURF CARE

- A. Turf must be well-established prior to final acceptance.
- B. Watering: Water lawns at such frequency as weather conditions required to replenish soil moisture below root zone.
- C. Weed control: If needed, control broad leaf weeds with selective herbicides.
- D. Mowing:
 - 1. Perform mowing at such times of the day or week as may be requested by the Owner so as not to impede the Owner's operations. Mowing times may be at times other than normal working hours or days. Perform work at Owner's convenience.
 - 2. Clean up grass clippings during and after mowing, and remove legally from site. Use of blowing type equipment in lieu of sweeping or vacuuming is not acceptable.
- E. Renovating:
 - 1. If required, remove thatch by verticutting preferable in the Fall of the year, but otherwise in the Spring. At this time, fertilize with nitrate and over-seed if needed. Over-seeding must precede pre-emergent herbicides by at least 4 to 6 weeks. Normally, this means that lawns which have been invaded by crabgrass would be renovated and over-seeded in the Fall and treated for crabgrass control in the following late Winter.
 - 2. Clean up grass clippings during and after mowing, and remove legally from site. Use of blowing type equipment in lieu of sweeping or vacuuming is not acceptable.

3.15 IRRIGATION SYSTEM

- A. Inspection: Check all systems for proper operation. Lateral lines must be flushed out after removing the last sprinkler head or two at each end of the lateral. Adjust heads as necessary for unimpeded coverage and no overspray.
- B. Controllers: Set and program automatic controllers for seasonal water requirements. Give Owner a key to controllers and instruction on how to turn off system in case of emergency as specified in other sections of these specifications.

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C. Repair all damages to irrigation system. Make all repairs within one watering period.

END OF SECTION 32 93 00

SECTION 329113 - SOIL PREPARATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes planting soils specified by composition of the mixes.
- B. Related Requirements:
 - 1. Section 311000 Site Clearing for topsoil stripping and stockpiling.
 - 2. Section 329700 Vegetated Roof Assemblies for growing media (soil).

1.2 DEFINITIONS

- A. Duff Layer: A surface layer of soil, typical of forested areas, that is composed of mostly decayed leaves, twigs, and detritus.
- B. Imported Soil: Soil that is transported to Project site for use.
- C. Manufactured Soil: Soil produced by blending soils, sand, stabilized organic soil amendments, and other materials to produce planting soil.
- D. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified as specified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
- E. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
- F. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.
- G. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil"; but in disturbed areas such as urban environments, the surface soil can be subsoil.
- H. USCC: U.S. Composting Council.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.

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- B. LEED Submittals:
 - 1. Product Certificates for Credit MR 5: For products and materials required to comply with requirements for regional materials, certificates indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating distance to Project, cost for each regional material, and fraction by weight that is considered regional.
- C. Samples: For each bulk-supplied material in sealed containers labeled with content, source, and date obtained; providing an accurate representation of composition, color, and texture.

1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent, state-operated, or university-operated laboratory; experienced in soil science, soil testing, and plant nutrition; with the experience and capability to conduct the testing indicated; and that specializes in types of tests to be performed.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Regional Materials: Imported soil, manufactured planting soil, and soil amendments and fertilizers shall be manufactured within 500 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.

2.2 PLANTING SOILS SPECIFIED BY COMPOSITION

- A. Planting Soil Type: Existing, on-site surface soil, with the duff layer, if any, retained; modified to produce viable planting soil. Blend existing, on-site surface soil with the following soil amendments and fertilizers in the following quantities to produce planting soil.
- B. Planting-Soil Type: Imported, naturally formed soil from off-site sources and consisting of sandy loam soil according to USDA textures; and modified to produce viable planting soil.
 - 1. Sources: Take imported, unamended soil from sources that are naturally well-drained sites where topsoil occurs at least 4 inches deep, not from agricultural land, bogs, or marshes; and that do not contain undesirable organisms; disease-causing plant pathogens; or obnoxious weeds and invasive plants including, but not limited to, quackgrass, Bermuda grass, poison oak, nutsedge, Canada thistle, bindweed, bentgrass, ground ivy, perennial sorrel, and bromegrass.
 - 2. Additional Properties of Imported Soil before Amending: Soil reaction of pH 6 to 7 and minimum of 4 percent organic-matter content, friable, and with sufficient structure to give good tilth and aeration.
 - 3. Unacceptable Properties: Clean soil of the following:

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- a. Unacceptable Materials: Concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.
 - b. Unsuitable Materials: Stones, roots, plants, sod, clay lumps, and pockets of coarse sand that exceed a combined maximum of 8 percent by dry weight of the imported soil.
 - c. Large Materials: Stones, clods, roots, clay lumps, and pockets of coarse sand exceeding 2 inches in any dimension.
4. Amended Soil Composition: Blend imported, unamended soil with the soil amendments and fertilizers in the quantities as recommended in the soils report to produce planting soil.
- C. Planting-Soil Type: Manufactured soil consisting of manufacturer's basic topsoil blended in a manufacturing facility with sand, stabilized organic soil amendments, and other materials to produce viable planting soil.
1. Additional Properties of Manufacturer's Basic Soil before Amending: Soil reaction of pH 6 to 7 and minimum of 4 percent organic-matter content, friable, and with sufficient structure to give good tilth and aeration.
 2. Unacceptable Properties: Manufactured soil shall not contain the following:
 - a. Unacceptable Materials: Concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.
 - b. Unsuitable Materials: Stones, roots, plants, sod, clay lumps, and pockets of coarse sand that exceed a combined maximum of 5 percent by dry weight of the manufactured soil.
 - c. Large Materials: Stones, clods, roots, clay lumps, and pockets of coarse sand exceeding 2 inches in any dimension.
 3. Blend manufacturer's basic soil with soil amendments and fertilizers in the quantities as recommended by the soils report to produce planting soil.

2.3 INORGANIC SOIL AMENDMENTS

- A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:
1. Class: T, with a minimum of 99 percent passing through a No. 8 sieve and a minimum of 75 percent passing through a No. 60 sieve.
 2. Class: O, with a minimum of 95 percent passing through a No. 8 sieve and a minimum of 55 percent passing through a No. 60 sieve.
 3. Form: Provide lime in form of ground mollusk shells.
- B. Sulfur: Granular, biodegradable, and containing a minimum of 99 percent elemental sulfur, with a minimum of 99 percent passing through a No. 6 sieve and a maximum of 10 percent passing through a No. 40 sieve.
- C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.
- D. Perlite: Horticultural perlite, soil amendment grade.

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- E. Agricultural Gypsum: Minimum 98 percent calcium sulfate, finely ground with 90 percent passing through a No. 50 sieve.
- F. Sand: Clean, washed, natural or manufactured, free of toxic materials, and according to ASTM C 33/C 33M.

2.4 ORGANIC SOIL AMENDMENTS

- A. Compost: Well-composted, stable, and weed-free organic matter produced by composting feedstock, and bearing USCC's "Seal of Testing Assurance," and as follows:
 - 1. Feedstock: Limited to leaves.
 - 2. Reaction: pH of 6.0 to 7.5.
 - 3. Salinity: Ensure that saturation extract conductivity does not exceed 3.5 millimohs per centimeter at 25 degrees c. as determined by saturation extract method.
 - 4. Moisture Content: 35 to 55 percent by weight.
 - 5. Organic-Matter Content: 30 to 40 percent of dry weight.
 - 6. Particle Size: 95 to 100 percent passing through a 6.33 mm standard sieve; 80 to 100 percent passing through a 2.33 mm sieve.
 - 7. Iron Content: Minimum 0.08 percent dilute acid soluble Fe on dry weight basis.
 - 8. Ash: 0 to 6 percent dry weight.
- B. Sphagnum Peat: Partially decomposed sphagnum peat moss, finely divided or of granular texture with 100 percent passing through a 1/2-inch sieve, a pH of 3.4 to 4.8, and a soluble-salt content measured by electrical conductivity of dS/m.
- C. Wood Derivatives: Shredded and composted, nitrogen-treated sawdust, ground bark, or wood waste; of uniform texture and free of chips, stones, sticks, soil, or toxic materials.
- D. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, debris, and material harmful to plant growth.

2.5 FERTILIZER

- A. Planting Fertilizer: Pelleted or granular form consisting of the following percents by weight and mixed by commercial fertilizer supplier: 6-nitrogen, 20-phosphoric acid, 20-potash.
- B. Planting Tablets: Provide slow-release type with potential acidity of not more than 5 percent by weight containing the following percents by weight of nutrients listed: 20-nitrogen, 10-phosphoric acid, 5-potash, 2.6 combined calcium, 1.60 combined sulphur, 0.35-iron elemental from ferrous sulfate. Provide in 21 gram tablets manufactured by Agriform or other approved.

PART 3 - EXECUTION

3.1 GENERAL

- A. Place planting soil and fertilizers according to requirements in other Specification Sections.

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- B. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in planting soil.

3.2 PREPARATION OF UNAMENDED, ON-SITE SOIL BEFORE AMENDING

- A. Excavation: Excavate soil from designated area(s) to a depth of 6 inches and stockpile until amended.
- B. Unacceptable Materials: Clean soil of concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.
- C. Unsuitable Materials: Clean soil to contain a maximum of 8 percent by dry weight of stones, roots, plants, sod, clay lumps, and pockets of coarse sand.
- D. Screening: Pass unamended soil through a 2-inch sieve to remove large materials.

3.3 PLACING AND MIXING PLANTING SOIL OVER EXPOSED SUBGRADE

- A. General: Apply and mix unamended soil with amendments on-site to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.
- B. Subgrade Preparation: Till subgrade to a minimum depth of 12 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
- C. Mixing: Spread unamended soil to total depth of 6 inches, but not less than required to meet finish grades after mixing with amendments and natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.
 - 1. Amendments: Apply soil amendments and fertilizer, if required, evenly on surface, and thoroughly blend them with unamended soil to produce planting soil.
 - a. Mix sulfur with dry soil before mixing fertilizer.
 - b. Mix fertilizer with planting soil no more than seven days before planting.
 - 2. Lifts: Apply and mix unamended soil and amendments in lifts not exceeding 12 inches in loose depth for material compacted by compaction equipment, and not more than 6 inches in loose depth for material compacted by hand-operated tampers.
- D. Compaction: Compact each blended lift of planting soil to 75 to 82 percent of maximum Standard Proctor density according to ASTM D 698 and tested in-place.
- E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

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3.4 PLACING MANUFACTURED PLANTING SOIL OVER EXPOSED SUBGRADE

- A. General: Apply manufactured soil on-site in its final, blended condition. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.
- B. Subgrade Preparation: Till subgrade to a minimum depth of 12 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
- C. Application: Spread planting soil to total depth of 6 inches, but not less than required to meet finish grades after natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.
 - 1. Lifts: Apply planting soil in lifts not exceeding 12 inches in loose depth for material compacted by compaction equipment, and not more than 6 inches in loose depth for material compacted by hand-operated tampers.
- D. Compaction: Compact each lift of planting soil to 75 to 82 percent of maximum Standard Proctor density according to ASTM D 698.
- E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.5 BLENDING PLANTING SOIL IN PLACE

- A. General: Mix amendments with in-place, unamended soil to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.
- B. Preparation: Till unamended, existing soil in planting areas to a minimum depth of 12 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
- C. Mixing: Apply soil amendments and fertilizer, if required, evenly on surface, and thoroughly blend them into full depth of unamended, in-place soil to produce planting soil.
 - 1. Mix sulfur with dry soil before mixing fertilizer.
 - 2. Mix fertilizer with planting soil no more than seven days before planting.
- D. Compaction: Compact blended planting soil to 75 to 82 percent of maximum Standard Proctor density according to ASTM D 698.
- E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.6 APPLYING COMPOST TO SURFACE OF PLANTING SOIL

- A. Application: Apply 6 inches to surface of in-place planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.
- B. Finish Grading: Grade surface to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

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3.7 PROTECTION AND CLEANING

- A. Protection Zone: Identify protection zones according to Section 015639 "Temporary Tree and Plant Protection."
- B. Protect areas of in-place soil from additional compaction, disturbance, and contamination. Prohibit the following practices within these areas except as required to perform planting operations:
 - 1. Storage of construction materials, debris, or excavated material.
 - 2. Parking vehicles or equipment.
 - 3. Vehicle traffic.
 - 4. Foot traffic.
 - 5. Erection of sheds or structures.
 - 6. Impoundment of water.
 - 7. Excavation or other digging unless otherwise indicated.
- C. Remove surplus soil and waste material including excess subsoil, unsuitable materials, trash, and debris and legally dispose of them off Owner's property unless otherwise indicated.
 - 1. Dispose of excess subsoil and unsuitable materials on-site where directed by Owner.

