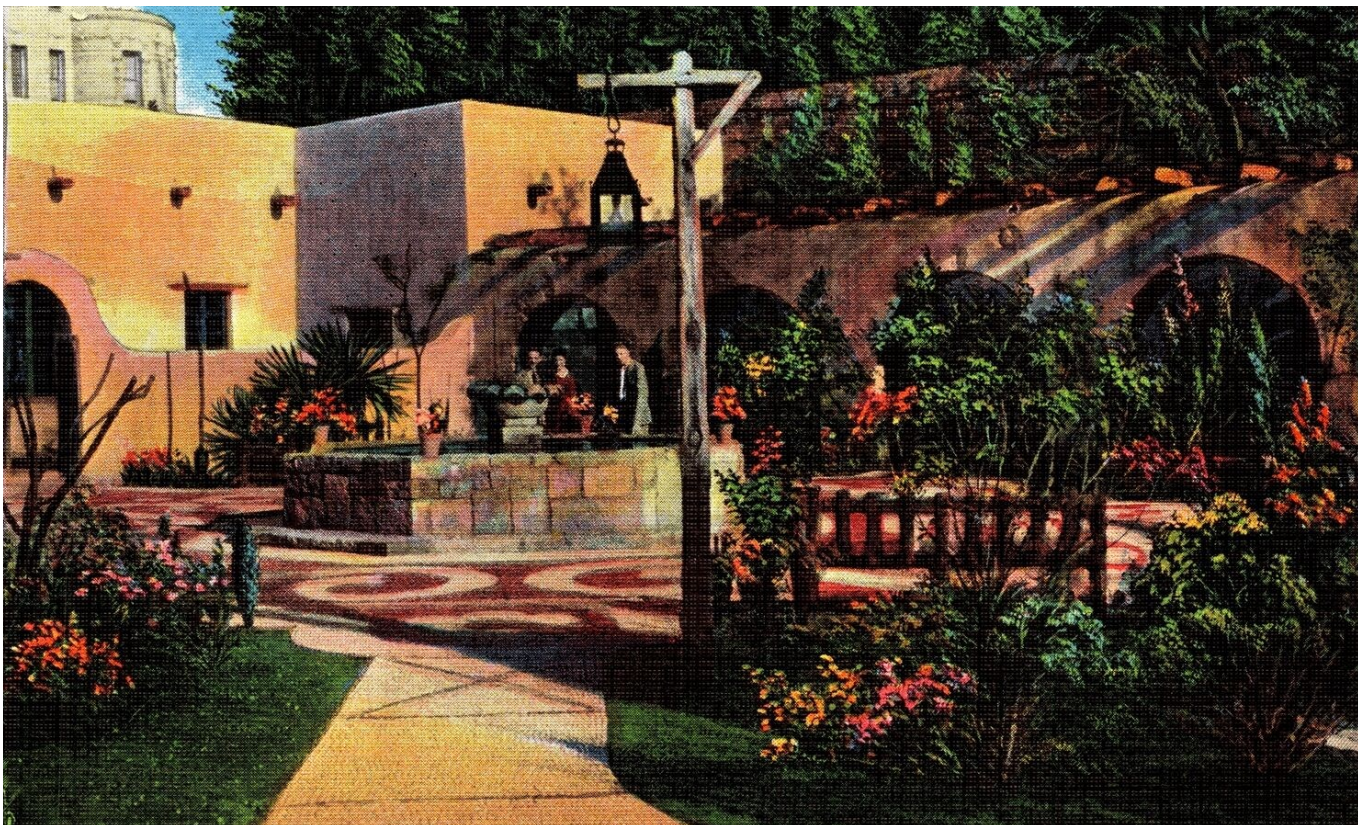
CITY OF SAN ANTONIO



SPANISH GOVERNOR'S PALACE

2022 BOND

ARCHITECT PROJECT NO. 2228 A1

APRIL, 2026

90% CD PROJECT MANUAL

ARCHITECT: Fisher Heck Inc., Architects

CIVIL ENGINEER: Bain Medina Bain, Inc.

STRUCTURAL ENGINEER: Lundy &Franke Engineering, Inc.

LANDSCAPE ARCHITECT: MP Studio

MEP ENGINEER: CNG Engineering, PLLC

Fisher Heck
ARCHITECTS
915 S. St. Mary's Street San Antonio, Texas 78205
el 210.299.1500 fax 210.299.1622 www.FisherHeck.com

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SECTION 000102
PROJECT INFORMATION

PART 1 GENERAL

1.01 PROJECT IDENTIFICATION

A. Architect's Project Number: 2228 A1.

B. The Owner, hereinafter referred to as Owner: City of San Antonio

1.02 PROJECT DESCRIPTION

A. Summary Project Description: Restoration of Nationally Registerred Historic Building involving the demolition of 1930's pathways and concrete patio, with reconstruction of new pathways on concrete slab, new electrical panels, new landscaping, new concrete slab patio, and new lighting throughout courtyard. _____.

1.03 PROCUREMENT TIMETABLE

A. The Owner reserves the right to change the schedule or terminate the entire procurement process at any time.

1.04 PROCUREMENT DOCUMENTS

A. Availability of Documents: Complete sets of procurement documents may be obtained:
   1. From Owner at the Project Manager's address listed above.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 000102

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SECTION 000107
SEALS PAGE

END OF SECTION 000107

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2.40 DIVISION 49 -- RESERVED (NOT USED)

END OF SECTION 000110

SECTION 012000
PRICE AND PAYMENT PROCEDURES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Procedures for preparation and submittal of applications for progress payments.

1.02 SCHEDULE OF VALUES

A. Electronic media printout including equivalent information will be considered in lieu of standard form specified; submit draft to Architect for approval.

B. Forms filled out by hand will not be accepted.

1.03 APPLICATIONS FOR PROGRESS PAYMENTS

A. Payment Period: Submit at intervals stipulated in the Agreement.

B. Electronic media printout including equivalent information will be considered in lieu of standard form specified; submit sample to Architect for approval.

C. Forms filled out by hand will not be accepted.

D. Execute certification by signature of authorized officer.

E. Submit one electronic and three hard-copies of each Application for Payment.

END OF SECTION 012000

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SECTION 012100
ALLOWANCES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Cash allowances.

B. Contingency allowance.

C. Inspecting and testing allowances.

D. Payment and modification procedures relating to allowances.

1.02 RELATED REQUIREMENTS

A. Section 012000 - Price and Payment Procedures: Additional payment and modification procedures.

1.03 CASH ALLOWANCES

A. Costs Included in Cash Allowances: Cost of product to Contractor or subcontractor, less applicable trade discounts, less cost of delivery to site , less applicable taxes .

1.04 CONTINGENCY ALLOWANCE

A. Contractor's costs for products, delivery, installation, labor, insurance, payroll, taxes, bonding, equipment rental, overhead and profit will be included in Change Orders authorizing expenditure of funds from this Contingency Allowance.

B. Funds will be drawn from the Contingency Allowance only by Change Order.

C. At closeout of Contract, funds remaining in Contingency Allowance will be credited to Owner by Change Order.

1.05 INSPECTING AND TESTING ALLOWANCES

A. Costs Included in Inspecting and Testing Allowances: Cost of engaging an inspecting or testing agency; execution of inspecting and tests; and reporting results.

B. Costs Not Included in the Inspecting and Testing Allowances:
   1. Costs of incidental labor and facilities required to assist inspecting or testing agency.
   2. Costs of testing services used by Contractor separate from Contract Document requirements.

1.06 ALLOWANCES SCHEDULE

A. Inspecting and Testing Allowance: Include the sum of $20,000 for payment of inspecting services specified in Section 014000 - Quality Requirements.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 012100

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SECTION 012500
SUBSTITUTION PROCEDURES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Procedural requirements for proposed substitutions.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

A. A Substitution Request for products, assemblies, materials, and equipment constitutes a representation that the submitter:
   1. Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product, equipment, assembly, or system.
   2. Agrees to provide the same warranty for the substitution as for the specified product.
   3. Agrees to coordinate installation and make changes to other work that may be required for the work to be complete, with no additional cost to Owner.
   4. Waives claims for additional costs or time extension that may subsequently become apparent.

B. Document each request with complete data substantiating compliance of proposed substitution with Contract Documents. Burden of proof is on proposer.

C. Content: Include information necessary for tracking the status of each Substitution Request, and information necessary to provide an actionable response.

D. Limit each request to a single proposed substitution item.

3.02 RESOLUTION

A. Architect may request additional information and documentation prior to rendering a decision. Provide this data in an expeditious manner.

B. Architect will notify Contractor in writing of decision to accept or reject request.
   1. Architect's decision following review of proposed substitution will be noted on the submitted form.

3.03 ACCEPTANCE

A. Accepted substitutions change the work of the Project. They will be documented and incorporated into work of the project by Change Order, Construction Change Directive, Architectural Supplementary Instructions, or similar instruments provided for in the Conditions of the Contract.

END OF SECTION 012500

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SECTION 013000
ADMINISTRATIVE REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. General administrative requirements.

B. Electronic document submittal service.

C. Progress photographs.

D. Number of copies of submittals.

E. Requests for Interpretation (RFI) procedures.

F. Submittal procedures.

1.02 GENERAL ADMINISTRATIVE REQUIREMENTS

A. Comply with requirements of Section 017000 - Execution and Closeout Requirements for coordination of execution of administrative tasks with timing of construction activities.