END OF SECTION 329113

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SECTION 330516 - UTILITY STRUCTURES

1. PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Manhole structures for gravity storm drain and sanitary sewer utilities.

1.02 RELATED SECTIONS

- A. Section 31 23 33 – Trenching and Backfilling.
- B. Section 33 40 00 – Storm Drainage Utilities.
- C. Section 32 05 23 – Cement and Concrete for Exterior Improvements.

1.03 RELATED DOCUMENTS

A. AASHTO:

- 1. M 199: Precast Reinforced Concrete Manhole Sections.

B. ASTM:

- 1. A 615/A615M: Deformed and Billet-Steel Bars for Concrete Reinforcement.
- 2. C 478: Precast Reinforced Concrete Manhole Sections.
- 3. C 1244: Test Method for Concrete Sewer Manholes by Negative Air Pressure (Vacuum) Test.

C. Caltrans Standard Specifications.

- 1. Section 51, Concrete Structures.
- 2. Section 75, Miscellaneous Metal.

D. California Building Code.

- 1. Section 1172B – Exterior Routes of Travel.

1.04 DEFINITIONS

- A. AASHTO: American Association of State Highway and Transportation Officials.
- B. ASTM: American Society for Testing Materials.

1.05 SUBMITTALS

- A. Follow submittal procedures outlined in Section 01 33 00 – Submittal Procedures.
- B. Product data for the following:
 - 1. Cleanout plugs or caps.
- C. Shop drawings: Include plans, elevations, details and attachments for the following:

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1. Precast concrete manholes, frames and covers.
 2. Precast concrete clean out boxes and box covers.
- D. Design Mix Reports and Calculations: For each class of cast-in-place concrete.
- E. Field Test Reports: Indicate and interpret test results for compliance with performance.
- 1.06 DELIVERY, STORAGE AND HANDLING
- A. Handle precast concrete manholes according to manufacturer's written instructions.
 - B. Protect imported bedding and backfill material from contamination by other materials.

2. PART 2 - PRODUCTS

2.01 CLEANOUTS

- A. Piping: Same as sanitary sewer line if possible.
- B. Top Cap: Threaded and of same material as piping if possible.
- C. Box Size: As required to provide access and allow easy removal and reinstallation of cap.
- D. Box Types:
 1. Landscape Areas: Portland cement concrete box and box cover (bolt-down), light duty.
 2. Traffic Areas: Portland cement concrete box and box cover or steel or cast iron cover, heavy duty, both box and cover (bolt down) to be rated for AASHTO H20 loading.
- E. Box Cover Markings: "S.D." for storm drain cleanouts, "S.S." for sanitary sewer cleanouts, unless otherwise specified.
- F. Available Manufacturers: Subject to compliance with requirements, box manufacturers offering products that may be incorporated into the Project include, but are not limited to the following:
 1. Associated Concrete Products, Inc. (Santa Ana, California) (Tel. 714-557-7470).
 2. Brooks Products Inc. (El Monte, California) (Tel. 818-443-3017).
 3. Christy Concrete Products, Inc. (Fremont, California) (Tel. 800-486 7070).

2.02 MANHOLES

- A. General: Size, shape, configuration, depth, etc. of manhole and frame and cover shall be as indicated.
- B. Portland Cement Concrete and Reinforcing:
 1. Cast-In-Place Portion: Use Class A Concrete per Caltrans Standard Specification Section 90, and ASTM A615 Grade 60 reinforcing steel bars.
 2. Precast Portion: ASTM C 478. Rate for AASHTO H20 loading in traffic areas.

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- C. Frames and Covers: As indicated and in accordance with Caltrans Standard Specification Section 75-1.02.
- D. Steps: ASTM C 478 or AASHTO M 199. Manufacture from deformed, ½-inch steel reinforcement rod complying with ASTM A 615 and encased in polypropylene complying with ASTM D4101. Include pattern designed to prevent lateral slippage off step. Acceptable manufacturer is Hanson Concrete Products, (Milpitas, CA) (Tel 408-262-1091) or equal.
- E. Force Main Piping Access Openings:
 - 1. General: As indicated.

2.03 JOINT SEALANT FOR STRUCTURES AND MANHOLES

- A. Mortar: Caltrans Standard Specification Section 51-1.135.
 - 1. Use to seal around pipes at connections to structures and manholes. Also use to seal joints between precast sections of structures and manholes.
- B. Gaskets: Preformed flexible rubber or plastic gasket.
 - 1. Rubber Gaskets: ASTM C443.
 - 2. Plastic Gaskets: Federal Specification SS-S-00210 (GSA-FSS), Type I, Rope Form; or alternate standard which may exist. Acceptable material is "Ram-Nek," as manufactured by the K. T. Snyder Company (Houston TX), or equal.

3. PART 3 - EXECUTION

3.01 CLEANOUT INSTALLATION

- A. General: Install as indicated.

3.02 MANHOLE INSTALLATION

- A. General: Install as indicated.

3.03 TESTING OF MANHOLES ON GRAVITY LINES

- A. At the option of the Contractor, either the following hydrostatic or vacuum test shall be performed.
- B. Hydrostatic Test:
 - 1. Insert inflatable plugs in all sewer inlets and outlets.
 - 2. Fill the manhole with water to a point six inches below the base of the manhole frame.
 - 3. Maintain the water at this point for one hour to allow time for absorption.
 - 4. Begin one-hour test period. Measure the amount of water added in one-hour period to maintain the water level at six inches below the base of the manhole frame. Do not allow water level to drop more than 25% of the manhole depth.
 - 5. Determine the allowable leakage by the following formula.

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6. $L=0.0002 \times D \times H \ 1/2$
7. L = Allowable leakage, gallons per minute.
8. D = Depth of manhole from top to bottom, feet.
9. H = Head of water in feet as measured from the surface of the water in the manhole to the sewer line invert or to the prevailing ground water surface outside the manhole. The lesser height governs.
10. If the leakage exceeds the allowable, determine the cause, take remedial action and re-test the manhole. If the leakage is less than the allowable and leaks are observed, repair the leaks.

C. Vacuum Test:

1. General: Test in accordance with ASTM C 1244.
2. Test prior to backfilling around the manhole.
3. Test Preparation: Plug all lift holes and pipes entering or exiting the manhole.
4. Place test head inside the top section of the manhole's cone section and inflate in accordance with the manufacturers instructions.
5. Draw a vacuum of 10-inches of mercury and shut the pump off.
6. With the valve closed, the time for the vacuum to drop 9-inches shall be measured.
7. The manhole shall pass the test if the time is greater than 60 seconds for a 48-inch diameter manhole, 75 seconds for a 60-inch diameter manhole and 90 seconds for a 72-inch diameter manhole.
8. If the manhole fails the initial test, make necessary repairs with a non-shrink grout while the vacuum is still being drawn. Retest until a satisfactory test is obtained.

END OF SECTION 330516

SECTION 331000 - WATER UTILITIES

1. PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Site water distribution system for domestic and fire protection services up to 5 feet of any on-site building being served.
- B. Domestic water and fire protection water transmission or distribution system within a roadway or street right-of-way.

1.02 RELATED SECTIONS

- A. Section 31 23 33 – Trenching and Backfilling.
- B. Section 32 05 23 – Cement and Concrete for Exterior Improvements.

1.03 RELATED DOCUMENTS

A. ASTM:

- 1. A 536: Specification for Ductile Iron Castings.
- 2. B 88: Specifications for Seamless Copper Water Tube.
- 3. D 1785: Specifications for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
- 4. D 2564: Specifications for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.

B. AWWA:

- 1. C104: Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
- 2. C105: Polyethylene Encasement for Ductile-Iron Pipe Systems.
- 3. C110: Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. (76 mm Through 1,219 mm) for Water.
- 4. C111: Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- 5. C115: Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
- 6. C150: Thickness Design of Ductile Iron Pipe.
- 7. C151: Ductile-Iron Pipe, Centrifugally Cast, for Water.
- 8. C153: Ductile- Iron Compact Fittings for Water Service.
- 9. C200: Steel Water Pipe-6 In. (150 mm) and larger.
- 10. C203: Coal-Tar Protective Coatings and Linings for Steel Water Pipelines-Enamel and Tape-Hot Applied.

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11. C205: Cement-Mortar Protective Lining and Coating for Steel Water Pipe- 4 In. and Larger-Shop Applied.
12. C207: Steel Pipe Flanges for Waterworks Service-Sizes 4 In. Through 144 In. (100 mm Through 3,600 mm).
13. C208: Dimensions for Fabricated Steel Water Pipe Fittings.
14. C209: Cold Applied Tape Coatings for the Exterior of Special Sections, Connections and Fittings for Steel Water Pipelines.
15. C210: Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.
16. C213: Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
17. C214: Tape Coating Systems for the Exterior of Steel Water Pipelines.
18. C218: Coating the Exterior of Aboveground Steel Water Pipelines and Fittings.
19. C219: Bolted, Sleeve-type Couplings for Plain-End Pipe.
20. C500: Metal-Seated Gate Valves for Water Supply Service.
21. C502: Dry-Barrel Fire Hydrants.
22. C503: Wet Barrel Fire Hydrants.
23. C504: Rubber Seated Butterfly Valves.
24. C507: Ball Valves 6 In. Through 8 In. (150 mm Through 1,200 mm).
25. C508: Swing-check Valves for Waterworks Service, 2 In. (50mm) Through 24 In. (600 mm) NPS.
26. C509: Resilient-Seated Gate Valves for Water Supply Service.
27. C510: Double Check Valve Backflow-Prevention Assembly.
28. C511: Reduced-Pressure Principle Backflow-Prevention Assembly.
29. C512: Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service.
30. C550: Protective Epoxy Interior Coatings for Valves and Hydrants.
31. C600: Installation of Ductile-Iron Water Mains and Their Appurtenances.
32. C605: Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings.
33. C606: Grooved and Shouldered Joints.
34. C651: Disinfecting Water Mains.
35. C800: Underground Service Line Valves and Fittings.
36. C900: Polyvinyl Chloride (PVC) Pressure Pipe and Fittings, 4 In. Through 12 In. (100mm Through 300mm) for Water Distribution.

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37. C901: Polyethylene (PE) Pressure Pipe and Tubing, ½ In. (13mm) Through 3 In. (76mm) for Water Service.
38. C905: Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 In. Through 48 In. (350 mm Through 1,200 mm) for Water Transmission and Distribution.
39. C906: Polyethylene (PE) Pressure Pipe and Fittings, 4 In. (100 mm) through 63 In (1,575 mm), for Water Distribution and Transmission.
40. C907: Polyvinyl Chloride (PVC) Pressure Fittings for Water – 4 In. through 8 In. (100 mm Through 200 mm).
41. C908: PVC Self-Tapping Saddle Tees for Use on PVC Pipe.
42. M11: Steel Pipe - A Guide for Design and Installation.
43. M23: PVC Pipe – Design and Installation.
44. M41: Ductile-Iron Pipe and Fittings.

1.04 DEFINITIONS

- A. AASHTO: American Association of State Highway and Transportation Officials.
- B. ASTM: American Society for Testing Materials.
- C. AWWA: American Waterworks Association
- D. DI: Ductile iron.
- E. DIP: Ductile iron pipe.
- F. FM: Factory Mutual.
- G. NFPA: National Fire Protection Association.
- H. NSF: National Sanitation Foundation.
- I. PCC: Portland cement concrete.
- J. PE: Polyethylene.
- K. PVC: Polyvinyl Chloride.
- L. UL: Underwriters Laboratory.

1.05 SYSTEM PERFORMANCE REQUIREMENTS

- A. Minimum Internal Pressures: As indicated on plans.
- B. External Load: Earth load indicated by depth of cover plus AASHTO H20 live load unless indicated otherwise.

1.06 SUBMITTALS

- A. Follow submittal procedures outlined in Section 01 33 00 – Submittal Procedures.

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B. Product Data: For the following:

1. Piping materials and fittings.
2. Pipe couplings.
3. Flexible pipe fittings.
4. Restrained pipe fittings.
5. High deflection fittings/ball joints.
6. Expansion joints.
7. Flexible expansion joints.
8. Gate valves.
9. Butterfly valves.
10. Check valves.
11. Air and vacuum relief valves.
12. Blow-off valves.
13. Pressure reducing valves.
14. Pressure sustaining valves.
15. Ball valves.
16. Fire hydrants.
17. Post indicator valves.
18. Fire department connections.
19. Backflow preventers.
20. Precast valve boxes and box covers.

C. Shop drawings: Include plans, elevations, details and attachments.

1. Precast and cast in-place vaults and covers.
2. Wiring diagrams for alarm devices.

D. Field test reports: Indicate and interpret test results for compliance with the Project requirements.

1.07 QUALITY ASSURANCE

A. Comply with requirements of utility supplying water. Do not operate existing valves or tap existing piping without written permission and/or presence of utility company representative.

B. Comply with the following requirements and standards:

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1. NSF 61: "Drinking Water System Components-Health Effects" for materials for potable water.
 2. NFPA 24: "Installation of Private Fire Service Mains and Their Appurtenances" for materials, installations, tests, flushing, and valve and hydrant supervision.
 3. CEC: "California Electric Code" for electrical connections between wiring and electrically operated devices.
- C. Provide listing/approval stamp, label, or other marking on piping and specialties made to a specified standard.

1.08 MATERIAL DELIVERY, STORAGE AND HANDLING

- A. Preparation for Transport: Prepare valves, including fire hydrants, according to the following:
1. Ensure that valves are dry and internally protected against rust and corrosion.
 2. Protect valves against damage to threaded ends and flange faces.
 3. Set Valves in best position for handling. Set valves closed to prevent rattling.
- B. Deliver piping with factory-applied end-caps. Maintain end-caps through shipping, storage and handling to prevent pipe end damage and to prevent entrance of dirt, debris and moisture.
- C. Handling: Use slings to handle valves and fire hydrants whose size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.
- D. During Storage: Use precautions for valves, including fire hydrants according to the following.
1. Do not remove end protectors, unless necessary for inspection, then reinstall for storage.
 2. Protection from Weather: Store indoors and maintain temperature higher than ambient dew-point temperature. Store indoors and maintain temperature higher than ambient dew point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.
- E. Do not store plastic pipe and fittings in direct sunlight.
- F. Protect pipe, fittings, flanges, seals and specialties from moisture, dirt and damage.
- G. Protect linings and coatings from damage.
- H. Handle precast boxes, vaults and other precast structures according to manufacturer's written instructions.
- I. Protect imported bedding and backfill material from contamination by other materials.

1.09 COORDINATION

- A. Coordinate connection to existing water mains with water utility supplying water.
- B. Coordinate piping materials, sizes, entry locations, and pressure requirements with building domestic water distribution piping and fire protection piping.

2. PART 2 - PRODUCTS

2.01 SMALL-SIZE SERVICE PIPES

- A. Copper Pipe: Sizes ¾-inch through 2-inch.
 - 1. Pipe and Fittings: ASTM B 88, Type K, seamless water tube, annealed.
 - 2. Joints: Restrain by couplings.
- B. PE Plastic Pipe: Sizes ½-inch through 3-inch.
 - 1. Pipe and Fittings: AWWA C901.
 - 2. Joints: Restrain with clamps or heat-fusion.
- C. PVC Pipe: Sizes 1/8-inch through 3 inch.
 - 1. Pipe and Fittings: ASTM D 1785, Schedule 40
 - 2. Joints: Restrain with solvent cement. Do not use threaded pipe.
 - 3. Solvent Cement: ASTM D2564.

2.02 LARGE-SIZE SERVICE AND DISTRIBUTION PIPES

- A. DIP: Sizes 4-inch through 48-inch.
 - 1. Pipe: AWWA C150 and C151.
 - 2. Fittings
 - (a) Standard: AWWA C110, sizes 4-inch through 48-inch.
 - (b) Compact: AWWA C153, sizes 4-inch through 24-inch.
 - 3. Pipe and Fitting Lining: Cement Mortar, AWWA C104.
 - 4. Pipe and Fitting Coating: Asphaltic, AWWA C151 or C115.
 - 5. Exterior Soil Corrosion Protection for Pipe and Fittings: Polyethylene encasement, AWWA C105.
 - 6. Unrestrained Joints:
 - (a) Push-On Bell and Spigot Joint: AWWA C111.
 - (b) Mechanical Joint: AWWA C111.
 - 7. Restrained Joints:
 - (a) Flanged Joint: AWWA C115.
 - (b) Push-On Bell and Spigot Joint: AWWA C111 with "Field Lok Gasket," sizes 4-inch through 24-inch; "TR Flex," sizes 4-inch through 64-inch; both by U. S. Pipe (Birmingham AL) (Tel.205-254-7442) or approved equal. "Megalug" restraint harness,

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Ebaa Iron (Eastland TX) (Tel 800-443-1716) or approved equal.

- (c) Mechanical Joint: AWWA C111 with “Mega Lug,” sizes 3-inch through 48-inch. Ebaa Iron (Eastland TX) (Tel 800-443-1716) or approved equal.
- (d) Grooved and Shouldered Joints: AWWA C150, AWWA C151 and AWWA C606. 24-inch maximum size.

8. Couplings:

- (a) Plain End Pipe to Plain End Pipe: Ductile iron or steel bolted couplings, manufacturer’s shop coating with low alloy steel bolts and nuts. Steel couplings to conform to AWWA C219. Smith-Blair, Inc, (Texarkana, AR) (Tel. 501-773-5127), Dresser (Bradford, PA) (Tel.-814-368-3131) or approved equal.
- (b) Plain End Pipe to Flanged Pipe: 1) Ductile iron or steel bolted flanged coupling adapters, manufacturer’s shop coating with low alloy steel bolts and nuts. Steel flanged couplings to conform to AWWA C219. Smith-Blair, Inc, (Texarkana, AR) (Tel. 501-773-5127), Dresser (Bradford, PA) (Tel.-814-368-3131) or approved equal; or 2) restrained flange adapter, “Megaflange,” sizes 3-inch through 36 inch, Ebaa Iron (Eastland TX) (Tel 800-443-1716) or approved equal.

B. PE Pipe: Sizes 4-inch through 64-inch.

- 1. Pipe and Fittings: AWWA C906.
- 2. Joints:
 - (a) Thermal Butt Fusion: AWWA C906 and pipe manufacturer’s recommendations.
 - (b) Flanged joining: AWWA C906 and pipe manufacturer’s recommendations.
 - (c) Other: Check with pipe manufacturer.

C. PVC Pipe: Sizes 4-inch through 48-inch.

- 1. Pipe:
 - (a) 4-inch through 12-inch: AWWA C900.
 - (b) 14-inch through 48-inch: AWWA C905.
- 2. Fittings: DI conforming to 2.2A above.
- 3. Unrestrained Joints:
 - (a) Push-On Bell and Spigot Joint: AWWA C900.
- 4. Restrained Joints:
 - (a) Push-On Bell and Spigot Joint: Harness assembly as manufactured by Ebaa Iron (Eastland, Tx) (Tel. 800-433-1716) or approved equal.
 - (b) Plain End PVC to DI Mechanical Joint: Ebaa Iron (Eastland, Tx) (Tel. 800-433-1716) or approved equal.

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5. Steel or Ductile Iron Couplings:
 - (a) Plain End Pipe to Plain End Pipe: Ductile iron or steel bolted couplings, manufacturer's shop coating with low alloy steel bolts and nuts. Steel couplings to conform to AWWA C219. Smith-Blair, Inc, (Texarkana, AR) (Tel. 501-773-5127), Dresser (Bradford, PA) (Tel.-814-368-3131) or approved equal.
 - (b) Plain End Pipe to DI or Steel Flanged Pipe: Ductile iron or steel bolted flanged coupling adapters, manufacturer's shop coating with low alloy steel bolts and nuts. Steel flanged couplings to conform to AWWA C219. Smith-Blair, Inc, (Texarkana, AR) (Tel. 501-773-5127), Dresser (Bradford, PA) (Tel.-814-368-3131) or approved equal.
6. PVC Couplings
 - (a) Unrestrained Plain End to Plain End Pipe: AWWA C900, as manufactured by CertainTeed (Valley Forge, PA) (Tel. 610 341-6820) or approved equal.
 - (b) Restrained Plain End to Plain End Pipe: AWWA C900, "Certa-Lock" as manufactured by CertainTeed (Valley Forge, PA) (Tel. 610 341-6820) or approved equal.

D. Cement Mortar Lined and Coated Steel Pipe: 6-inch and larger.

1. Pipe: AWWA C200 and AWWA M11.
2. Special Sections and Fittings: AWWA C200, C207, C208 and AWWA M11 for all bends, tees, nozzles, closures, etc.
3. Flanges: AWWA C207. Includes blind flanges.
4. Linings and Coatings for Pipe, Special Sections and Fittings: Cement Mortar Lining and Coating: AWWA C205.
 - (a) Liquid Epoxy Lining and Coating: AWWA C210.
 - (b) Fusion Bonded Epoxy Lining and Coating: AWWA C213.
 - (c) Coal-Tar Lining and Coating: AWWA C203.
 - (d) Cold-Applied Tape Coatings, Piping: AWWA C214.
 - (e) Cold-Applied Tape Coatings, Specials, Connection and Fittings: AWWA C209.
 - (f) Cold Applied Petrolatum Tape and Petroleum Wax Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Buried or Submerged Steel Water Pipelines.
 - (g) Aboveground Pipe Coatings: AWWA C218.]
5. Non-Restrained Joints: AWWA M11.
 - (a) Rubber Gasket: Carnegie-shape rubber gasket as indicated.
6. Restrained Joints: AWWA M11. Where a flanged joint, butt strap or coupling are not indicated, either restrained joint a, or b, as follows, is acceptable, but the selected joint shall be used throughout the project.

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- (a) Rubber Gasket: Carnegie-shape rubber gasket with field welded restraint bar as indicated.
 - (b) Field Lap Welded Slip Joint: As indicated.
 - (c) Field Welded Butt Strap: As indicated.
 - (d) Flanged Joint: AWWA C207 with Type 316L stainless steel bolts and nuts as indicated.
7. Joint Coating for Cement Mortar Lined and Coated Steel Pipe:
- (a) Field Joint Encasement: Cement mortar contained in fabric lined with closed cell polyethylene foam as indicated. Attach fabric to pipe with Type 316L stainless steel straps as indicated. Closed cell polyethylene foam encasement shall be by Industrial Specialties (Fullerton, CA) (Tel. 800-638-8127) or approved equal.
8. Non-Restrained Flexible Couplings: AWWA C219, Smith Blair, Inc (Texarkana, TX) (Tel. 501-773-5127), Number 411 or approved equal, with factory applied fusion-bond epoxy coating and Type 316L stainless steel bolts and nuts.
9. Restrained Flexible Couplings: Non-restrained flexible coupling supplemented with a restraining harness as indicated and as follows:
- (a) Restraining harness design by Contractor's pipe manufacturer using criteria presented in Section 13.10 of AWWA M11.
 - (b) Space harness-lugs and tie bolts equally around the pipe.
 - (c) Type 316L stainless steel harness tie bolts and nuts.
 - (d) Design and dimensions of harness lugs to be modified from that shown in AWWA M11, as necessary, to provide additional height to clear the coupling.
10. Field Coating of Coupling Assemblies: Apply either of the following flexible tape and mastic or putty coating systems to the all non-restrained or restrained flexible steel couplings.
- (a) Denso Coating System – Denso North American, Inc., (Houston, TX), (Tel 281-821-3355).
 - (b) Trenton Coating System – Allied Utility Products, (Livermore, CA) (Tel. 510-484-4007 or 510-373-7400).

2.03 HIGH DEFLECTION FITTINGS/BALL JOINTS

- A. Plain End Pipe: Xtra Flex Restrained Joint High Deflection Fittings, 4-inch through 24-inch, U. S. Pipe, (Birmingham, AL) (Tel. 205-254-7442) or approved equal.
- B. Mechanical or Flanged Joint: Flex 900, 4-inch through 12-inch, Ebaa Iron Sales, (Eastland, TX) (Tel. 800-433-1716) or approved equal.

2.04 EXPANSION JOINTS

- A. TR Flex Joints: TR Flex Telescoping Sleeve, 4-inch through 64 inch, U. S. Pipe, (Birmingham, AL) (Tel. 205-254-7442).
- B. Mechanical or Flanged Joint: Ex-Tend 200, 4-inch through 36-inch, EBAA Iron Sales, (Eastland,

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TX) (Tel. 800-433-1716) or approved equal.