B. Make the following types of submittals to Architect:
   1. Requests for Interpretation (RFI).
   2. Requests for substitution.
   3. Shop drawings, product data, and samples.
   4. Test and inspection reports.
   5. Design data.
   6. Manufacturer's instructions and field reports.
   7. Applications for payment and change order requests.
   8. Progress schedules.
   9. Coordination drawings.
   10. Correction Punch List and Final Correction Punch List for Substantial Completion.
   11. Closeout submittals.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 ELECTRONIC DOCUMENT SUBMITTAL SERVICE

A. All documents transmitted for purposes of administration of the contract are to be in electronic (PDF, MS Word, or MS Excel) format, as appropriate to the document, and transmitted via an Internet-based submittal service that receives, logs and stores documents, provides electronic stamping and signatures, and notifies addressees via email.
   1. Besides submittals for review, information, and closeout, this procedure applies to Requests for Interpretation (RFIs), progress documentation, contract modification documents (e.g. supplementary instructions, change proposals, change orders), applications for payment, field reports and meeting minutes, Contractor's correction punchlist, and any other document any participant wishes to make part of the project record.
   2. Contractor and Architect are required to use this service.
   3. It is Contractor's responsibility to submit documents in allowable format.
   4. Subcontractors, suppliers, and Architect's consultants will be permitted to use the service at no extra charge.
   5. Users of the service need an email address, internet access, and PDF review software that includes ability to mark up and apply electronic stamps (such as Adobe Acrobat, www.adobe.com, or Bluebeam PDF Revu, www.bluebeam.com), unless such software capability is provided by the service provider.
   6. Paper document transmittals will not be reviewed; emailed electronic documents will not be reviewed.

7. All other specified submittal and document transmission procedures apply, except that electronic document requirements do not apply to samples or color selection charts.

B. Submittal Service: The selected service is:ProCore

C. Training: One, one-hour, web-based training session will be arranged for all participants, with representatives of Architect and Contractor participating; further training is the responsibility of the user of the service.

D. Project Closeout: Architect will determine when to terminate the service for the project and is responsible for obtaining archive copies of files for Owner.

3.02 PROGRESS MEETINGS

A. Schedule and administer meetings throughout progress of the work at maximum weekly intervals.

B. Make arrangements for meetings, prepare agenda with copies for participants, preside at meetings.

C. Attendance Required:
1. Contractor.
2. Owner.
3. Architect.
4. Contractor's superintendent.
5. Major subcontractors.

D. Agenda:
1. Review minutes of previous meetings.
2. Review of work progress.
3. Field observations, problems, and decisions.
4. Identification of problems that impede, or will impede, planned progress.
5. Review of submittals schedule and status of submittals.
6. Maintenance of progress schedule.
7. Corrective measures to regain projected schedules.
8. Planned progress during succeeding work period.
9. Maintenance of quality and work standards.
10. Effect of proposed changes on progress schedule and coordination.
11. Other business relating to work.

E. Record minutes and distribute copies within two days after meeting to participants, with two copies to Architect, Owner, participants, and those affected by decisions made.

3.03 REQUESTS FOR INTERPRETATION (RFI)

A. Definition: A request seeking one of the following:
1. An interpretation, amplification, or clarification of some requirement of Contract Documents arising from inability to determine from them the exact material, process, or system to be installed; or when the elements of construction are required to occupy the same space (interference); or when an item of work is described differently at more than one place in Contract Documents.
2. A resolution to an issue which has arisen due to field conditions and affects design intent.

B. Whenever possible, request clarifications at the next appropriate project progress meeting, with response entered into meeting minutes, rendering unnecessary the issuance of a formal RFI.

C. Preparation: Prepare an RFI immediately upon discovery of a need for interpretation of Contract Documents. Failure to submit a RFI in a timely manner is not a legitimate cause for claiming additional costs or delays in execution of the work.
1. Prepare a separate RFI for each specific item.
a. Review, coordinate, and comment on requests originating with subcontractors and/or materials suppliers.

b. Do not forward requests which solely require internal coordination between subcontractors.

2. Prepare using software provided by the Electronic Document Submittal Service.

D. Reason for the RFI: Prior to initiation of an RFI, carefully study all Contract Documents to confirm that information sufficient for their interpretation is definitely not included.

1. Improper RFIs: Requests not prepared in compliance with requirements of this section, and/or missing key information required to render an actionable response. They will be returned without a response, with an explanatory notation.
2. Frivolous RFIs: Requests regarding information that is clearly indicated on, or reasonably inferable from, Contract Documents, with no additional input required to clarify the question. They will be returned without a response, with an explanatory notation.

3.04 SUBMITTAL SCHEDULE

A. Submit to Architect for review a schedule for submittals in tabular format.

3.05 SUBMITTALS FOR REVIEW

A. When the following are specified in individual sections, submit them for review:

1. Product data.
2. Shop drawings.
3. Samples for selection.
4. Samples for verification.

B. Submit to Architect for review for the limited purpose of checking for compliance with information given and the design concept expressed in Contract Documents.

C. Samples will be reviewed for aesthetic, color, or finish selection.

D. After review, provide copies and distribute in accordance with SUBMITTAL PROCEDURES article below and for record documents purposes described in Section 017800 - Closeout Submittals.

3.06 NUMBER OF COPIES OF SUBMITTALS

A. Electronic Documents: Submit one electronic copy in PDF format; an electronically-marked up file will be returned. Create PDFs at native size and right-side up; illegible files will be rejected.

B. Samples: Submit the number specified in individual specification sections; one of which will be retained by Architect.

1. After review, produce duplicates.
2. Retained samples will not be returned to Contractor unless specifically so stated.

3.07 SUBMITTAL PROCEDURES

A. General Requirements:

1. Use a separate transmittal for each item.
2. Submit separate packages of submittals for review and submittals for information, when included in the same specification section.
3. Sequentially identify each item. For revised submittals use original number and a sequential numerical suffix.
4. Apply Contractor's stamp, signed or initialed certifying that review, approval, verification of products required, field dimensions, adjacent construction work, and coordination of information is in accordance with the requirements of the work and Contract Documents.
5. Identify variations from Contract Documents and product or system limitations that may be detrimental to successful performance of the completed work.
6. Provide space for Contractor and Architect review stamps.
7. When revised for resubmission, identify all changes made since previous submission.
8. Incomplete submittals will not be reviewed, unless they are partial submittals for distinct portion(s) of the work, and have received prior approval for their use.

B. Product Data Procedures:

1. Submit only information required by individual specification sections.
2. Collect required information into a single submittal.
3. Do not submit (Material) Safety Data Sheets for materials or products.

C. Samples Procedures:
1. Transmit related items together as single package.
2. Identify each item to allow review for applicability in relation to shop drawings showing installation locations.

3.08 SUBMITTAL REVIEW

A. Submittals for Review: Architect will review each submittal, and approve, or take other appropriate action.

B. Submittals for Information: Architect will acknowledge receipt and review. See below for actions to be taken.

C. Architect's actions will be reflected by marking each returned submittal using virtual stamp on electronic submittals.

D. Architect's and consultants' actions on items submitted for review:
1. Authorizing purchasing, fabrication, delivery, and installation:
a. "Approved", or language with same legal meaning.
b. "Approved as Noted, Resubmission not required", or language with same legal meaning.
1) At Contractor's option, submit corrected item, with review notations acknowledged and incorporated.
c. "Approved as Noted, Resubmit for Record", or language with same legal meaning.
2. Not Authorizing fabrication, delivery, and installation:
a. "Revise and Resubmit".
1) Resubmit revised item, with review notations acknowledged and incorporated.
b. "Rejected".
1) Submit item complying with requirements of Contract Documents.

E. Architect's and consultants' actions on items submitted for information:
1. Items for which no action was taken:
a. "Received" - to notify the Contractor that the submittal has been received for record only.
2. Items for which action was taken:
a. "Reviewed" - no further action is required from Contractor.

END OF SECTION 013000

SECTION 013591
PERIOD TREATMENT PROCEDURES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Construction procedures appropriate for working with historic sites and structures.

1.02 DEFINITIONS

A. Consolidate: Strengthen loose or deteriorated materials in situ.

B. Dismantle: Disassemble and detach items by hand from existing construction to the limits indicated, using small hand tools and small one-hand power tools, to protect nearby historic surfaces, and legally dispose of dismantled items off-site, unless indicated to be salvaged or reinstalled.

C. Existing to Remain: Existing items that are not to be removed or dismantled. Protect materials as indicated.

D. Historic: Spaces, areas, rooms, surfaces, materials, finishes, and overall appearance subject to preservation, rehabilitation, restoration, and reconstruction procedures defined in NPS (THP). Designation “HF” and words such as “historic,” “historic fabric,” “historic materials,” “historic building materials,” 'historic character,' or words of similar meaning indicate that the material or feature is considered to have aspects that require period treatment procedures.

E. Historic Preservation Conservator: Person or firm retained by Owner to provide guidance on compliance with NPS (THP) requirements.

F. In-Kind: Matching existing in physical and visual aspects including, but not limited to, material, form, color, texture, and workmanship.

G. Matching: Blending with adjacent construction and showing no apparent difference in material type, form, detail, color, texture, finish, or other visible and readily discernible characteristics, as determined and approved by Architect.

H. Preserve: Apply measures to sustain existing form, integrity, and materials of a historic property; may include preliminary measures to protect and stabilize the property.

I. Protect: Take precautions to keep historic materials of the building from damage or injury.

J. Reconstruct: Remove existing item, refurbish existing or replicate damaged or missing components as indicated or directed, and reinstall in original position.

K. Refinish: Remove existing finishes from base material and apply new finish to match original or as otherwise indicated.

L. Remove: Detach or dismantle items from existing construction and dispose of them off-site, unless items are indicated to be salvaged or reinstalled.

M. Remove and Reinstall: Detach or dismantle items from existing construction in a manner to prevent damage. Clean and prepare for reuse and reinstall in original location or in other location where indicated.

N. Remove and Salvage: Detach or dismantle items from existing construction in a manner to prevent damage. Clean, package, label, and deliver salvaged items to Owner in ready-for-reuse condition.

O. Repair: Correct damage and defects, retaining existing materials, features, and finishes and employing as few new materials as possible. Includes patching, piecing-in, splicing, consolidating, or reinforcing or upgrading materials with appropriate and approved materials and methods.

P. Replace: Remove, duplicate, and reinstall entire item with new material. Use original item as the pattern unless noted otherwise.

Q. Replicate or Reproduce: Fabricate a new item in exact detail, materials, and finish as the original, unless otherwise indicated; referred to as replicas or reproductions.

R. Restore: Return to original condition; return to the condition extant during the period of interpretation.

S. Retain: Existing to remain; keep existing items that are not to be removed or dismantled.

T. Reversible: New construction work, treatment, or processes that can be removed or undone in the future without damaging historic materials.

U. Stabilize: Provide reinforcement of unsafe or deteriorated items and maintain the present, essential form; reestablish weather-resistant enclosure.

V. Strip: Remove existing finish down to base material, unless otherwise indicated.

1.03 REFERENCE STANDARDS

A. NPS (THP) - The Secretary of The Interior's Standards For the Treatment of Historic Properties with Guidelines For Preserving, Rehabilitating, Restoring & Reconstructing Historic Buildings; 2017.

1.04 QUALITY ASSURANCE

A. Craftspersons: Perform specific cleaning, repairing, and refinishing tasks; have demonstrated applicable successful experience in past historical preservation and restoration projects.

B. Testing Agency Qualifications: Independent testing laboratory with specific expertise in historic materials technology to examine materials prior to use and continuously inspect the work for compliance with requirements of construction documents; approved by Architect.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Storage and Protection:
   1. Use and reuse materials original to the existing structure wherever practical. Store removed materials under cover, inside, and protect from damage.
   2. Label specific pieces or items to be removed. Label consistently and inconspicuously indicating original location, and document original position.
   3. Protect materials during storage and construction from rain, snow, or groundwater and from soiling with earth or other materials.
      a. Store cementitious materials off ground, under cover, and in a dry location. Protect liquid components from freezing.
      b. Comply with manufacturer's recommendations for minimum and maximum temperature requirements for storage.
   4. Store restoration and cleaning chemicals off-site or in metal cabinets on-site. Do not leave cans open or out of the cabinet overnight. Do not store in unlabeled containers.

1.06 FIELD CONDITIONS

A. Smoking and use of tobacco products by personnel performing work on or about designated period treatment areas is not allowed.

B. Environmental Requirements:
   1. Wet or Humid Weather:
      a. Do not remove exterior elements of structures when raining or rain is forecasted.
      b. Do not apply primer, paint, putty, or epoxy when the relative humidity is above 80 percent and in accordance with manufacturer's recommendations.
      c. Do not repair exterior features in rain or fog.
   2. Hot Weather: Work in the shade when the temperature is above 75 degrees F. Shield features or areas from excessive heat with protective netting or tarpaulins.
   3. Cold Weather: Do not perform exterior wet work when the air temperature is below 40 degrees F.

C. Exterior Cleaning Procedures: Perform cleaning and rinsing of the exterior elements only during daylight hours.

D. Protection of Existing Elements: In accordance with manufacturer's recommendations for use of proposed products and procedures and compatibility with adjacent historic building materials, components, and vegetation.

PART 2 - PRODUCTS

2.01 PROTECTION PRODUCTS

A. Adhesive Walk-Off, Tacky Mats: Mats with multiple layers of disposable, adhesive-coated sheets.

2.02 CLEANING MATERIALS

A. General: Do not use incompatible materials that may contribute to damage of the element being cleaned.

B. Use products specifically intended by the manufacturer for cleaning historic materials or elements.

2.03 REPAIR MATERIALS

A. General: Do not use incompatible materials contributing to damage of repaired elements.

B. Matching: Unless otherwise required, use new materials that match historic materials in type, design, dimension, texture, detailing, and external appearance.

PART 3 - EXECUTION

3.01 PREPARATION

A. Dismantling: Follow the reverse order of original construction to the extent practicable.

3.02 PERIOD TREATMENT SPECIAL PROCEDURES

A. Period Treatment Work: Intended to halt deterioration and stabilize the condition of building elements. Repair is necessary where preservation is not sufficient to ensure mid- to long-term survival. Select repair means and methods based on minimal disturbance of existing materials, systems, and assemblies.

B. Review proposed procedures for each type of element with Architect. Obtain approval from _____ before commencing work.

END OF SECTION 013591

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SECTION 014000
QUALITY REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Testing and inspection agencies and services.

B. Control of installation.

C. Mock-ups.

D. Manufacturers' field services.

E. Defect Assessment.

1.02 TESTING AND INSPECTION AGENCIES AND SERVICES

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 CONTROL OF INSTALLATION

A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce work of specified quality.

B. Comply with manufacturers' instructions, including each step in sequence.

C. Should manufacturers' instructions conflict with Contract Documents, request clarification from Architect before proceeding.

D. Comply with specified standards as minimum quality for the work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

E. Have work performed by persons qualified to produce required and specified quality.

F. Verify that field measurements are as indicated on shop drawings or as instructed by the manufacturer.

G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, and disfigurement.

3.02 MOCK-UPS

A. Before installing portions of the Work where mock-ups are required, construct mock-ups in location and size indicated for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work. The purpose of mock-up is to demonstrate the proposed range of aesthetic effects and workmanship.

B. Accepted mock-ups establish the standard of quality the Architect will use to judge the Work.

C. Integrated Exterior Mock-ups: Construct integrated exterior mock-up as indicated on drawings. Coordinate installation of exterior envelope materials and products as required in individual Specification Sections. Provide adequate supporting structure for mock-up materials as necessary.

D. Tests shall be performed under provisions identified in this section and identified in the respective product specification sections.

E. Assemble and erect specified items with specified attachment and anchorage devices, flashings, seals, and finishes.

F. Architect will use accepted mock-ups as a comparison standard for the remaining Work.

G. Where mock-up has been accepted by Architect and is specified in product specification sections to be removed, protect mock-up throughout construction, remove mock-up and clear area when directed to do so by Architect.

3.03 TESTING AND INSPECTION

A. Testing Agency Duties:
   1. Provide qualified personnel at site. Cooperate with Architect and Contractor in performance of services.
   2. Perform specified sampling and testing of products in accordance with specified standards.
   3. Ascertain compliance of materials and mixes with requirements of Contract Documents.
   4. Promptly notify Architect and Contractor of observed irregularities or non-compliance of Work or products.
   5. Perform additional tests and inspections required by Architect.
   6. Submit reports of all tests/inspections specified.

B. Limits on Testing/Inspection Agency Authority:
   1. Agency may not release, revoke, alter, or enlarge on requirements of Contract Documents.
   2. Agency may not approve or accept any portion of the Work.
   3. Agency may not assume any duties of Contractor.
   4. Agency has no authority to stop the Work.

C. Contractor Responsibilities:
   1. Deliver to agency at designated location, adequate samples of materials proposed to be used that require testing, along with proposed mix designs.
   2. Cooperate with laboratory personnel, and provide access to the Work and to manufacturers' facilities.
   3. Provide incidental labor and facilities:
      a. To provide access to Work to be tested/inspected.
      b. To obtain and handle samples at the site or at source of Products to be tested/inspected.
      c. To facilitate tests/inspections.
      d. To provide storage and curing of test samples.
   4. Notify Architect and laboratory 24 hours prior to expected time for operations requiring testing/inspection services.
   5. Employ services of an independent qualified testing laboratory and pay for additional samples, tests, and inspections required by Contractor beyond specified requirements.
   6. Arrange with Owner's agency and pay for additional samples, tests, and inspections required by Contractor beyond specified requirements.

D. Re-testing required because of non-compliance with specified requirements shall be performed by the same agency on instructions by Architect.

E. Re-testing required because of non-compliance with specified requirements shall be paid for by Contractor.

3.04 MANUFACTURERS' FIELD SERVICES

A. When specified in individual specification sections, require material or product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, test, adjust, and balance equipment, and _____ as applicable, and to initiate instructions when necessary.

B. Report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.

3.05 DEFECT ASSESSMENT

A. Replace Work or portions of the Work not complying with specified requirements.

END OF SECTION 014000

SECTION 016116
VOLATILE ORGANIC COMPOUND (VOC) CONTENT RESTRICTIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Requirements for Indoor-Emissions-Restricted products.

B. Requirements for VOC-Content-Restricted products.

1.02 RELATED REQUIREMENTS

A. Section 013000 - Administrative Requirements: Submittal procedures.

1.03 DEFINITIONS

A. Indoor-Emissions-Restricted Products: All products in the following product categories, whether specified or not:
   1. Interior paints and coatings applied on site.
   2. Interior adhesives and sealants applied on site, including flooring adhesives.
   3. Products making up wall and ceiling assemblies.
   4. Thermal and acoustical insulation.

B. VOC-Content-Restricted Products: All products in the following product categories, whether specified or not:
   1. Interior paints and coatings applied on site.
   2. Interior adhesives and sealants applied on site, including flooring adhesives.

C. Interior of Building: Anywhere inside the exterior weather barrier.

D. Adhesives: All gunnable, trowelable, liquid-applied, and aerosol adhesives, whether specified or not; including flooring adhesives, resilient base adhesives, and pipe jointing adhesives.

E. Sealants: All gunnable, trowelable, and liquid-applied joint sealants and sealant primers, whether specified or not; including firestopping sealants and duct joint sealers.

F. Inherently Non-Emitting Materials: Products composed wholly of minerals or metals, unless they include organic-based surface coatings, binders, or sealants; and specifically the following:
   1. Concrete.
   2. Clay brick.
   3. Metals that are plated, anodized, or powder-coated.
   4. Glass.
   5. Ceramics.
   6. Solid wood flooring that is unfinished and untreated.

1.04 REFERENCE STANDARDS

A. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency; Current Edition.

B. ASTM D3960 - Standard Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings; 2025.

C. CARB (SCM) - Suggested Control Measure for Architectural Coatings; California Air Resources Board; 2020.

D. SCAQMD 1113 - Architectural Coatings; 1977, with Amendment (2016).

E. SCAQMD 1168 - Adhesive and Sealant Applications; 1989, with Amendment (2022).

1.05 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: For each VOC-restricted product used in the project, submit evidence of compliance.

1.06 QUALITY ASSURANCE

A. VOC Content Test Method: 40 CFR 59, Subpart D (EPA Method 24), or ASTM D3960, unless otherwise indicated.
   1. Evidence of Compliance: Acceptable types of evidence are:
      a. Report of laboratory testing performed in accordance with requirements.

B. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of the type specified in this section.

PART 2 PRODUCTS

2.01 MATERIALS

A. VOC-Content-Restricted Products: VOC content not greater than required by the following:
   1. Adhesives, Including Flooring Adhesives: SCAQMD 1168 Rule.
   2. Joint Sealants: SCAQMD 1168 Rule.
   3. Paints and Coatings: Each color; most stringent of the following:
      a. 40 CFR 59, Subpart D.
      b. SCAQMD 1113 Rule.
      c. CARB (SCM).