2.05 FLEXIBLE EXPANSION JOINTS

- A. Plain End to Plain End Pipe: "Xtra Flex," sizes 4-inch through 24-inch, U. S. Pipe, (Birmingham AL) (Tel. 205-254-7442) or equal.
- B. Flanged or mechanical Joint: "Flex-Tend," sizes 3-inch through 48-inch, Ebaa Iron (Eastland TX) (Tel. 800-433-1716) or equal.
- C. Flanged Joint: Starflex, Series 500, Star Pipe Products, (Tel. 800-999-3009) or equal.

2.06 GATE VALVES

- A. Provide on lines 10-inch and smaller.
- B. Valves, 3-Inch through 20-Inch: AWWA C509, resilient-seated, non-rising stem, gray or ductile-iron body and bonnet, with bronze or gray or ductile-iron gate, bronze stem and square stem operating nut unless noted otherwise. All bolts, nuts and washers, except operating nut, shall be stainless steel. Stem operating nut to be 2-inches square and open counter-clockwise. Stem extensions shall be installed to bring the stem operating nut to within 2-feet of finish grade where the depth from finish grade to the stem operating nut exceeds 4-feet. Equip valves in pump stations and other interior or vault installations with hand-wheels. Provide protective epoxy interior and exterior coating according to AWWA C550 and manufacturer's recommendations.
- C. Service Line Valves and Fittings, 2-Inch and Smaller: AWWA C800
- D. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Project include, but are not limited to, the following:
 - 1. Mueller Company (Decatur, IL) (Tel.800-423-1323).
 - 2. M&H Valve Company (Anniston, AL) (Tel. 205-237-3521).
 - 3. Crane Company (New York, NY).
- E. Valve Box and Cover: 9-inch minimum diameter PCC box with extensions of length required for depth of bury of valve, and cast iron or ductile iron cover with lettering "WATER". Both the box and the cover shall be rated for AASHTO H20 loading.

2.07 BUTTERFLY VALVES

- A. Provide on lines larger than 10-inch.
- B. Valves, 3-Inch through 72-Inch: AWWA C 504, rubber seated, Class 150B cast iron body, cast or ductile iron discs, stainless steel shafts, adjustable field replaceable rubber seats mating against stainless steel seat rings and field-replaceable seals. Flanged or mechanical joint end connections. No wafer type valves allowed. Traveling nut type valve actuators designed for buried service unless noted otherwise. All bolts, nuts and washers, except wrench nut, shall be stainless steel. Wrench nut to be 2-inches square and open counter-clockwise. Stem extensions shall be installed to bring the wrench nut to within 2-feet of finish grade where the depth from finish grade to the wrench nut exceeds 4-feet. Equip valves in pump stations and other interior or vault installations with hand-wheels. Provide protective epoxy interior and exterior coating according to AWWA C550 and manufacturer's recommendations.

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- C. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Project include, but are not limited to, the following:
 - 1. Mueller Company (Decatur, IL) (Tel.800-423-1323).
 - 2. M&H Valve Company (Anniston, AL) (Tel. 205-237-3521).
 - 3. Crane Company (New York, NY).
- D. Valve Box and Cover: 9-inch minimum diameter PCC box with extensions of length required for depth of bury of valve, and cast iron or ductile iron cover with lettering "WATER". Both the box and the cover shall be rated for AASHTO H20 loading.

2.08 AIR RELEASE, AIR/VACUUM AND COMBINATION AIR VALVES

- A. AWWA C512, specific type of valve, size, details and valve box as indicated.
- B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Project include, but are not limited to, the following:
 - 1. Apco Valves, Valve and Primer Corporation (Schaumburg, IL) (Tel. 708-529-9000).
 - 2. Crispin Valve (Berwick, PA) (Tel. 800-247-8258).

2.09 BLOW-OFF VALVES

- A. Blow-off valve assemblies, details and boxes as indicated.

2.10 SWING CHECK VALVES

- A. Valves 2-Inch through 24-Inch: AWWA C508, details as indicated.
- B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Project include, but are not limited to, the following:
 - 1. Mueller Company (Decatur, IL) (Tel.800-423-1323).
 - 2. M&H Valve Company (Anniston, AL) (Tel. 205-237-3521).

2.11 BALL VALVES

- A. Valves 6-Inch through 48-Inch: AWWA C507, details as indicated.
- B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Project include, but are not limited to, the following:
 - 1. Crane Company (New York, NY).

2.12 PRESSURE-REGULATING VALVES

- A. Valve: Automatic, pilot-operated, cast-iron body with interior coating according to AWWA C550. 250-psi Working-pressure, bronze pressure-reducing pilot valve and tubing, and means for discharge pressure adjustment. Details as indicated.
- B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Project include, but are not limited to, the following:

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1. Cla-Val Company (Newport Beach, CA) (Tel. 714-548-2201).
2. Bermad (Porterville, CA) (Tel. 209-781-6630).
3. Ames Company (Woodland, CA) (Tel. 916-666-2493).

2.13 FLOW-REGULATING VALVES

- A. Valve: Automatic, pilot-operated, cast-iron body with interior coating according to AWWA C550. 250-psi working-pressure, bronze pressure-reducing pilot valve and tubing, and means for flow adjustment. Details as indicated.
- B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Project include, but are not limited to, the following:
 1. Cla-Val Company (Newport Beach, CA) (Tel. 714-548-2201).
 2. Bermad (Porterville, CA) (Tel. 209-781-6630).
 3. Ames Company (Woodland, CA) (Tel. 916-666-2493).

2.14 SERVICE CONNECTIONS AND WATER METERS

- A. Service connections and water meter details and boxes as indicated.

2.15 FIRE HYDRANTS

- A. Wet Barrel: AWWA C503, details as indicated.
- B. Dry Barrel: AWWA C502, details as indicated.

2.16 REDUCED PRESSURE PRINCIPLE BACKFLOW PREVENTER

- A. Provide as indicated and as required by State or local agency.
- B. General: AWWA C511, with OS gate valve on inlet and outlet, and strainer on inlet. Include test cocks and pressure-differential relief valve with ASME A112.1.2 air gap fitting located between 2 positive-seating check valves for continuous-pressure application.
- C. Body:
 1. 2-Inch and Smaller: Bronze with threaded ends.
 2. 2-1/2-Inch and Larger: Bronze, cast iron steel, or stainless steel with flanged ends.
- D. Interior Lining: AWWA C550, epoxy coating for cast iron or steel bodies.
- E. Interior Components: Corrosion-resistant materials.
- F. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Project include, but are not limited to, the following:
 1. Cla-Val Company (Newport Beach, CA) (Tel. 714-548-2201).
 2. Ames Company (Woodland, CA) (Tel. 916-666-2493).

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3. Febco, CMB Industries, Inc. (Fresno, CA) (Tel. 559-252-0791).
4. Hersey Products, Inc. (Dedham, MA) (Tel. 617-326-9400).

2.17 DOUBLE CHECK DETECTOR ASSEMBLY

- A. FM approved or UL listed, with OS&Y gate valve on inlet and outlet, and strainer on inlet. Include two positive-seating check valves and test cocks, and bypass with displacement-type water meter, valves, and double-check backflow preventer, for continuous pressure application.
- B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Project include, but are not limited to, the following:
 1. Cla-Val Company (Newport Beach, CA) (Tel. 714-548-2201).
 2. Ames Company (Woodland, CA) (Tel. 916-666-2493).
 3. Febco, CMB Industries, Inc. (Fresno, CA) (Tel. 559-252-0791).
 4. Hersey Products, Inc. (Dedham, MA) (Tel. 617-326-9400).

2.18 POST INDICATOR VALVE

- A. General: UL 789, FM approved, vertical-type, cast-iron body with operating wrench extension rod, and adjustable cast-iron barrel of length required for depth of bury of valve. Review fire department connection with agency having jurisdiction. Check hose threads and all sizes with fire department.
- B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Project include, but are not limited to, the following:
 1. Mueller Co. (Decatur, IL) (Tel.800-423-1323).
 2. Clow Corporation (Oskaloosa, IA).

2.19 FIRE DEPARTMENT CONNECTION

- A. Exposed, Freestanding Fire Department Connection: UL 405, cast brass body with threaded inlets according to NFPA 1963 and matching local fire department hose threads and threaded bottom outlet. Include lugged caps, gaskets and chains; lugged swivel connections and drop clapper for each hose-connection inlet; 18-inch high brass sleeve; and round escutcheon plate. Four 2-1/2-inch NPS inlets and 6-inch NPS outlet.

2.20 UNDERGROUND VAULTS/PITS

- A. General: Portland cement concrete, precast or cast-in-place as indicated.
- B. Portland Cement Concrete and Reinforcing Steel: Section 32 05 23 – Cement and Concrete for Exterior Improvements.
- C. Access Openings: As indicated.
- D. External Load: Earth load plus AASHTO H20 live load if located in paved areas.
- E. Lids: Bolt down type.

2.21 TRACER WIRE

- A. General: Minimum #12 AWG stranded copper wire with blue THW, THWN, or THHN rated insulation.

2.22 WARNING TAPE

- A. General: Non-detectable 3-inch warning tape made of solid blue film with continuously printed black-letter message reading "CAUTION—WATER LINE BURIED BELOW."

2.23 PCC THRUST BLOCKS

- A. Portland Cement Concrete and Reinforcing Steel: Section 32 05 23 – Cement and Concrete for Exterior Improvements. See Civil Plans for details.

3. PART 3 - EXECUTION

3.01 PIPE INSTALLATION

- A. General: Install pipe, fittings, and appurtenances utilizing best practices, manufacturer's instructions, and in accordance with the following:
 - 1. DIP: AWWA M41 and AWWAC600.
 - 2. PVC pipe: AWWA M23 and AWWA C605.
 - 3. Steel Pipe: AWWA M11.
- B. Pipe Depth and Trench Configuration: Conform to elevations, profiles and typical trench section(s) indicated.
- C. Excavation, Bedding, Backfill, and Compaction: Section 31 23 33 – Trenching and Backfilling.
- D. Handling: Carefully handle during loading, hauling, unloading and placing operations to avoid breakage or damage. Use strap type slings for lifting and placing; no chains or hooks will be permitted. Comply with manufacturer's recommendations.
- E. Laying: Before lowering pipe into the trench, remove all stakes, debris, loose rock and other hard materials from the bottom of the trench. Lay accurately in conformance with lines and grades indicated. Lay pipe on a bed of bedding material specified and prepared by handwork, dug true to grade. Furnish firm bearing for pipe throughout it's entire length with bell holes provided at the ends of each pipe length of sufficient size to permit making up the particular type of joint being used. Adjust pipe to line and grade by scraping away or filling and tamping material under the body of the pipe for the entire pipe length and not by blocking or wedging. After final positioning, hold pipe in place in trench with backfill material placed equally on both sides of the pipe at as many locations as required to hold the pipe section in place.
- F. Curved Alignment: When necessary to conform to the alignment specifically indicated, lay pipe on a curved alignment by means of asymmetrical closure of joints or bending of the pipe barrel. If necessary, use shorter than the standard lengths of pipe to achieve curvature specified. Do not exceed the recommendations of the pipe manufacture for deflections at the joints or pipe bending.
- G. Closure: Close open ends of pipes and appurtenance openings at the end of each days work or

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when work is not in progress.

3.02 CONNECTING TO EXISTING MAINS

- A. Pressure Tap Connections: Perform in accordance with the requirements of the owner of the system being tapped. Maintain a positive pressure flow from the main being tapped to the tapping device to flush plastic chips, metal ribbons, etc. into the tapping device and not into the pipe being tapped.
- B. Other Connections: As indicated and in accordance with the requirements of the owner of the line being connected to.

3.03 ANCHORAGE INSTALLATION

- A. Mechanically Restrained Joints: Install where indicated for lengths indicated in accordance with manufacturer's instructions.
- B. PCC Thrust Blocks: Install where required and as indicated. Bearing area indicated is to be against undisturbed earth. Allow a minimum of 24-hours curing time before introducing water into the pipeline and allow a minimum of 7-days curing time before pressure testing.

3.04 HIGH DEFLECTION FITTINGS/BALL JOINTS, EXPANSION JOINTS, AND FLEXIBLE EXPANSION JOINTS

- A. Install as indicated and in accordance with the manufacturer's recommendations.