PART 3 EXECUTION

3.01 FIELD QUALITY CONTROL

A. Owner reserves the right to reject non-compliant products, whether installed or not, and require their removal and replacement with compliant products at no extra cost to Owner.

B. Additional costs to restore indoor air quality due to installation of non-compliant products will be borne by Contractor.

END OF SECTION 016116

SECTION 017800
CLOSEOUT SUBMITTALS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Project record documents.

B. Warranties and bonds.

1.02 RELATED REQUIREMENTS

A. Individual Product Sections: Warranties required for specific products or Work.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 PROJECT RECORD DOCUMENTS

A. Maintain on site one set of the following record documents; record actual revisions to the Work:
   1. Drawings.
   2. Addenda.
   3. Change Orders and other modifications to the Contract.

B. Ensure entries are complete and accurate, enabling future reference by Owner.

C. Store record documents separate from documents used for construction.

D. Record information concurrent with construction progress.

E. Record Drawings: Legibly mark each item to record actual construction including:
   1. Field changes of dimension and detail.
   2. Details not on original Contract drawings.

3.02 WARRANTIES AND BONDS

A. Obtain warranties and bonds, executed in duplicate by responsible Subcontractors, suppliers, and manufacturers, within 10 days after completion of the applicable item of work. Except for items put into use with Owner's permission, leave date of beginning of time of warranty until Date of Substantial completion is determined.

B. Verify that documents are in proper form, contain full information, and are notarized.

C. Co-execute submittals when required.

D. Retain warranties and bonds until time specified for submittal.

END OF SECTION 017800

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SECTION 024100
DEMOLITION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Selective demolition of building elements for alteration purposes.

PART 2 PRODUCTS -- NOT USED

PART 3 EXECUTION

3.01 SCOPE

A. Demolish portions of site as identified per drawings. All portions of site not explicitly identified for demolition shall be protected and remain. .

3.02 GENERAL PROCEDURES AND PROJECT CONDITIONS

A. Comply with applicable codes and regulations for demolition operations and safety of adjacent structures and the public.
   1. Obtain required permits.
   2. Use of explosives is not permitted.
   3. Take precautions to prevent catastrophic or uncontrolled collapse of structures to be removed; do not allow worker or public access within range of potential collapse of unstable structures.
   4. Provide, erect, and maintain temporary barriers and security devices.
   5. Conduct operations to minimize effects on and interference with adjacent structures and occupants.
   6. Conduct operations to minimize obstruction of public and private entrances and exits; do not obstruct required exits at any time; protect persons using entrances and exits from removal operations.

B. Do not begin removal until receipt of notification to proceed from Owner.

C. Protect existing structures and other elements that are not to be removed.
   1. Stop work immediately if adjacent structures appear to be in danger.

D. Minimize production of dust due to demolition operations; do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.

E. Hazardous Materials: Comply with 29 CFR 1926 and state and local regulations.

3.03 EXISTING UTILITIES

A. Protect existing utilities to remain from damage.

B. Do not close, shut off, or disrupt existing life safety systems that are in use without at least 7 days prior written notification to Owner.

C. Do not close, shut off, or disrupt existing utility branches or take-offs that are in use without at least 3 days prior written notification to Owner.

D. Locate and mark utilities to remain; mark using highly visible tags or flags, with identification of utility type; protect from damage due to subsequent construction, using substantial barricades if necessary.

E. Remove exposed piping, valves, meters, equipment, supports, and foundations of disconnected and abandoned utilities.

3.04 SELECTIVE DEMOLITION FOR ALTERATIONS

A. Drawings showing existing construction and utilities are based on casual field observation and existing record documents only.

B. Remove existing work as indicated and as required to accomplish new work.

C. Protect existing work to remain.
   1. Repair adjacent construction and finishes damaged during removal work.

3.05 DEBRIS AND WASTE REMOVAL

A. Remove debris, junk, and trash from site.

B. Leave site in clean condition, ready for subsequent work.

C. Clean up spillage and wind-blown debris from public and private lands.

END OF SECTION 024100

SECTION 033000
CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Concrete formwork.

1.02 RELATED REQUIREMENTS

1.03 PRICE AND PAYMENT PROCEDURES

A. Cast-in-place concrete work will be paid for by the unit price method.

B. See Section 012200 - Unit Prices for additional unit price requirements.

1.04 REFERENCE STANDARDS

A. ACI 117 - Specification for Tolerances for Concrete Construction and Materials; 2010 (Reapproved 2015).

B. ACI 301 - Specifications for Concrete Construction; 2020.

C. ACI 318 - Building Code Requirements for Structural Concrete; 2019, with Errata (2021).

D. ACI 347R - Guide to Formwork for Concrete; 2014, with Errata (2017).

E. ASTM C150/C150M - Standard Specification for Portland Cement; 2021.

1.05 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Submit manufacturers' data on manufactured products showing compliance with specified requirements and installation instructions.

1.06 QUALITY ASSURANCE

A. Perform work of this section in accordance with ACI 301 and ACI 318.

PART 2 PRODUCTS

2.01 FORMWORK

A. Formwork Design and Construction: Comply with guidelines of ACI 347R to provide formwork that will produce concrete complying with tolerances of ACI 117.

2.02 CONCRETE MATERIALS

A. Cement: ASTM C150/C150M, Type I - Normal Portland type.

1. Acquire cement for entire project from same source.

2.03 CONCRETE MIX DESIGN

A. Concrete Strength: Establish required average strength for each type of concrete on the basis of field experience or trial mixtures, as specified in ACI 301.

1. For trial mixtures method, employ independent testing agency acceptable to Architect for preparing and reporting proposed mix designs.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify lines, levels, and dimensions before proceeding with work of this section.

3.02 PREPARATION

A. Formwork: Comply with requirements of ACI 301. Design and fabricate forms to support all applied loads until concrete is cured, and for easy removal without damage to concrete.

3.03 PLACING CONCRETE

A. Place concrete in accordance with ACI 304R.

3.04 CONCRETE FINISHING

A. Repair surface defects, including tie holes, immediately after removing formwork.

3.05 CURING AND PROTECTION

A. Comply with requirements of ACI 308R. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.

3.06 DEFECTIVE CONCRETE

A. Test Results: The testing agency shall report test results in writing to Architect and Contractor within 24 hours of test.

3.07 PROTECTION

A. Do not permit traffic over unprotected concrete floor surface until fully cured.

END OF SECTION 033000

SECTION 040300
CONSERVATION TREATMENT FOR PERIOD MASONRY

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Replacement of existing masonry units.

B. Repair of damaged existing masonry.

C. Raking and repointing of existing mortar joints.

1.02 RELATED REQUIREMENTS

A. Section 013591 - Period Treatment Procedures for general historic preservation project requirements.

B. Section 079200 - Joint Sealants.

1.03 REFERENCE STANDARDS

A. ASTM C144 - Standard Specification for Aggregate for Masonry Mortar; 2018.

B. ASTM C568/C568M - Standard Specification for Limestone Dimension Stone; 2022.

C. ASTM C1713 - Standard Specification for Mortars for the Repair of Historic Masonry; 2023.

D. NPS (THP) - The Secretary of The Interior’s Standards For the Treatment of Historic Properties with Guidelines For Preserving, Rehabilitating, Restoring & Reconstructing Historic Buildings; 2017.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data on cleaning compounds.

C. Repointing Schedule: Detailed schedule of areas to be repointed, including assessment of the problem areas and detailed description of repointing procedures. Include the following:

PART 2 PRODUCTS

2.01 MORTAR MATERIALS

A. Sand: ASTM C144.

B. Mortar Mixing:
   1. General Requirements:
      a. Do not use modern additives unless permitted in writing by Architect.
      b. Match the historic mortar in color, texture, and tooling.

PART 3 EXECUTION

3.01 RESTORERS

A. Acceptable Restorers:
   1. Curtis Hunt Restorations, Inc..

3.02 PERIOD TREATMENT, GENERAL

A. See Section 013591 for special procedure requirements related to elements and features of historical significance and value.

3.03 PREPARATION

A. Protect other elements from damage that may result from restoration procedures.

B. Carefully remove and store identified items located in areas to be restored including, but not limited to, fixtures, fittings, finish hardware, and accessories; reinstall upon completion of restoration work.

C. Protect nonrestoration areas from restoration areas to prevent damage.

D. Mask or cover adjacent surfaces and permanent equipment. Secure coverings without using nails and without tape that leaves residue. Do not use impervious sheeting which produces condensation.
   1. Use materials that will withstand cleaning and restoration procedures.

E. Cover existing landscaping within work areas with tarpaulins or similar covers during work periods.
   1. Provide coverings that allow plants to breathe.
   2. Remove coverings at the end of each workday. Do not cover plants with waterproof membranes for more than eight hours at a time.

F. When using liquid cleaning methods, provide drainage devices to prevent runoff over adjacent surfaces, unless those surfaces are impervious to damage from runoff.

G. Do not allow cleaning runoff to drain into sanitary or storm sewers.

H. Do not attach scaffolding, ladders, or working platforms to the building without written authorization and instructions from Architect.

3.04 INSTALLATION

A. Do not mix or apply materials when the ambient temperature or humidity are outside of range recommended by their manufacturers.

B. Schedule conservation treatments to be carried out during appropriate environmental conditions to avoid weather-related failures.

3.05 MASONRY UNIT REPLACEMENT

A. Cut out damaged and deteriorated masonry to prevent damage to adjacent materials.

B. Support structure as necessary prior to cutting out units.

C. Cut away loose or unsound, adjoining masonry as directed.

D. Build in new units for new work as specified in other sections.

3.06 REPOINTING

A. Perform repointing prior to cleaning masonry surfaces.

B. Cut out loose or disintegrated mortar in joints to minimum 1/2-inch depth or until sound mortar is reached.

C. Use hand tools only. Do not use power tools.

D. Exercise appropriate caution to prevent damage to existing masonry.

E. When cutting is complete, remove dust and loose material with air jet.

F. Premoisten joints and apply pointing mortar. Pack tightly in maximum 1/4-inch layers. Form a smooth, compact concave joint to match existing.