3.05 VALVE INSTALLATION

- A. Install all valves in accordance with the manufacturer's instructions and the following:
 - 1. General:
 - (a) Gate Valves: Appendix A of AWWA C509.
 - (b) Butterfly Valves: Appendix A of AWWA C504.
 - 2. Joints:
 - (a) Valves on DI, PE and PVC Pipe: Mechanical joint valves for buried locations. Flanged-end valves for installation in vaults/pits.
 - (b) Valves on Steel Pipe: As indicated for buried locations. Flanged-end valves for installation in vaults/pits.

3.06 SERVICE CONNECTIONS INSTALLATION

- A. Install as indicated and in accordance with the requirements of the owner of the system.

3.07 WATER METER INSTALLATION

- A. Install as indicated and in accordance with the requirements of the owner of the system.

3.08 FIRE HYDRANT INSTALLATION

- A. Install as indicated and in accordance with the requirements of the owner of the system and the fire department.

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3.09 REDUCED PRESSURE PRINCIPLE BACKFLOW PREVENTER INSTALLATION

- A. Install as indicated and in accordance with the requirements of the owner of the system and the local health department requirements.

3.10 DOUBLE CHECK DETECTOR ASSEMBLY INSTALLATION

- A. Install as indicated and in accordance with the requirements of the owner of the system and the fire department.

3.11 POST INDICATOR VALVE INSTALLATION

- A. Install as indicated and in accordance with the requirements of the owner of the system and the fire department.

3.12 FIRE DEPARTMENT CONNECTION INSTALLATION

- A. Install as indicated and in accordance with the requirements of NFPA #24 and the fire department.

3.13 UNDERGROUND VAULT/PIT INSTALLATION

- A. Install as indicated.
- B. Excavation and Backfill: Section 31 23 33 – Trenching and Backfilling.

3.14 TRACER WIRE INSTALLATION

- A. Install on trench bottom under the vertical projection of the pipe to protect it in all installations.
- B. Form a mechanically and electrically continuous line throughout the pipeline, extending to the nearest valve or other pipeline appurtenance designated by the owner of the system or the Owner. Extend the wire up the outside of the valve box/riser and cut a hole that is 8-inches from the top, extend a 12-inch wire lead to the inside of the box. At other pipeline appurtenances, designated by the owner of the system or the Owner, terminate the 12-inch wire lead inside the enclosure.
- C. Splice wire with a splicing device consisting of and electro-tin plated seamless copper sleeve conductor. Install as recommended by the manufacturer. Wrap splices and damaged insulation with electrician's tape.

3.15 WARNING TAPE INSTALLATION

- A. Install tape approximately 1-foot above and along the centerline of the pipe.
- B. Where tape is not continuous, lap tape ends a minimum of 2-feet.

3.16 HYDROSTATIC PRESSURE AND LEAKAGE TEST

- A. General:
 - 1. Provide all necessary materials and equipment, including water.
 - 2. Backfill all trenches sufficient to hold pipe firmly in position.
 - 3. Allow time for thrust blocks to cure prior to testing.
 - 4. Flush all pipes prior to testing to remove all foreign material.

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5. Perform pressure and leakage test concurrently.
 6. Test pressure: See Subsection titled "System Performance Requirements."
 7. Apply test pressure by means of a pump connected to the pipe.
 8. Base test pressure on the elevation of the lowest point in the line.
 9. Fill each closed valve section or bulk-headed section slowly. Expel air from section being tested by means of permanent air vents installed at high points or by means of temporary corporation cocks installed at such points. Remove and plug the temporary corporation cocks at the conclusion of the test.
 10. Allow water to stand in the pipe for 24 hours before test pressure is applied.
 11. Allow the system to stabilize at the test pressure before conducting the leakage test.
 12. Do not operate valves in either the opening or closing direction at differential pressures above the valves rated pressure.
 13. Maintain test pressure as specified for type of pipe being tested.
 14. Pressure Test: Examine any exposed pipe, fittings, valves, hydrants and joints during the test, if no leaks are observed the section of line has passed the pressure test. If leaks are observed, repair any damaged or defective pipe, fittings, valves, or hydrants, and repeat the pressure test.
 15. Leakage Test: Perform as specified hereafter for the type of pipe being installed.
- B. DIP Leakage Test: Perform in accordance with AWWA C600. Selected requirements of AWWA C600 are repeated as follows:
1. Maintain the test pressure, +/- 5 psi, for a minimum of two hours.
 2. No piping will be accepted if the leakage is greater than that determined by the following formula:
$$L = (S \times D \times P^{1/2}) / 133,200$$

L = Allowable leakage, gallons per hour.
S = Length of pipe tested, feet.
D = Nominal diameter of pipe, inches.
P = Average test pressure during the leakage test, pounds per square inch (gauge).
- C. PE Pipe Leakage Test:
1. Apply the test pressure and allow the pipe to stand, without makeup pressure, for sufficient time to allow for diametric expansion or pipe stretching to stabilize, approximately two to three hours.
 2. After the above stabilization has occurred, return the section being tested to the test pressure. Hold the test pressure for one to three hours. If the pressure in the test section drops, and it is determined the drop may be the result of expansion resulting from increasing temperature, a limited amount of additional water may be added to bring the pressure back to the test pressure. Allowable amounts of make-up water, to compensate for expansion due to

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increasing temperature, are as shown in the following table. Make-up water is only allowed during this final test period and not during the initial stabilization described in the previous paragraph. If the additional water added is less than the allowable shown in the table and there are no visual leaks or significant pressure drops, the tested section passes the test.

3. Nominal Allowance for Expansion

(U.S. Gals./100 Feet of Pipe)			
Pipe Size (in.)	1-Hour Test	2-Hour Test	3-Hour Test
3	0.10	0.15	0.25
4	0.13	0.25	0.40
6	0.30	0.60	0.90
8	0.50	1.0	1.50
10	0.75	1.3	2.1
11	1.0	2.0	3.0
12	1.1	2.3	3.4
14	1.4	2.8	4.2
16	1.7	3.3	5.0
18	2.2	4.3	6.5
20	2.8	5.5	8.0
22	3.5	7.0	10.5
24	4.5	8.9	13.3
28	5.5	11.1	16.8
32	7.0	14.3	21.5
36	9.0	18.0	27.0
40	11.0	22.0	33.0
48	15.0	27.0	43.0

D. PVC Pipe Leakage Test: Perform in accordance with AWWA M23. Selected requirements of AWWA M23 are repeated as follows:

1. Maintain the test pressure, +/- 5 psi, for a minimum of two hours.
2. No piping will be accepted if the leakage is greater than that determined by the following formula:

$$L = (N \times D \times P^{1/2}) / 7,400$$

L = Allowable leakage, gallons per hour.

N = Number of joints in the length of the pipeline tested.

D = Nominal diameter of pipe, inches.

P = Average test pressure during the leakage test, pounds per square inch (gauge).

E. Cement Mortar Lined and Coated Steel Pipe Leakage Test: Perform in accordance with AWWA M11. Selected requirements of AWWA M11 are repeated as follows:

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1. Maintain the test pressure, +/- 5 psi, for a minimum of two hours.
2. There shall be no significant leakage for pipe with welded joints or mechanical couplings.
3. For pipe joined with O-ring rubber gaskets, a leakage of 25 gallons per inch of diameter per mile per 24-hours is allowed.

3.17 DISINFECTION

- A. All New Pipelines shall be disinfected in accordance with one of the three methods specified in AWWA C651 and the following:
 1. Disinfect after pressure and leakage test have been performed and accepted.
 2. The method used shall be at the Contractor's option, unless specified by the owner of the water system.
 3. Engage the services of a commercial testing laboratory, approved by the owner of the water system, to perform the bacteriological tests specified in Section 5.1 of AWWA C651. Direct the testing laboratory to send the original report of the bacteriological testing to the owner of the water system. Should the laboratory report show that any sample taken was not acceptable, repeat the sterilization process shall until a satisfactory sterilization is accomplished.
 4. Lawfully dispose of the chlorinated water.

END OF SECTION 331000

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SECTION 333000 - SANITARY SEWERAGE UTILITIES

1. PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Roadway and/or site sanitary gravity sewers and force mains up to 5 feet of any on-site building.

1.02 RELATED SECTIONS

- A. Section 31 23 33 – Trenching and Backfilling.
- B. Section 32 05 23 – Cement and Concrete for Exterior Improvements.
- C. Section 33 05 16 – Utility Structures.

1.03 RELATED DOCUMENTS

A. AASHTO:

- 1. M 252: Corrugated Polyethylene Drainage Tubing.
- 2. M 294: Corrugated Polyethylene Pipe, 12 to 24-inch Diameter.

B. ASTM:

- 1. A 615/A615M: Deformed and Billet-Steel Bars for Concrete Reinforcement.
- 2. A 674 Practice for Polyethylene Encasement for Ductile Iron Pipe for Water and Other Liquids.
- 3. C 443: Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
- 4. C 1173: Flexible Transition Couplings for Underground Piping Systems.
- 5. D 1785: Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
- 6. D 2235: Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
- 7. D 2321: Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications.
- 8. D 2564: Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
- 9. D 2751: Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.
- 10. D 3034: Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- 11. D 4101: Propylene Injection and Extrusion Materials.
- 12. F 477: Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
- 13. F 656: Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings.

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14. F 679: Poly(Vinyl Chloride) (PVC) Large Diameter Plastic Gravity Sewer Pipe and Fittings.
15. F-1336: Poly(Vinyl Chloride) (PVC) Gasket Sewer Fittings.

C. AWWA:

1. C104: Cement Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
2. C105: Polyethylene Encasement for Ductile-Iron Pipe Systems.
3. C110: Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. (76 mm Through 1,219 mm) for Water.
4. C111: Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
5. C150: Thickness design of Ductile Iron Pipe.
6. C151: Ductile-Iron Pipe, Centrifugally Cast, for Water.
7. C153: Ductile-Iron Compact Fittings for Water Service.
8. M41: Ductile Iron Pipe and Fittings.

D. Caltrans Standard Specifications.

1. Section 65, Reinforced Concrete Pipe.

E. California Building Code.

F. Section 1806A.11 – Pipes and Trenches.

G. California Plumbing Code.

1.04 DEFINITIONS

- A. AASHTO: American Association of State Highway and Transportation Officials.
- B. ABS: Acrylonitrile-butadiene-styrene.
- C. ASTM: American Society for Testing Materials.
- D. AWWA: American Water Works Association.
- E. HDPE: High-density polyethylene.
- F. PE: Polyethylene.
- G. DIP: Ductile iron pipe.
- H. PVC: Polyvinyl Chloride.
- I. RCP: Reinforced concrete pipe.
- J. NPS: Nominal pipe size.

1.05 SUBMITTALS

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- A. Follow submittal procedures outlined in Section 01 33 00 – Submittal Procedures.
- B. Product data for the following:
 - 1. Piping materials and fittings.
 - 2. Special pipe couplings.
 - 3. Joint sealants.
 - 4. Sewage air relief valves.
- C. Shop drawings: Include plans, elevations, details and attachments for the following:
 - 1. Force main piping access openings.
- D. Design Mix Reports and Calculations: For each class of cast-in-place concrete.
- E. Field Test Reports: Indicate and interpret test results for compliance with performance.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Do not store plastic pipe and fittings in direct sunlight.
- B. Protect pipe, fittings, and seals from dirt and damage.
- C. Handle precast concrete pipe and other precast structures according to manufacturer's written instructions.
- D. Protect imported bedding and backfill material from contamination by other materials.

2. PART 2 - PRODUCTS

2.01 PIPING MATERIALS FOR GRAVITY FLOW

- A. ABS Pipe and Fittings: 4-inch through 12 inch, ASTM D 2751, SDR 35. Bell and spigot joints.
 - 1. Bell and Spigot Joint Gasket: Elastomeric seal, ASTM F 477.
- B. DIP: Sizes 4-inch through 48-inch.
 - 1. Pipe: AWWA C150 and C151.
 - 2. Pressure Class: Minimum pressure class for size indicated.
 - 3. Fittings
 - (a) Standard: AWWA C110, sizes 4-inch through 48-inch.
 - (b) Compact: AWWA C153, sizes 4-inch through 24-inch.
 - 4. Pipe and Fitting Lining: Cement Mortar, AWWA C104.
 - 5. Pipe and Fitting Coating: Asphaltic, AWWA C151 or C115.