G. Moist cure for 72 hours.

END OF SECTION 040300

SECTION 040515
PREPARING LIME MORTARS FOR MASONRY

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This standard includes guidance on preparing lime mortar for repointing and repairing designated historical limestone masonry in which the construction consists of lime mortar.

SUMMARY

A. Lime mortars are preferable to portland cement mortars for repointing and repairing historic masonry:
   1. Lime mortars are more permeable by water. Water passing through lime mortar will dissolve a small portion of the lime and then will deposit it in hairline cracks as the water evaporates.
   2. Lime mortars expand slightly during setting, and resists shrinkage which causes cracking.

B. 3. Lime mortars are more durable than generally recognized.

C. See 01100-07-S for general project guidelines to be reviewed along with this procedure. These guidelines cover the following sections:
   1. Safety Precautions
   2. Historic Structures Precautions
   3. Submittals
   4. Quality Assurance
   5. Delivery, Storage and Handling
   6. Project/Site Conditions
   7. Sequencing and Scheduling
   8. General Protection (Surface and Surrounding) These guidelines should be reviewed prior to performing this procedure and should be followed, when applicable, along with recommendations from the Regional Historic Preservation Officer (RHPO).

REFERENCES

A. American Society for Testing and Materials (ASTM), 100 Barr Drive, West Conshohocken, PA 19428, (610) 832-9585 or FAX (610) 832-9555.

DELIVERY, STORAGE AND HANDLING

A. Storage and Protection: Lime and cement must be protected from rainwater and ground moisture, as water vapor in the air can begin the setting process. Other materials also should be protected from contamination.

PART 2 PRODUCTS

5.01 MATERIALS

A. Lime: Should conform to ASTM C207, Type S, high plasticity, Hydrated Lime for Masonry Purposes.
   1. Lime which meets this standard will "work" well, resists drying during curing, and is sufficiently strong for the purpose of repointing and repairing.
   2. Lime expands as it hydrates, making high lime mortars more resistant to crack formation.

B. Cement: Should conform to ASTM C150, Type I, White. It should not have more than 0.60% alkali nor more than 0.15% water soluble alkali. Use gray portland cement ONLY if a dark mortar is to be matched.
   1. Cement meeting this standard should increase the workability of the mortar, accelerate the setting time and slightly increase the strength of the mortar.
   2. The low alkali content will prevent efflorescence.

C. Sand: Free of impurities and conforming to ASTM C144.

1. Sand color, size, and texture should match the original as closely as possible. Provide a sample of the sand for comparison to the original, and have it approved by the RHPO before beginning repointing work.
2. When possible, use bar sand or beach sand rather than crushed sand for the repointing mortar. Bar sand or beach sand should be washed to remove the salts before using.
    a. Crushed sand has sharp edges, which makes it more "sticky" and difficult to work into the joints.
    b. Bar sand, on the other hand, has rounded edges and flows easily during the mortar application.
    c. The working characteristics of mortar made with crushed sand may be improved by adding a slight amount of portland cement. The amount of cement should be determined by experimentation, but should not exceed 20% of the total lime/cement binder. 20% or less of cement has minimal effect on the hardness of the mortar. Cement content above 20% will make the mortar too hard.

D. Clean, potable water: If the water must be transported or stored in a container, the container must not impart any chemicals to the water.

E. Stone dust finely ground from the same stone as that to be repointed.

F. Additives: No antifreeze compounds or other admixture shall be used. Do not use anti-freeze compounds. These compounds are designed for use with cement mortars, and their effectiveness with high lime mortars is questionable. Furthermore, the compounds contain salts which can lead to serious problems in the masonry at a later time.

G. Air entraining agents are not recommended. These agents are designed for use with cement rather than lime, and they result in decreased bonding of the mortar and the masonry. Air entraining is not necessary with high lime mortars because of the natural ability of these mortars to flex with temperature changes.

EQUIPMENT

A. Surface temperature thermometer - can be either mechanical (less expensive but must be calibrated often) or digital electronic

B. Wooden mortar boxes

C. Hoe

D. Mesh screen

E. Hawks: Plywood or steel hawk (mortar board)

MIXES

A. Some factors to consider when mixing lime mortar include durability, color and texture, and workability.
1. Durability: Repointing mortar should be softer than the masonry units and the original mortar to reduce stresses at the edge of the masonry and, in the case of lime mortar, to reduce shrinkage which can cause cracks in the mortar.
    a. If the new mortar is harder than the masonry or the original mortar, it can cause serious stresses within the wall during thermal expansion and contraction, which can lead to deterioration of the masonry units rather than the mortar.
    b. If the mortar is softer, any deterioration which occurs will take place in the mortar, which is easier to replace than the units themselves.
2. The repointing mortar should allow the passage of water, both liquid and vapor. If the mortar does not allow water to pass freely through it, the water can become trapped inside the wall, freeze and cause serious deterioration to the masonry.
3. Color and texture: The repointing mortar should match the original mortar in color, texture and physical characteristics.
    a. Obtaining an accurate color match is best achieved by selecting an appropriate sand.
        1) Use sand which is similar to the original in color and gradation. Sand from more than one source may be required.

2) For repointing of natural stones, use finely ground stone "dust" in the mortar to match the joints as closely as possible to the stone.
   (a) If the original mortar was tinted, or if it is impossible to obtain a color match through the use of sand, it may be necessary to use a special mortar pigment. Caution: pigments may react with other ingredients in the mortar to form efflorescence. They may also weather at a different rate than natural coloring and cause a color variation in the mortar.
   (b) If pigments must be used, pure mineral oxides should be used because they do not fade or leach out of the mortar. Amount of pigment should not exceed 2% of the mortar mix by weight.
   (c) Many mortars used before the twentieth century have small lumps of incompletely burned or ground lime, or other impurities. To match the original appearance of the masonry, these impurities must be included in the new repointing mortar. Use identical materials, such as ground oyster shells (obtained at feed stores) or lumps of lime, to duplicate original lumps.
      (1) Workability: The workability or plasticity of the mortar is a direct result of the selection of materials.

B. Mortar Mix:
   (1) Have the existing mortar completely analyzed to insure that the repointing mortar will not be less permeable/harder than the masonry units or the original mortar. IT IS BETTER TO HAVE MORTAR THAT IS MORE PERMEABLE THAN LESS.
   (2) Measure all ingredients by cubic volume using a pre-established uniform measure, such as a small bucket, rather than a less uniform measure such as a shovel.
   (3) For historic masonry set in lime mortar, use the following mortar mix:
   (4) 4 parts buff colored river sand
   (5) 1 part lime
   (6) ¼ part Portland cement.
   (7) samples to architect prior to repointing.
   (8) Mix a final "job-size" batch once the correct sand color, cement content, etc. have been determined through small tests to ensure the on-site mixing conditions will result in the same final product.

PART 3 EXECUTION

8.01 ERECTION, INSTALLATION, APPLICATION

A. Mix Hydrated Lime:
   (1) Add dry bagged hydrated lime to water. Stir and hoe the mass to form a thick cream.
   (2) Allow to stand at least 24 hours before use.

B. Prepare Roughage Premix (for later use):
   (1) Accurately proportion the sand and lime using measuring boxes constructed to contain the exact volume of each ingredient required to make on batch.
   (2) Mix sand and lime thoroughly for about ten minutes. Store in plastic-lined drums and seal until required. This compound may be stored indefinitely if. Kept sealed from air and kept from freezing.
   (3) When required for use, add and mix the correct portion of gauging cement as specified and use immediately. Accurate portioning is very important.

C. Add cements to lime and aggregate mixes immediately before the use of the mortar.

(1) Perform all batching with wooden boxes or plastic pails of known volume to ensure standardization and conformity of measurement; shovel measurement of materials is not permitted.
(2) Use box sizes that are sufficient for producing a batch size equal to one mixer load.
(3) Mix dry ingredients thoroughly before adding any water (approximately five minutes).

D. Add a small amount of water so that the mortar is just wet enough to hang on a trowel. Excess water will cause shrinkage and too little water will retard carbonation. Record the amount of water added so that it may be used as a guide for future batches.

E. Mix mortars at least 10 minutes before using to improve workability and ensure thorough mixing. Automatic mixers should have rubber blades. Clean mixing boards and mixing machines thoroughly after each use to prevent hardened lumps of mortar from contaminating the next batch of mortar.

(1) Repointing mortars may sit 1-2 hours after initial mixing and then may be remixed to a workable consistency. This is done to reduce shrinkage.
(2) Test the mix by holding a trowel with mortar on it upside down and shaking it once.

b. If the mortar falls off without shaking, it has too much sand.
c. If more than one shake is required, the mortar is too sticky or "plastic" and the lime content must be decreased.

F. F. Coloring Mortars:

(1) Take samples of freshly-broken mortar from the original masonry pointing. Note color of aggregate for color-matching. Do not try to match the color of the binder. Use unweathered, unsoiled samples only.
(2) Prepare test patties of mortar approximating the inner color of the sample and set aside to dry for at least 72 hours. Drying time may be accelerated by placing the patty sample in an oven or over a hot-plate.
(3) Break the sample test patties and compare the inner portions to the original.

G. Use repointing mortar within approximately 1-2 hours of final mixing. Retemper the mortar as necessary to maintain workability.

END OF SECTION 040515

SECTION 050300
CONSERVATION TREATMENT FOR PERIOD METALS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Restoration cleaning of metal surfaces.

B. Repair of damaged metal elements.

C. Replacement of metal elements.

1.02 RELATED REQUIREMENTS

A. Section 013591 - Period Treatment Procedures: For general historic preservation project requirements.

1.03 REFERENCE STANDARDS

A. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency; Current Edition.

B. ASTM A29/A29M - Standard Specification for General Requirements for Steel Bars, Carbon and Alloy, Hot-Wrought; 2023.

C. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.

D. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings; 1999, with Editorial Revision (2022).

E. ASTM A48/A48M - Standard Specification for Gray Iron Castings; 2022.

F. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2024.

G. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2016a.

H. ASTM A501/A501M - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing; 2021.

I. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2020.

J. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable; 2025.

K. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2025.

L. ASTM B36/B36M - Standard Specification for Brass Plate, Sheet, Strip, and Rolled Bar; 2023.

M. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings; 2017 (Reapproved 2025).

N. ASTM B135/B135M - Standard Specification for Seamless Brass Tube; 2026.

O. ASTM B138/B138M - Standard Specification for Manganese Bronze Rod, Bar, and Shapes; 2011 (Reapproved 2024).

P. ASTM B248 - Standard Specification for General Requirements for Wrought Copper and Copper-Alloy Plate, Sheet, Strip, and Rolled Bar; 2022.

Q. ASTM B248M - Standard Specification for General Requirements for Wrought Copper and Copper-Alloy Plate, Sheet, Strip, and Rolled Bar (Metric); 2022.

R. ASTM B370 - Standard Specification for Copper Sheet and Strip for Building Construction; 2012 (Reapproved 2019).

S. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications; 2022.

T. ASTM C834 - Standard Specification for Latex Sealants; 2017 (Reapproved 2023).

U. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018 (Reapproved 2024).

V. ASTM F3125/F3125M - Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi, 144 ksi, and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength; 2025a.

W. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2025, with Amendment (2026).

PART 2 PRODUCTS

2.01 METAL MATERIALS FOR REPLICATION OR REPRODUCTIONS

A. Cast Iron Components:
   1. Gray-Iron Castings: ASTM A48/A48M.
   2. Malleable-Iron Castings: ASTM A47/A47M, grade recommended by restoration specialist firm.

B. Wrought Iron Components: ASTM A29/A29M.

C. Steel Components:
   1. Sections, Shapes, Plate, and Bar: ASTM A36/A36M.
   2. Tubing: ASTM A501/A501M structural tubing, round and shapes as indicated.
   3. Pipe: ASTM A53/A53M Grade B Schedule 40, black finish.
   4. Ungalvanized Steel Sheet: Hot- or cold-rolled, except use cold-rolled where finished work will be exposed to view.
      a. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Designation CS (commercial steel).
      b. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Designation CS (commercial steel).
   5. Galvanized Steel Sheet: ASTM A653/A653M, Structural Steel (SS) Grade 33/230 with G40/Z120 coating.
   6. Iron Castings: ASTM A47/A47M, malleable.
   7. Bolts, Nuts, and Washers: ASTM F3125/F3125M, Type 1, and galvanized to ASTM A153/A153M where connecting galvanized components.
   8. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.

D. Bronze Components: ASTM B138/B138M.
   1. Concealed: Alloy UNS C28000 muntz metal; color similar to alloy USN C38500.
   2. Exposed: Architectural extruded bronze; color similar to alloy 280.
   3. Bronze Sheet: ASTM B36/B36M, UNS No. C28000 (muntz metal, 60 percent copper).
   4. Copper Sheet: ASTM B370, H00 temper; cold-rolled copper sheet.
   5. Copper Alloy UNS C83600 - Ounce Alloy - Castings: ASTM B62.
   6. Copper Alloy UNS C8 Sand Castings: ASTM B584.
   7. Bronze Finish: Match existing finish.
   8. Protective Coating: Thermoset clear enamel or acrylic.

E. Brass Components:
   1. Tubing: ASTM B135/B135M, UNS C26000.
   2. Sheet: ASTM B248 or ASTM B248M, No.26 yellow brass.
   3. Sheet: ASTM B36/B36M, UNS No. C26000 - cartridge brass, 70 percent copper.
   4. Protective Coating: Lemon oil seal.

2.02 BONDING ADHESIVES

A. General: For repairing and bonding metal.

B. Epoxy Adhesive: Two-component, exterior grade, clear, tintable adhesive with gel viscosity.
   1. Cured Properties:
      a. Tensile Strength: 2,044 psi at 7 days, tested in accordance with ASTM D638.

b. Compressive Strength: 8,182 psi at 7 days, tested in accordance with ASTM D695.
c. Flexural Strength: 9,896 psi at 7 days, tested in accordance with ASTM D790.

2.03 SEALANTS

A. Replacement for Existing White Lead Paste Caulk: Silicone sealant; ASTM C920, Grade NS, Uses M and A; single or multi-component; not expected to withstand continuous water immersion or traffic.

B. Replacement for Existing White Lead Paste Caulk: Polyurethane sealant; ASTM C920, Grade NS, Uses M and A; single or multi-component; not expected to withstand continuous water immersion or traffic.

C. Joint Sealer, Interior: Nonsag, paintable, nonstaining latex sealant complying with ASTM C834; of type and grade required to seal joints in metal element, and with a VOC content of not more than 250 g/L, calculated in accordance with 40 CFR 59, Subpart D - EPA Method 24.

PART 3 EXECUTION

3.01 PERIOD TREATMENT, GENERAL

A. See Section 013591 for special procedure requirements related to elements and features of historical significance and value.

3.02 REPAIR

A. General: Perform repairs in properly equipped fabrication facility or in situ, in accordance with Conservation Treatment Quality Control Plan and mock-up.
   1. Match repair method to condition of the element and applicability to the element's metal composition.
   2. Exercise care during dismantling of brittle elements, especially during cold weather.
   3. Complete the repair procedures by preparing surfaces for application of specified finishes.

B. Metal Stitching: Use along partial cracks in cast iron elements, or to attach together existing or new sections of such an element.
   1. Use overlapping metal stitching pins and locks to bridge and seal cracks and align surfaces.
   2. Grind away protrusions.

C. Brazing: Use for reattachment of nonstructural cast iron elements.
   1. Use brazing rods as filler material for joining pieces together.
   2. Clean the area to be worked with a file, grinder, or wire brush.
   3. Heat the work surface until the work surface is hot enough to melt the rod.
   4. Scratch the rod all around the area to be repaired.
   5. Ensure rod has melted and fused down into the metal being repaired.
   6. Preparation for Refinishing: Use techniques appropriate to the repair, such as deburring, surface grinding, planishing, fine sanding, and polishing.

D. Welding: Use for reattachment of cast iron elements.
   1. Identify the alloy. Do not weld white cast iron.
   2. Remove surface materials to completely clean the casting in the area of the weld.
   3. Preheat cast iron elements prior to welding to prevent cracking possible during rapid cooling of weld areas.
   4. Select appropriate electrode for welding.
   5. Select appropriate type and profile of weld for effective repair.
   6. Preparation for Refinishing: Use techniques appropriate to the repair, such as deburring, surface grinding, planishing, fine sanding, and polishing.

E. Patching: Use compatible patching compound on nonstructural cracks and surface area with small defects such as chips or where corroded portions of the metal have been removed.

F. Splicing: Splice in new or restored portions of cast iron elements by in situ brazing.

G. Reinforcing: Supplement existing elements with braces, stiffeners, plates, to relieve the total carried load.
   1. Integrate reinforcing pieces into existing element by bolting, riveting, pinning, or welding in a manner not adversely affecting aesthetic qualities.

3.03 GENERAL REQUIREMENTS FOR RESTORATION CLEANING

A. Perform in situ cleaning and rinsing of exterior elements only during daylight hours.

B. Perform in situ cleaning and rinsing of interior elements with adequate artificial lighting.

3.04 CAST IRON RESTORATION CLEANING

A. Removal of Rust: Use techniques least likely to damage cast iron elements. Test effectiveness of proposed techniques on a small area prior to determining appropriateness of their use.
   1. Hand scrape and remove loose rust chips using a wire brush. Apply sufficient pressure to remove rust, but avoid scoring the metal surfaces or damaging detail components of the element.
   2. Use low-pressure dry grit blasting to remove substantial corrosion.
   3. Use multi-flame-head oxyacetylene torch to remove substantial corrosion.
   4. Use chemicals to remove substantial corrosion by acid-pickling from elements that can be removed from their location.
      a. Chemicals: Use diluted phosphoric acid, diluted sulfuric acid, ammonium citrate-based product, oxalic acid-based product, or hydrochloric acid-based product.
      b. Neutralize surface of cast iron to pH 7 level after cleaning.

3.05 REMOVAL OF EXISTING COATINGS

A. Remove existing coatings. Observe remover manufacturer's instructions. Leave metal in a clean, chemical-free, pH neutral condition free of residue.

B. Removal of Coatings: Use techniques least likely to damage cast iron elements. Test effectiveness of proposed techniques on a small area prior to determining appropriateness of their use.
   1. Hand scrape and remove loose paint using a wire brush. Apply sufficient pressure to remove rust, but avoid scoring the metal surfaces or damaging detail components of the element.
   2. Use low-pressure dry grit blasting to remove multiple-coat paint build-up.

C. Remove old lacquer using lacquer remover applied with a cotton cloth wiped along the grain of the metal.
   1. Allow the remover to stand on the lacquer for several minutes.
   2. Wipe away remover with a cotton cloth or by flushing with water. Several applications of the stripper may be necessary in order to remove all traces of the lacquer from the metal.
   3. Follow the stripping operation with an application of metal cleaner on a soft cloth, rubbing along the grain of the metal.

3.06 IN SITU RESTORATION

A. Do not mix or apply materials or products when ambient temperature or humidity are outside of range recommended by their manufacturers.

B. Schedule conservation treatments to avoid weather-related failures.

3.07 REINSTALLATION OF REPAIRED ELEMENTS

A. Separate dissimilar metals to prevent corrosion by galvanic action by painting contact surfaces with primer or with sealant or tape recommended by manufacturer for the purpose.

B. Reinstall.

3.08 FINAL CLEANING

A. Remove stains resulting from the work of this section without delay.

B. Clean surrounding surfaces.

END OF SECTION 050300

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SECTION 057000
DECORATIVE METAL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Decorative metal units.

PART 2 PRODUCTS

2.01 DECORATIVE METAL UNITS

A. Decorative Mouldings: Cornice Trim, Cove Trim, and Medallions.
   1. Base Metal: Bronze.
   2. Edges: Square.

2.02 FABRICATION

A. Fit and shop assemble items in largest practical sections for delivery to site.

B. Fabricate items with joints tightly fitted and secured.

C. 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.

D. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that substrate and site conditions are acceptable and ready to receive work.

B. Verify field dimensions of locations and areas to receive work.

C. Notify Architect immediately of conditions that would prevent satisfactory installation.

D. Do not proceed with work until detrimental conditions have been corrected.

3.02 INSTALLATION

A. Comply with manufacturer's drawings and written instructions.

B. Install components plumb and level, accurately fitted, free from distortion or defects, and with tight joints, except where necessary for expansion.