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6. Exterior Soil Corrosion Protection for Pipe and Fittings: Polyethylene encasement, AWWA C105.
7. Joints:
 - (a) Push-On Bell and Spigot Joint: AWWA C111.
 - (b) Mechanical Joint: AWWA C111.
 - (c) Flanged joint. AWWA C115.
- C. PE Pipe and Fittings (HDPE): 4-inch through 10-inch, AASHTO M252 Type S, smooth interior and corrugated exterior. Bell and spigot joints.
 1. Bell and Spigot Joint Gasket: Elastomeric seal, ASTM F 477.
 2. Couplings: AASHTO M 252, corrugated band type, engage a minimum of 4 corrugations, 2 on each side of pipe joint.
- D. PE Pipe and Fittings (HDPE): 12-inch through 48-inch, AASHTO M 294. Type S, smooth interior and corrugated exterior. Bell and spigot joints.
 1. Bell and Spigot Joint Gasket: Elastomeric seal, ASTM F 477.
 2. Couplings: AASHTO M 252, corrugated band type, engage a minimum of 4 corrugations, 2 on each side of pipe joint.
- E. PVC Pipe:
 1. Pipe:
 - (a) 4-inch through 15-inch: ASTM D 3034, SDR 35. Bell and spigot joints.
 - (b) 18 inch through 36-inch: ASTM F 679, T-1 wall. Bell and spigot joints.
 2. Fittings:
 - (a) 4-inch through 27-inch: ASTM F 1336.
 - (b) 30-inch through 36-inch: ASTM D 3034, SDR 35
 3. Joint Gasket: Elastomeric seal, ASTM F 477.
- F. Reinforced Concrete Pipe: Designated by Class, rubber gasketed joints, Type II or V cement.
 1. Circular Reinforced Concrete Pipe: Caltrans Standard Specification Section 65-1.02A(1). Class III.
 2. Oval shaped (Elliptical) Reinforced Concrete Pipe: Caltrans Standard Specification Section 65-1.02B. Class HE-III and VE-III.
 3. Rubber Gasketed Joints: Caltrans Standard Specification Section 65-1.06.

2.02 PIPING MATERIALS FOR FORCE MAINS

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- A. DIP: See Section 33 10 00 – Water Utilities.
- B. PE Pipe: See Section 33 10 00 – Water Utilities.
- C. PVC Pipe: See Section 33 10 00 – Water Utilities.

2.03 SPECIAL PIPE COUPLINGS

- A. Gravity Piping: ASTM C 1173. Rubber or elastomeric sleeve and band assembly fabricated to match outside diameters of pipes to be joined.
- B. Force Main piping: See Section 33 10 00 – Water Utilities.

2.04 MANHOLES AND CLEANOUTS

- A. See Section 33 05 16 – Utility Structures.

2.05 SEWAGE AIR RELIEF VALVE ASSEMBLY FOR FORCE MAINS

- A. General: As indicated.

2.06 THRUST BLOCKS FOR FORCE MAINS

- A. General: Location, configuration bearing area, etc. as indicated.
- B. Portland Cement Concrete: Section 32 05 23 – Cement and Concrete for Exterior Improvements.

3. PART 3 - EXECUTION

3.01 GRAVITY PIPE INSTALLATION

- A. General: Install pipe, fittings, and appurtenances utilizing best practices, manufacturer's instructions, and in accordance with Section 6 and 7 of ASTM D 2321 for plastic pipe, Caltrans Standard Specification Section 65-1.07 for reinforced concrete pipe and chapter 11.3.3 of AWWA M41 for ductile iron pipe.
- B. Pipe Depth and Trench Configuration: Conform to typical trench section(s) indicated.
- C. Excavation, Bedding, Backfill, and Compaction: Section 31 23 33 – Trenching and Backfilling.
- D. Handling: Carefully handle during loading, hauling, unloading and placing operations to avoid breakage or damage. Use strap type slings for lifting and placing; no chains or hooks will be permitted. Comply with the manufacturer's recommendations.
- E. Laying: Before lowering pipe into the trench, remove all stakes, debris, loose rock and other hard materials from the bottom of the trench. Lay accurately in conformance with lines and grades indicated. Start laying the pipeline at the low end and proceed upstream. Lay bell and spigot pipe with the bell end facing upstream. Lay pipe on a bed prepared by handwork, dug true to grade. Furnish firm bearing for pipe throughout it's entire length with bell holes provided at the ends of each pipe length of sufficient size to permit making up the particular type of joint being used. Adjust pipe to line and grade by scraping away or filling and tamping material under the body of the pipe for the entire pipe length and not by blocking or wedging. After final positioning, hold

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pipe in place in trench with backfill material placed equally on both sides of the pipe at as many locations as required to hold the pipe section in place.

- F. Curved Alignment: When necessary to conform to the alignment specifically indicated, lay pipe on a curved alignment by means of asymmetrical closure of joints or bending of the pipe barrel. Use shorter lengths of pipe than the standard length if necessary to achieve curvature specified. Do not exceed the recommendations of the pipe manufacture for deflections at the joints or pipe bending.
- G. Closure: Close open ends of pipes and appurtenance at the end of each days work or when work is not in progress.

3.02 FORCE MAIN PIPE INSTALLATION

- A. General: See Section 33 10 00 – Water Utilities.

3.03 SPECIAL PIPE COUPLINGS

- A. General: Use where required to join piping and no other appropriate method is specified. Do not use instead of specified joining methods.
- B. Installation: Per manufacturer's instructions.

3.04 AIR RELIEF VALVE ASSEMBLY INSTALLATION

- A. General: Install as indicated.

3.05 TESTING OF GRAVITY PIPING MAINS

- A. Obstructions: After backfilling and compacting, but before paving or other surface improvements, test sewer for obstructions either by rodding or by the sewer ball method. Provide for intercepting all grit, rocks and other flushed debris to keep debris from entering the existing system.
- B. At the option of the Contractor, either the following hydrostatic or air test shall be performed.
- C. Hydrostatic Test:
 - 1. Test after backfilling to finish grade or pavement structural section subgrade in paved areas.
 - 2. Test sewer mains between successive manholes by closing the lower end of the sewer main to be tested and the inlet sewer main of the upper manhole with stoppers.
 - 3. Fill pipe and manholes with water to a point four feet below the ground surface of the upper manhole, but in no case less than four feet above the pipe invert. If ground water is present, the water surface at the upper manhole shall be at least four feet above the level of the ground water.
 - 4. Fill piping at least one hour prior to testing.
 - 5. Test piping at least two hours by maintaining the head specified above with measured additions of water. The sum of these additions of water, in the two-hour test period, shall be the leakage amount.
 - 6. The maximum allowable head of water above any portion of sewer being tested shall be 15-feet. Where the difference in elevation between successive manholes exceeds 15-feet, a test

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tee shall be installed between manholes, and the testing shall be carried on between the tee and the manhole.

7. The allowable leakage shall not exceed 0.1-gallons per minute per inch diameter, per 1000-feet of sewer main being tested.
8. If the leakage exceeds the above amount, determine the cause and remedy it prior to retesting.
9. If the leakage is less than the allowable, but leaks are observed, repair the observed leaks.

D. Air Test:

1. Test after backfilling to finish grade or pavement structural section subgrade in paved areas.
2. Apply to each length between adjacent manholes.
3. Supply pressure gauge with minimum divisions of 0.10-psi and with an accuracy of +/- 0.04-psi. When requested by the Owner, provide certification that the gauge has been tested for accuracy within the last six months by a reliable testing firm.
4. Pressurize the test section to 3.5-psi, and then hold the pressure above 3.0-psi during a saturation period of at least 5 minutes. At the end of the saturation period, note the pressure, which must be a minimum of 3.0-psi, and begin the timed period. If the pressure drops 0.5-psi in less than the time given in the following table the section of pipe has not passed the test.

5. PipeSize	Minimum Time Allowed for Pressure to Drop 0.5-PSI
4"	125 seconds
6"	185 seconds
8"	245 seconds
10"	310 seconds
12"	370 seconds
15"	460 seconds
18"	555 seconds
21"	10 minutes
24"	12 minutes
27"	14 minutes
30"	16 minutes
36"	18 minutes
42"	20 minutes

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48"	23 minutes
54"	26 minutes

6. If the time for the pressure to drop 0.5-psi is 125% or less of the time indicated, the line shall immediately be re-pressurized to 3.0-psi and the test repeated. If, during the 5-minute saturation period, the pressure drops less than 0.5-psi after the initial pressurization and air is not added, the section undergoing the test shall have passed.
7. If the test did not pass, find and repair the leak to the satisfaction of the Owner.
8. When the prevailing ground water is above the line being tested the air pressure shall be increased 0.43-psi for each foot the water table is above the invert of the pipe at the highest manhole.

3.06 TESTING OF LATERALS

A. At the option of the Contractor, either the following hydrostatic or air test shall be performed.

B. Hydrostatic Test:

1. Test laterals before backfilling.
2. Plug lateral at its ends and fill with water through the cleanouts.
3. Maintain the water level in the cleanouts as high as possible throughout the test period.
4. One hour after filling with water, examine the lateral for leakage.
5. Repair all leaks to the satisfaction of the Owner.
6. Do not backfill the trench until testing and repairs of the lateral are complete, and approved by the Owner.
7. Following approval of the Owner, remove all plugs, dispose of the water and complete the connection to the main.

C. Air Test

1. Test after backfilling to finish grade or pavement structural section subgrade in paved areas.
2. Test in accordance with subsection above titled "Testing of Gravity Piping Mains," paragraph titled "Air Test."

3.07 HYDROSTATIC AND LEAKAGE TESTING OF FORCE MAINS

A. General: Perform hydrostatic and leakage test in accordance with Section 33 10 00 – Water Utilities.

END OF SECTION 333000

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SECTION 334000 - STORM DRAINAGE UTILITIES

1. PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Roadway and/or site storm drainage up to 5-feet of any on-site building.

1.02 RELATED SECTIONS

- A. Section 31 23 33 – Trenching and Backfilling.

1.03 RELATED DOCUMENTS

A. AASHTO:

- 1. M 252: Corrugated Polyethylene Drainage Tubing.
- 2. M 294: Corrugated Polyethylene Pipe, 12 to 24-inch Diameter.

B. ASTM:

- 1. A 74: Cast Iron Soil Pipe and Fittings.
- 2. A 615/A615M: Deformed and Billet-Steel Bars for Concrete Reinforcement.
- 3. C 443: Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
- 4. C 564: Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
- 5. C 1173: Flexible Transition Couplings for Underground Piping Systems.
- 6. D 1785: Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
- 7. D 2235: Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and fittings.
- 8. D 2321: Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications.
- 9. D 2564: Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
- 10. D 2751: Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.
- 11. D 3034: Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- 12. D 4101: Specifications for Propylene Injection and Extrusion Materials.
- 13. F 477: Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
- 14. F 656: Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
- 15. F 679: Specification for Poly(Vinyl Chloride) (PVC) Large Diameter Plastic Gravity Sewer Pipe and Fittings.

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16. F-1336: Poly(Vinyl Chloride) (PVC) Gasket Sewer Fittings.

C. AWWA:

1. C104: Cement Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
2. C105: Polyethylene Encasement for Ductile-Iron Pipe Systems.
3. C110: Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. (76 mm Through 1,219 mm) for Water.
4. C111: Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
5. C150: Thickness design of Ductile Iron Pipe.
6. C151: Ductile-Iron Pipe, Centrifugally Cast, for Water.
7. C153: Ductile-Iron Compact Fittings for Water Service.
8. M41: Ductile Iron Pipe and Fittings.

D. Caltrans Standard Specifications:

1. Section 65, Reinforced Concrete Pipe.
2. Section 66, Corrugated Metal Pipe.
3. Section 70. Miscellaneous Facilities.
4. Section 72, Slope Protection.

E. Caltrans Standard Plans:

1. Plan D94A: Metal and Plastic Flared End Sections.
2. Plan D94B: Concrete Flared End Sections.
3. Plan D97A: Corrugated Metal Pipe Coupling Details No. 1, Annular Coupling Band Bar and Strap and Angle Connection.
4. Plan D97B: Corrugated Metal Pipe Coupling Details No. 2, Hat Band Coupler and Flange Details.
5. Plan D97C: Corrugated Metal Pipe Coupling Details No. 3, Helical and Universal Couplers.
6. Plan D97D: Corrugated Metal Pipe Coupling Details No. 4, Hugger Coupling Bands.
7. Plan D97E: Corrugated Metal Pipe Coupling Details No. 5, Standard Joint.
8. Plan D97F: Corrugated Metal Pipe Coupling Details No. 6, Positive Joint.
9. Plan D97G: Corrugated Metal Pipe Coupling Details No. 7, Positive Joints and Downdrains.
10. Plan D98A: Slotted Corrugated Steel Pipe Drain Details.
11. Plan D98B: Slotted Corrugated Steel Pipe Drain Details.

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- F. California Building Code:
- G. Section 1806A.11 – Pipes and Trenches.
- H. Section 1133B.7.2 – Gratings.
- I. California Plumbing Code.

1.04 DEFINITIONS

- A. AASHTO: American Association of State Highway and Transportation Officials.
- B. ABS: Acrylonitrile-butadiene-styrene.
- C. ASTM: American Society for Testing Materials.
- D. AWWA: American Water Works Association.
- E. CMP: Corrugated metal pipe.
- F. DIP: Ductile iron pipe.
- G. HDPE: High-density polyethylene.
- H. NPS: Nominal pipe size.
- I. PE: Polyethylene.
- J. PVC: Polyvinyl chloride.
- K. RCP: Reinforced concrete pipe.

1.05 SUBMITTALS

- A. Follow submittal procedures outlined in Section 01 33 00 – Submittal Procedures.
- B. Product Data Shop Drawings, Etc.: For the following:
 - 1. Piping materials and fittings.
 - 2. Special pipe couplings.
 - 3. Polymer-concrete, channel drainage systems (trench drains).
 - 4. Joint sealants.
 - 5. Plastic area drains.
 - 6. Precast concrete catch basins, inlets, curb inlets, and area drains, including frames and grates.
 - 7. Concrete, metal and plastic flared end sections.
- C. Design Mix Reports and Calculations: For each class of cast in place concrete.
- D. Field Test Reports: Indicate and interpret test results for compliance with performance.

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1.06 DELIVERY, STORAGE AND HANDLING

- A. Do not store plastic structures, pipe and fittings in direct sunlight.
- B. Protect pipe, fittings, and seals from dirt and damage.
- C. Handle precast concrete pipe and other precast structures according to manufacturer's written instructions.
- D. Protect imported bedding and backfill material from contamination by other materials.

2. PART 2 - PRODUCTS

2.01 PIPING MATERIALS

- A. ABS Pipe and Fittings: Smaller than 4-inch, ASTM D 2751, SDR 35. Solvent cement joints.
 - 1. Solvent Cement: ASTM D 2235.
- B. ABS Pipe and Fittings: 4-inch through 12 inch, ASTM D 2751, SDR 35. Bell and spigot joints.
 - 1. Bell and Spigot Joint Gasket: Elastomeric seal, ASTM F 477.
- C. Cast Iron Pipe and Fittings: Hub and spigot, 2-inch through 15-inch, ASTM A74, service class.
 - 1. Gaskets: ASTM 564, rubber, compression type, thickness to match class of pipe.
- D. Corrugated Metal Pipe and Fittings: Caltrans Standard Specification Section 66.
 - 1. Bituminous Coating: Caltrans Standard Specification Section 66-1.03.
 - 2. Bituminous Lining: Caltrans Standard Specification Section 66-1.03.
 - 3. Bituminous Pavings: Caltrans Standard Specification Section 66-1.03.
 - 4. Corrugated Aluminum Pipe: Caltrans Standard Specification Section 66-2.
 - 5. Corrugated Steel Pipe: Caltrans Standard Specification Section 66-3.
 - 6. Slotted Corrugated Steel Pipe: Caltrans Standard Specification Section 66-3.09.
 - 7. Details: Caltrans Standard Plans D97A, D97B, D97C, D97D, D97E, D97F, D97G, D98A and D98B.
- E. DIP: Sizes 4-inch through 48-inch.
 - 1. Pipe: AWWA C150 and C151.
 - 2. Pressure Class: Minimum pressure class for size indicated.
 - 3. Fittings:
 - (a) Standard: AWWA C110, sizes 4-inch through 48-inch.

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- (b) Compact: AWWA C153, sizes 4-inch through 24-inch.
- 4. Pipe and Fitting Lining: Cement Mortar, AWWA C104.
- 5. Pipe and Fitting Coating: Asphaltic, AWWA C151 or C115.
- 6. Exterior Soil Corrosion Protection for Pipe and Fittings: Polyethylene encasement, AWWA C105.
- 7. Joints:
 - (a) Push-On Bell and Spigot Joint: AWWA C111.
 - (b) Mechanical Joint: AWWA C111.
 - (c) Flanged joint. AWWA C115.
- F. Reinforced Concrete Pipe: Designated by Class, rubber gasketed joints.
 - 1. Circular Reinforced Concrete Pipe: Caltrans Standard Specification Section 65-1.02A(1). Class III.
 - 2. Oval shaped (Elliptical) Reinforced Concrete Pipe: Caltrans Standard Specification Section 65-1.02B. Class HE-III and VE-III.
 - 3. Reinforced Concrete Pipe Arch: Caltrans Standard Specification Section 65-1.02C.
 - 4. Rubber Gasketed Joints: Caltrans Standard Specification Section 65-1.06.
- G. PE Pipe and Fittings: 4-inch through 10-inch, AASHTO M 252 Type S, smooth interior and corrugated exterior. Bell and spigot joints.
 - 1. Bell and Spigot Joint Gasket: Elastomeric seal, ASTM F 477.
 - 2. Couplings: AASHTO M 252, corrugated band type. Engage a minimum of 4 corrugations, 2 on each side of pipe joint.
- H. PE Pipe and Fittings: 12-inch through 48-inch, AASHTO M 294. Type S, smooth interior and corrugated exterior. Bell and spigot joints.
 - 1. Bell and Spigot Joint Gasket: Elastomeric seal, ASTM F 477.
 - 2. Couplings: AASHTO M 252, corrugated band type. Engage a minimum of 4 corrugations, 2 on each side of pipe joint.
- I. PVC Pipe and Fittings-Smaller than 4-Inch: ASTM D1785, Schedule 40.
 - 1. Joints: Solvent Cement, ASTM D 2564. Include primer according to ASTM F656.
- J. PVC Pipe and Fittings, 4-Inch and Larger
 - 1. Pipe:
 - (a) 4-inch through 15-inch: ASTM D 3034, SDR 35. Bell and spigot joints.

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(b) 18 inch through 36-inch: ASTM F 679, T-1 wall. Bell and spigot joints.

2. Fittings:

(a) 4-inch through 27-inch: ASTM F 1336.

(b) 30-inch through 36-inch: ASTM D 3034, SDR 35

3. Joint Gasket: Elastomeric seal, ASTM F 477.

2.02 PIPE ANCHORS

A. Section 32 05 23 – Cement and Concrete for Exterior Improvements.

2.03 SPECIAL PIPE COUPLINGS

A. Plastic, Cast Iron and Ductile Iron Pipe: ASTM C 1173, rubber or elastomeric sleeve and band assembly fabricated to match outside diameters of pipes to be joined.

B. Reinforced Concrete Pipe: Portland cement concrete collar as indicated.

2.04 CURB INLETS, CATCH BASINS, DROP INLETS, AREA DRAINS, ETC.

A. General: Size, shape, configuration, depth, etc. of structure and frame, grate, or cover shall be as indicated.

B. Precast Structure: Rate for AASHTO H20 loading in paved areas.

C. Steps: ASTM C 478 or AASHTO M 199. Manufacture from deformed, ½-inch steel reinforcement rod complying with ASTM A 615 and encased in polypropylene complying with ASTM D4101. Include pattern designed to prevent lateral slippage off step. Acceptable manufacturer is Hanson Concrete Products, (Milpitas, CA) (Tel 408-262-1091).

D. Frames, Grates and Covers: Caltrans Standard Specification Section 75-1.02, 75-1.03 and 75-1.05.

1. Galvanize steel frames, grates and covers.

2. Grates and covers shall be non-rocking, bolt-down type.

3. Rate for AASHTO H20 loading in paved areas.

2.05 METAL, CONCRETE OR PLASTIC FLARED END SECTIONS

A. General: Caltrans Standard Specification Section 70-1.02C and Caltrans Standard Plan D94A and D94B.

2.06 SLOPE PROTECTION

A. Rock Slope Protection: Caltrans Standard Specification Section 72-2.02.

1. Fabric: Caltrans Standard Specification Section 72-2.025.

B. Concrete/Shotcrete Slope Protection: Caltrans Standard Specification Section 72-4.03.

1. Bar Reinforcement: Caltrans Standard Specification Section 52-1.02A, minimum Grade 40.

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2. Welded Wire Fabric: Caltrans Standard Specification Section 52-1.02C. Use 6 x 6-W1.4 xW1.4 unless otherwise indicated.
- C. Concreted-Rock Slope Protection: Caltrans Standard Specification Section 72-5.02.
- D. Sacked Concrete Slope Protection.
1. Concrete: Caltrans Standard Specification Section 90, Class 3.
 2. Sacks: 10 ounce burlap measuring approximately 19.5-inches by 36 inches when empty and laid flat.

2.07 CONCRETE/SHOTCRETE DITCH LINING

- A. General: Caltrans Standard Specification Section 72-4.03.
1. Bar Reinforcement: Caltrans Standard Specification Section 52-1.02A, minimum Grade 40.
 2. Welded Wire Fabric: Caltrans Standard Specification Section 52-1.02C. Use 6 x 6-W1.4 xW1.4 unless otherwise indicated.

3. PART 3 - EXECUTION

3.01 PIPE INSTALLATION

- A. General: Install pipe, fittings, and appurtenances utilizing best practices, manufacturer's instructions, and in accordance with Section 6 and 7 of ASTM D 2321 for plastic pipe, Caltrans Standard Specification Section 65-1.07 for reinforced concrete pipe, Caltrans Standard Specification Sections 66-1.045 and 66-105 for corrugated metal pipe and chapter 11.3.3 of AWWA M41 for cast iron and ductile iron pipe.
- B. Pipe Depth and Trench Configuration: Conform to typical trench section(s) indicated.
- C. Excavation, Bedding, Backfill, and Compaction: Section 31 23 33 – Trenching and Backfilling.
- D. Handling: Carefully handle during loading, hauling, unloading and placing operations to avoid breakage or damage. Use strap type slings for lifting and placing; no chains or hooks will be permitted. Comply with manufacturer's recommendations.
- E. Laying: Before lowering pipe into the trench, remove all stakes, debris, loose rock and other hard materials from the bottom of the trench. Lay accurately in conformance with lines and grades indicated. Start laying the pipeline at the low end and proceed upstream. Lay bell and spigot pipe with the bell end facing upstream. Lay pipe on a bed prepared by handwork, dug true to grade. Furnish firm bearing for pipe throughout it's entire length with bell holes provided at the ends of each pipe length of sufficient size to permit making up the particular type of joint being used. Adjust pipe to line and grade by scraping away or filling and tamping material under the body of the pipe for the entire pipe length and not by blocking or wedging. After final positioning, hold pipe in place in trench with backfill material placed equally on both sides of the pipe at as many locations as required to hold the pipe section in place.
- F. Curved Alignment: When necessary to conform to the alignment specifically indicated, lay pipe on a curved alignment by means of asymmetrical closure of joints or bending of the pipe barrel. Use

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shorter lengths of pipe than the standard length if necessary to achieve curvature specified. Do not exceed the recommendations of the pipe manufacture for deflections at the joints or pipe bending.

- G. Closure: Close open ends of pipes and appurtenance openings at the end of each days work or when work is not in progress.

3.02 INSTALLATION OF PIPE ANCHORS

- A. Install at location, configuration and details shown on the Plans.

3.03 SPECIAL PIPE COUPLINGS

- A. General: Use where required to join piping and no other appropriate method is specified. Do not use instead of specified joining methods.
- B. Installation: Per manufacturer's instructions.

3.04 INSTALLATION OF CURB INLETS, CATCH BASINS, DROP INLETS, AREA DRAINS, ETC.

- A. Excavation, Bedding, Backfill, and Compaction: Section 31 23 33 – Trenching and Backfilling.
- B. Poured in Place Structures: Install as indicated and Caltrans Standard Specification Section 51.
 - 1. Shape bottoms to convey flows as indicated.
- C. Precast Structures: Install as indicated.
 - 1. Seal all joints and pipe entrances and exits.
 - 2. Place concrete in bottom and shape to convey flows as indicated.