C. Anchor securely to structure.

D. Conceal anchor bolts and screws whenever possible. Where not concealed, use flush countersunk fastenings.

E. Isolate dissimilar materials with bituminous coating, bushings, grommets, or washers to prevent electrolytic corrosion.

END OF SECTION 057000

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SECTION 060300
CONSERVATION TREATMENT FOR PERIOD WOOD

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Repair of damaged wood components.

B. Replacement of damaged wood components.

C. Removal of existing wood finishes and refinishing.

1.02 REFERENCE STANDARDS

A. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition; 2014, with Errata (2016).

B. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards; 2021, with Errata.

PART 2 PRODUCTS

2.01 REPLACEMENT ROUGH CARPENTRY MATERIALS

A. Sizes: Nominal sizes as indicated on drawings, S4S.

B. Moisture Content: S-dry or MC19.

2.02 REPLACEMENT FINISH CARPENTRY MATERIALS

A. Wood or Wood-Based Materials:
   1. Wood fabricated from old growth timber is not permitted.

B. Quality Standard: Items fabricated in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), Section 12, unless noted otherwise.

C. Surface Burning Characteristics: Provide materials having fire and smoke properties as required by applicable code.

D. Exterior Finish Carpentry Items: Matching existing elements.

2.03 WOOD REPAIR MATERIALS

A. Source Limitations: Obtain compatible consolidants and patching and filling compounds from single manufacturer.

PART 3 EXECUTION

3.01 PERIOD TREATMENT, GENERAL

A. See Section 013591 for special procedure requirements related to elements and features of historical significance and value.

3.02 EXAMINATION

A. Verify that surfaces to be cleaned and restored are ready for work of this section.

3.03 PREPARATION

A. Protect surrounding elements from damage that may result due to performance of restoration procedures.

B. Remove and store removable items located in areas to be restored including, but not limited to, fixtures, fittings, finish hardware, and accessories; reinstall upon completion.

C. Separate areas to be protected from restoration areas to prevent damage.

D. Mask or cover adjacent surfaces and permanent equipment. Secure coverings without nails or tapes that leave residue. Do not use impervious sheeting which produces condensation.
   1. Use materials that withstand cleaning and restoration procedures.

E. When using liquid cleaning methods, install drainage devices to prevent runoff over adjacent surfaces unless those surfaces are impervious to damage from runoff.

F. Do not allow cleaning runoff to drain into sanitary or storm sewers.

3.04 REPLACEMENT ELEMENT INSTALLATION

A. Match existing elements unless otherwise required for protection of wood materials from the weather and approved by Architect.

B. Maintain continuity of historic architectural fabric.

C. Rough Carpentry Elements:
   1. Set structural members level and plumb.
   2. Provide for erection loads, and temporary bracing to maintain structure safe, plumb, and in true alignment until completion of erection and installation of permanent bracing.
   3. Do not field cut or alter structural members without approval of Architect.

D. Finish Carpentry:
   1. Exterior Elements: Coordinate sequence of reinstallation with period treatment sequences of other exterior elements.
      a. General: Use corrosion-resistant fasteners.
      b. Set and secure materials and components in place, plumb, and level.
      c. Scribe to abutting components, with gaps of 1/32 inch, maximum. Do not use overlay trim to conceal larger gaps.

3.05 REPAIR

A. General: Use corrosion-resistant or nonferrous fasteners. Isolate dissimilar metals from each other.

B. Consolidation: For wood elements indicated on drawings.

C. Patching: For wood elements indicated on drawings.
   1. Mix patching compound components and colorants as recommended by manufacturer.
   2. Mask off areas to be kept free of compound.
   3. Apply with putty knife or similar implement into and over areas to be repaired.

D. Dutchman Installation: For wood elements indicated on drawings.
   1. Trim and square area of replacement.
   2. Check prepared dutchman piece for proper fit.
   3. Mix adhesive components as recommended by manufacturer.
   4. Spread adhesive thinly on both faces keeping adhesive away from edges to avoid squeezing out.
   5. Press dutchman into place.
   6. Remove excess adhesive at glue line.

END OF SECTION 060300

SECTION 062000
FINISH CARPENTRY

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Finish carpentry items.

B. Water-repellant-treated wood materials.

C. Preservative-treated wood materials.

1.02 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data:

C. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, and accessories.

PART 2 PRODUCTS

2.01 FINISH CARPENTRY ITEMS

A. Exterior Woodwork Items:
   1. Enclosing Structural Members: Softwood lumber; "PT" preservative treated.
   2. Handrails: Redwood; prepare for stained and sealed finish.
   3. Brackets, Finials, and Pediments: Prepare for paint finish.
   4. Bench Seats and Backs: "PT" preservative treated.

2.02 FABRICATION

A. Shop assemble work for delivery to site, permitting passage through building openings.

B. When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide trim for scribing and site cutting.

PART 3 EXECUTION

3.01 INSTALLATION

A. Set and secure materials and components in place, plumb and level.

B. Carefully scribe work abutting other components, with maximum gaps of 1/32 inch. Do not use additional overlay trim to conceal larger gaps.

END OF SECTION 062000

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SECTION 075216
STYRENE-BUTADIENE-STYRENE MODIFIED BITUMINOUS MEMBRANE ROOFING - MBTECHNOLOGY

PART 1 GENERAL

1.01 SECTION INCLUDES

A. SBS modified bituminous membrane roofing systems.

B. Insulation.

C. Cover boards.

D. Roofing accessories.

1.02 RELATED REQUIREMENTS

A. Section 061000 - Rough Carpentry: Wood nailers associated with roofing system.

B. Section 077100 - Roof Specialties: Manufactured copings, fascias, and other flashing-related items associated with roofing system.

1.03 REFERENCE STANDARDS

A. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018 (Reapproved 2024).

B. ASTM C1177/C1177M - Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing; 2024.

C. ASTM C1289 - Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board; 2025.

D. ASTM D41/D41M - Standard Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing; 2011 (Reapproved 2023).

E. ASTM D4586/D4586M - Standard Specification for Asphalt Roof Cement, Asbestos-Free; 2007 (Reapproved 2024).

F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2024.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide manufacturer's catalog data for membrane and bitumen materials, cap sheets, interply sheets, base sheets, flashing materials, backer sheets, insulation, insulation fasteners, membrane fasteners, surfacing, insulation cover boards, deck cover boards, roof sealants, traffic pads, insulation adhesives, cold adhesives, and _____.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing work of this section with minimum three years documented experience, and approved by manufacturer.

1.06 FIELD CONDITIONS

A. Do not apply roofing membrane when environmental conditions are outside the ranges recommended by manufacturer.

B. Do not apply roofing membrane when ambient temperature is below 40 degrees F.

C. Do not apply roofing membrane to damp or frozen deck surface or when precipitation is expected or occurring.

D. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed the same day.

E. Schedule applications so that no partially completed sections of roof are left exposed at end of workday.

1.07 WARRANTY

A. See Section 017800 - Closeout Submittals for additional warranty requirements.

B. Provide manufacturer's, non-prorated, material and labor warranty covering leaks caused by faulty workmanship or material.
   1. Warranty Length: See warranty length in Part 2 roofing systems.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. SBS Modified Bituminous Membrane Roofing:
   1. MBTechnology; _____: www.mbtechnology.com/#sle.

2.02 SBS MODIFIED BITUMINOUS MEMBRANE ROOFING SYSTEMS

2.03 SBS MODIFIED BITUMINOUS MEMBRANE MATERIALS

A. Granulated Surface Dual-Reinforced Torch-Grade Membrane:
   1. Product: MBTechnology; fireguard fastorch SBS FGFT160CWH: www.mbtechnology.com/#sle.

2.04 ROOF INSULATION AND COVER BOARDS

A. Polyisocyanurate Board Insulation: Closed-cell polyisocyanurate foam with black glass-reinforced mat laminated to faces, complying with ASTM C1289 Type II, Class 2.

B. Cover Board: Non-combustible, water-resistant gypsum core with embedded glass mat facers, pre-primed, complying with ASTM C1177/C1177M.
   1. Size: 48 inches by 96 inches, nominal.
   2. Thickness: 1/2 inch.
   3. Surface Burning Characteristics: Flame spread index of 0 (zero), smoke-developed index of 0 (zero) when tested in accordance with ASTM E84.

C. Cover Board Adhesive: Fast-acting, two-component, low-rise polyurethane foam adhesive.

2.05 ROOFING ACCESSORIES

A. Asphalt Primer: In compliance with ASTM D41/D41M.

B. Asphalt Roof Cement: ASTM D4586/D4586M, Type II, asbestos-free.

C. Flashing Sealant: High-build, liquid applied, waterproofing sealant.

D. Liquid-Reinforced Flashing System: Single-component, elastomeric asphalt emulsion with polyester reinforcing fleece fabric fully embedded into resin.

E. Surfacing: Second coat of liquid reinforced flashing system and mineral granules to match adjacent SBS-modified bitumen cap sheet.

F. Wood Nailers: See Section 061000.

G. Metal Roof Edging and Fascia: See Section 077100.

H. Cant Strips: 45-degree face slope; fabricate from preservative treated redwood.

I. Lead Flashing: Soft lead sheet, minimum 3 psf

J. Walkway Pads: Manufactured from recycled tires; minimum thickness: 1/2 inch.

K. Walkway Pad Adhesive: Moisture-curing, non-shrinking polyether adhesive/sealant in compliance with ASTM C920 Type S, Grade NS, Class 35; ASTM E84 Class A.

PART 3 INSTALLATION

3.01 EXAMINATION

A. Verify that surfaces and site conditions are ready to receive work.

3.02 INSULATION AND COVER BOARD INSTALLATION

3.03 MEMBRANE INSTALLATION

A. Do not expose materials vulnerable to water in quantities greater than can be weatherproofed the same day.

B. Apply base sheets and cap sheets in shingle fashion starting at low end of roof and proceeding upwards; apply base sheets in half-width starter rolls; apply caps sheets in full widths.