3.05 POLYMER-CONCRETE TRENCH DRAIN INSTALLATION

- A. Excavation, Bedding, Backfill, and Compaction: Section 31 23 33 – Trenching and Backfilling.
- B. Install: As indicated and in accordance with the manufacturer's instructions.

3.06 CONCRETE OR PLASTIC FLARED END SECTION INSTALLATION

- A. Install: As indicated.

3.07 SLOPE PROTECTION PLACEMENT

- A. Rock Slope Protection: Caltrans Standard Specification Section 72-2.03 and as indicated.
 - 1. Use Method B Placement unless otherwise indicated.
- B. Concrete/Shotcrete Slope Protection: Caltrans Standard Specification Section 72-4.02 and 72-4.04.
- C. Concreted-Rock Slope Protection: Caltrans Standard Specification Section 72-5.03 and 72-5.04.
 - 1. Use Method B Placement unless otherwise indicated.
- D. Sacked Concrete Slope Protection.
 - 1. Detailed configuration: As indicated.

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2. Use one cubic foot of concrete per sack.
3. Locate headers and stretchers as indicated.
4. Headers: Folded end to bank.
5. Stretchers: Folded ends are not to be adjacent.
6. Place no more than four vertical courses until initial set has taken place in first course.

3.08 CONCRETE/SHOTCRETE DITCH LINING PLACEMENT

- A. Concrete/Shotcrete Slope Protection: Caltrans Standard Specification Section 72-4.02 and 72-4.04.

3.09 TESTING

- A. General: Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
1. Do not enclose, cover, or put into service before inspection and approval.
 2. Test completed piping systems according to authorities having jurisdiction.
 3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours advance notice.
 4. Submit separate reports for each test.
 5. Where authorities having jurisdiction do not have published procedures, perform tests in accordance with latest edition of the Uniform Plumbing Code (UPC) Section 1109.0, Testing.
 6. Leaks and loss in test pressure constitute defects that must be repaired.
 7. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

END OF SECTION 334000

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SECTION 334600 - SUBDRAINAGE

1. PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Subdrains in trenches and subdrains or prefabricated composite drainage panels at walls or foundations.
- B. Bioretention in parking lot areas.

1.02 RELATED SECTIONS

- A. Section 31 23 33 – Trenching and Backfilling.
- B. Section 33 05 16 – Utility Structures.
- C. Section 33 40 00 – Storm Drainage Utilities.

1.03 RELATED DOCUMENTS

A. AASHTO:

- 1. M 252: Corrugated Polyethylene Drainage Tubing.
- 2. M 278: Class PS 50 Polyvinyl Chloride (PVC) Pipe.
- 3. M 288: Geotextiles Used for Subsurface Drainage Purposes.
- 4. M 294: Corrugated Polyethylene Pipe, 12- to 24-in. Diameter.

B. ASTM:

- 1. C 1173: Specifications for Flexible Transition Couplings for Underground Piping System.
- 2. D 448: Classification for Sizes of Aggregate for Road and Bridge Construction.
- 3. D 1621: Test Method for Compressive Properties of Rigid Cellular Plastics.
- 4. D 1785: Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
- 5. D 2235: Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and fittings.
- 6. D 2321: Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
- 7. D 2564: Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
- 8. D 2729: Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- 9. D 2751: Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.
- 10. D 3034: Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- 11. D 4716: Test Method for Constant Head Hydraulic Transmissivity (in-Plane Flow) of

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Geotextiles and Geotextile Related Products.

12. F 477: Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
 13. F 656: Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
 14. F-1336: Poly(Vinyl Chloride) (PVC) Gasket Sewer Fittings.
- C. Caltrans Standard Specifications:
1. Section 68-Subsurface Drains
 2. Section 88-Engineering Fabrics

1.04 DEFINITIONS

- A. AASHTO: American Association of State Highway and Transportation Officials.
- B. ABS: Acrylonitrile-Butadiene-Styrene.
- C. AWWA: American Water Works Association.
- D. ABS: Acrylonitrile-butadiene-styrene.
- E. HDPE: High-density polyethylene.
- F. PE: Polyethylene.
- G. PVC: Polyvinyl Chloride.

1.05 SUBMITTALS

- A. Follow submittal procedures outlined in Section 01 33 00 – Submittal Procedures.
- B. Product data for the following:
 1. Perforated pipe and fittings.
 2. Solid pipe and fittings.
 3. Prefabricated composite drainage panels.
 4. Geotextile fabrics.
- C. Samples:
 1. Drainage Fill.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Do not store plastic structures, pipe, and fittings in direct sunlight.
- B. Protect pipe, pipe-fittings, and seals from dirt and damage.
- C. Protect permeable material from contamination by other materials.

2. PART 2 - PRODUCTS

2.01 PERFORATED WALL AND SOLID WALL PIPE

- A. ABS Pipe and Fittings: Smaller than 4-inch, ASTM D 2751, SDR 35. Solvent cement joints.
 - 1. Solvent Cement: ASTM D 2235.
 - 2. Perforation Size, Location, and Spacing: ASTM D 2729.
- B. ABS Pipe and Fittings: 4-inch through 12-inch, ASTM D 2751, SDR 35. Bell and spigot joints.
 - 1. Bell and Spigot Joint Gasket: Elastomeric seal, ASTM F 477.
 - 2. Perforation Size, Location, and Spacing: ASTM D 2729.
- C. PE Pipe and Fittings (HDPE): 4-inch through 10-inch, AASHTO M252 Type S (Solid wall.) or SP (Perforated wall.), smooth interior and corrugated exterior. Bell and spigot joints.
 - 1. Bell and Spigot Joint Gasket: Elastomeric seal, ASTM F 477.
 - 2. Couplings: AASHTO M 252, corrugated band type. Engage a minimum of 4 corrugations, 2 on each side of pipe joint.
 - 3. Perforation Size, Location, and Spacing: AASHTO M 252, Class 2.
- D. PE Pipe and Fittings (HDPE): 12-inch through 48-inch, AASHTO M 294. Type S (Solid Wall.) or Type SP (Perforated wall.), smooth interior and corrugated exterior. Bell and spigot joints.
 - 1. Bell and Spigot Joint Gasket: Elastomeric seal, ASTM F 477.
 - 2. Couplings: AASHTO M 252, corrugated band type. Engage a minimum of 4 corrugations, 2 on each side of pipe joint.
 - 3. Perforation Size, Location, and Spacing: AASHTO M 294, Class 2.
- E. PVC pipe and Fittings: Smaller than 4-inch, ASTM D1785, Schedule 40. Solvent cement joints.
 - 1. Solvent Cement: ASTM D 2564. Include primer according to ASTM F656.
 - 2. Perforation Size, Location, and Spacing: ASTM D 2729.
- F. PVC Pipe and Fittings:
 - 1. Pipe: 4-inch through 15-inch, ASTM D 3034, SDR 35. Bell and spigot joints.
 - 2. Perforation Size, Location, and Spacing: ASTM D 2729.
 - 3. Fittings: ASTM F 1336.
 - 4. Joint Gasket: Elastomeric seal, ASTM F 477.

2.02 SPECIAL PIPE COUPLINGS

- A. Description: ASTM C 1173. Rubber or elastomeric sleeve and band assembly fabricated to match

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outside diameters of pipes to be joined.

2.03 CLEANOUTS

- A. See 33 05 16 – Utility Structures.

2.04 PREFABRICATED COMPOSITE DRAINAGE PANELS

- A. Description: Prefabricated composite panels, 36 to 60-inches wide and manufactured with geotextile facing laminated to molded drainage core.
- B. Drainage Core: Three-dimensional, non-biodegradable, molded Polypropylene or Polystyrene.
1. Minimum Compressive Strength: 10,000-lbf./sq. ft. when tested according to ASTM D 1621.
 2. Minimum Flow Rate: 7 gpm per foot at hydraulic gradient of 0.1 and compressive stress of 25 psig when tested according to ASTM D 4716.
- C. Geotextile: Non-woven needle-punched geotextile, manufactured for subsurface drainage, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with the following properties determined according to AASHTO M 288.
1. Survivability Class: 2.
 2. Apparent Opening Size: No. 60 sieve maximum.
 3. Permittivity: 0.2 per second, minimum.
- D. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Project include, but are not limited to, the following:
1. American Wick Drain Corporation (Matthews, NC).
 2. Mirafi Inc. (Charlotte, NC) (Tel. 800-438-1855).
 3. Multi-Flow (Prinsburg, MN) (Tel. 800978-8007).
 4. Phillips Fibers Corporation (Greenville, SC) (Tel. 800-845-5737).

2.05 DRAINAGE FILL MATERIAL

- A. Caltrans Permeable Material: Conform to Section 68-1.025 of Caltrans Standard Specifications.
1. Class 2
- B. Washed, evenly graded mixture of crushed stone, or crushed or uncrushed gravel, ASTM D 448, coarse aggregate, Sieve No. 57, with 100 percent passing 1-1/2-inch sieve and not more than 5 percent passing No. 8 sieve.
- C. Sand: Conform to Section 19-3.025B of Caltrans Standard Specifications.

2.06 FILTER FABRIC

- A. When required, use filter fabric for encasing permeable material around subdrains.

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1. Caltrans Filter Fabric: Section 88-1.03 of Caltrans Standard Specifications.
2. Mirafi 140N (Mirafi Inc., Charlotte, NC) (Tel. 800-438-1855) or equal.

3. PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine surfaces and areas for suitable conditions where subdrainage systems are to be installed.
- B. Install only after unsatisfactory conditions have been corrected.

3.02 PIPING APPLICATIONS

- A. Refer to Plans for location, size, and material designation for individual subdrains.

3.03 INSTALLATION OF PERFORATED PORTIONS OF SUBDRAINS

- A. Excavation: Section 6 of ASTM D 2321 and as indicated.
- B. Subdrain Bedding: Place supporting layer of drainage fill over compacted subgrade to compacted depth indicated. If drainage fill requires encasement in filter fabric, lay filter fabric in trench and overlap trench sides before installing drainage fill.
- C. Piping Installation: Install pipe in accordance with Section 7 of ASTM D 2321. Install piping beginning at low point of system, true to grades and alignment indicated, with unbroken continuity of invert. Excavate recesses for bottoms of bell ends of pipe. Lay pipe with bells facing upslope and with spigot end centered fully into adjacent bell. Bed piping with full pipe bearing in drainage fill material. Lay perforated pipe with perforations down. Install gaskets, seals, sleeves, and couplings in accordance with manufacturers written instructions. Use increasers, reducers, and couplings made for different sizes of materials of pipes and fittings being connected. Reduction of pipe size in direction of flow is prohibited.
- D. Initial Subdrain Backfill: After installing drainage piping, add drainage fill up to top of pipe to perform tests.
- E. Testing Subdrain: After installing drainage fill to top of pipe, test drain piping with water to ensure free flow before backfilling with drainage fill. Remove obstructions, replace damaged components, and repeat test until results are satisfactory.
- F. Subsequent Subdrain Backfill: After satisfactory testing, cover piping with drainage fill to width and height indicated. Place drainage fill in layers not exceeding 3 inches in loose depth; compact each layer placed. If filter fabric is required complete the filter fabric encasement by bringing fabric to top and closing the encasement.
- G. Fill to Grade: Place native fill material over compacted drainage fill to thickness indicated. Place material in loose-depth layers not exceeding 6 inches. Thoroughly compact each layer. Fill to finish elevations unless otherwise specified on the plans.

3.04 INSTALLATION OF NON-PERFORATED PORTIONS OF SUBDRAINS

- A. Conform to Section 31 23 33 – Trenching and Backfilling, and Section 33 46 00 – Storm Drainage

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3.05 PREFABRICATED COMPOSITE DRAINAGE PANELS

- A. Coordinate placement with other drainage materials.
- B. Install prefabricated drainage panels in accordance with manufacturer's instructions.
- C. Place perforated drainage pipe at base of footing and attach to composite drainage panels in accordance with the manufacturer's instructions.

3.06 JOINING PIPE

- A. Join ABS and PVC pipe and fittings with elastomeric seals according to ASTM D 2321 or solvent cement.
- B. Special pipe couplings: Join piping made of different materials and dimensions with special couplings made for this application. Use couplings that are compatible with and that fit both pipe materials and dimensions.

3.07 CLEANING

- A. Clear interior of installed piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe at end of each day or when work stops.

END OF SECTION 334600