3.04 FLASHING AND ACCESSORIES INSTALLATION

A. Install flashings, including laps, splices, joints, bonding, adhesion, and attachment, as required by membrane manufacturer's written instructions and details.

END OF SECTION 075216

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SECTION 079200
JOINT SEALANTS - DOW SILICONES CORPORATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Nonsag gunnable joint sealants.

B. Self-leveling pourable joint sealants.

C. Joint backings and accessories.

1.02 RELATED REQUIREMENTS

A. Section 016116 - Volatile Organic Compound (VOC) Content Restrictions.

1.03 REFERENCE STANDARDS

A. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018 (Reapproved 2024).

B. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2016 (Reapproved 2023).

C. ASTM C1248 - Standard Test Method for Staining of Porous Substrate by Joint Sealants; 2022.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data for Joint Sealants: Submit manufacturer's technical datasheets for each product to be used, and include the following:
   1. Physical characteristics, including movement capability, VOC content, hardness, cure time, and color availability.
   2. List of backing materials approved for use with the specific product.
   3. Substrates that product is known to satisfactorily adhere to and with which it is compatible.
   4. Substrates that product is not compatible with.

C. Executed warranty.

1.05 WARRANTY

A. See Section 017800 - Closeout Submittals for additional warranty requirements.

B. Manufacturer Warranty: Provide 2-year manufacturer warranty for installed sealants and accessories that fail to achieve a watertight seal, exhibit loss of adhesion or cohesion, or do not cure. Complete forms in Owner's name and register with manufacturer.

PART 2 PRODUCTS

2.01 JOINT SEALANT APPLICATIONS

A. Scope:
   1. Exterior Joints: Seal open joints, whether or not the joint is indicated on drawings unless specifically indicated not to be sealed. Exterior joints to be sealed include, but are not limited to:
      a. Wall expansion and control joints.
      b. Joints between door, window, and other frames and adjacent construction.
      c. Joints between different exposed materials.
      d. Openings below ledge angles in masonry.
      e. Other joints are indicated below.
   2. Do not seal the following types of joints:
      a. Intentional weep holes in masonry.
      b. Joints indicated to be treated with manufactured expansion joint cover or some other type of sealing device.
      c. Joints where sealant is specified to be provided by manufacturer of product to be sealed.
      d. Joints where installation of sealant is specified in another section.
      e. Joints between suspended panel ceilings/grid and walls.

B. Type ___ - Exterior Joints: Use nonsag nonstaining silicone sealant, unless otherwise indicated.

2.02 JOINT SEALANTS - GENERAL

A. Sealants and Primers: Provide products with acceptable levels of volatile organic compound (VOC) content; see Section 016116.

2.03 NONSAG JOINT SEALANTS

A. Type ___ - Nonstaining Silicone Sealant: ASTM C920, Grade NS, Uses M and A; not expected to withstand continuous water immersion or traffic.
   1. Movement Capability: Plus and minus 50 percent, minimum.
   2. Porous Stone: Nonstaining to light-colored natural stone when tested in accordance with ASTM C1248.
   3. Dirt Pick-Up: Reduced dirt pick-up compared to other silicone sealants.

2.04 SELF-LEVELING JOINT SEALANTS

A. Type ____ - Self-Leveling Silicone Sealant: ASTM C920, Grade P, Uses M and A; single- or multi-component, explicitly approved by manufacturer for traffic exposure when recessed below traffic surface; not expected to withstand continuous water immersion.
   1. Movement Capability: Plus 100 percent, minus 50 percent, minimum.
   2. Color: To be selected by Architect from manufacturer's standard range.

2.05 ACCESSORIES

A. Backer Rod: Cylindrical cellular foam rod with surface that sealant will not adhere to, compatible with specific sealant used, and recommended by backing and sealant manufacturers for specific application.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that joints are ready to receive work.

B. Verify that backing materials are compatible with sealants.

C. Verify that backer rods are of the correct size.

3.02 PREPARATION

A. Remove loose materials and foreign matter that could impair adhesion of sealant.

B. Clean joints and prime as necessary, in accordance with manufacturer's instructions.

C. Perform preparation in accordance with manufacturer's instructions and ASTM C1193.

D. Mask elements and surfaces adjacent to joints from damage and disfigurement due to sealant work; be aware that sealant drips and smears may not be completely removable.

3.03 INSTALLATION

A. Install this work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.

B. Provide joint sealant installations complying with ASTM C1193.

C. Install bond breaker backing tape where backer rod cannot be used.

D. Install sealant free of air pockets, foreign embedded matter, ridges, and sags, and without getting sealant on adjacent surfaces.

E. Do not install sealant when ambient temperature is outside manufacturer's recommended temperature range, or will be outside that range during the entire curing period, unless manufacturer's approval is obtained and instructions are followed.

F. Nonsag Sealants: Tool surface concave, unless otherwise indicated; remove masking tape immediately after tooling sealant surface.

END OF SECTION 079200

SECTION 092523
NATURAL HYDRAULIC LIME-BASED PLASTERING (HISTORIC EXTERIOR WORK – DIRECT TO MASONRY)

PART 1 – GENERAL

1.01 REFERENCE STANDARDS

A. ASTM C897 - Standard Specification for Aggregate for Job-Mixed Portland Cement-Based Plasters; 2015 (Reapproved 2020).

B. ASTM C926 - Standard Specification for Application of Portland Cement-Based Plaster; 2023a.

1.02 1.1 SUMMARY

A. THIS SECTION INCLUDES MATERIALS AND APPLICATION OF TRADITIONAL LIME-BASED PLASTER ON EXTERIOR MASONRY WALLS AT THE SPANISH GOVERNOR'S PALACE IN SAN ANTONIO, TEXAS.

B. WORK INVOLVES APPLICATION DIRECTLY TO EXISTING MASONRY SURFACES WITHOUT LATH.

C. INTENT IS TO MATCH THE HISTORIC CHARACTER AND PERFORMANCE OF THE ORIGINAL EXTERIOR PLASTER USING NATURAL HYDRAULIC LIME (NHL) AND HISTORICALLY APPROPRIATE METHODS.

D. RELATED SECTIONS:

1. SECTION 041000 – HISTORIC MASONRY RESTORATION

2. SECTION 090000 – FINISHES

NOTE (THC/OHP): THIS WORK IS CONSIDERED REHABILITATION UNDER SOI STANDARDS. RETAIN AS MUCH ORIGINAL MATERIAL AS POSSIBLE. USE NHL PLASTER SYSTEMS ONLY WHERE ORIGINAL LIME PLASTER IS MISSING OR IRREPARABLY DETERIORATED.

1.2 REFERENCES

A. ASTM C1418 – STANDARD SPECIFICATION FOR NATURAL HYDRAULIC LIME FOR STRUCTURAL PURPOSES

A. ASTM C897 – AGGREGATE FOR JOB-MIXED CEMENT-BASED PLASTERS

A. ASTM C926 – APPLICATION OF PORTLAND CEMENT-BASED PLASTER (GUIDANCE ONLY)

A. ICOMOS GUIDELINES – PRINCIPLES FOR THE PRESERVATION OF HISTORIC MASONRY STRUCTURES

A. THE SECRETARY OF THE INTERIOR'S STANDARDS FOR THE TREATMENT OF HISTORIC PROPERTIES

A. EN 459-1 – BUILDING LIME – DEFINITIONS, SPECIFICATIONS, AND CONFORMITY CRITERIA

1.3 SUBMITTALS

A. PRODUCT DATA: INCLUDE TECHNICAL DATA SHEETS AND CERTIFICATION OF SAINT-ASTIER NHL 3.5.

B. MIX DESIGN: SUBMIT RATIO OF NHL TO SAND, CONFIRMING 1:2.5 VOLUMETRIC MIX.

C. SAMPLE PANEL: PROVIDE MINIMUM 24 INCH. X 24 IN. ON-SITE MOCK-UP FOR REVIEW.

D. INSTALLER QUALIFICATIONS: DEMONSTRATE EXPERIENCE WITH LIME PLASTER ON HISTORIC BUILDINGS.

NOTE (THC/OHP): MOCK-UP IS CRITICAL FOR MATCHING HISTORIC APPEARANCE. LOCATE SAMPLE PANEL IN A DISCREET AREA AND PRESERVE FOR COMPARISON.

1.4 QUALITY ASSURANCE

A. QUALIFICATIONS:

1. INSTALLER SHALL HAVE MINIMUM 5 YEARS' EXPERIENCE WITH NHL-BASED PLASTER SYSTEMS ON HISTORIC MASONRY.

2. WORK SHALL COMPLY WITH GUIDANCE PROVIDED BY THE TEXAS HISTORICAL COMMISSION (THC), AND REVIEW BY THE CITY OF SAN ANTONIO OFFICE OF HISTORIC PRESERVATION (OHP).

B. MOCK-UP:

1. CONSTRUCT ON ACTUAL WALL SURFACE AT INCONSPICUOUS AREA.

2. APPROVED MOCK-UP SHALL SERVE AS STANDARD FOR ACCEPTANCE.

3. DO NOT PROCEED WITH GENERAL WORK UNTIL MOCK-UP IS APPROVED.

1.5 DELIVERY, STORAGE, AND HANDLING

A. DELIVER NHL IN SEALED, CLEARLY LABELED BAGS BEARING MANUFACTURER'S IDENTIFICATION.

B. STORE IN DRY CONDITIONS, PROTECTED FROM WEATHER AND MOISTURE.

1.6 PROJECT CONDITIONS

A. DO NOT APPLY PLASTER IN AMBIENT TEMPERATURES BELOW 45°F OR ABOVE 85°F, OR WHEN FREEZING OR DIRECT SUN EXPOSURE IS EXPECTED WITHIN 72 HOURS.

B. PROTECT WALLS WITH SHADE CLOTH OR DAMP BURLAP TO CONTROL EVAPORATION.

PART 2 – PRODUCTS

36.01 2.1 NATURAL HYDRAULIC LIME (NHL)

A. BASIS-OF-DESIGN PRODUCT: SAINT-ASTIER NHL 3.5

1. CONFORMS TO ASTM C1418 AND EN 459-1: TYPE NHL 3.5

2. FREE OF CEMENT, GYPSUM, OR OTHER ADDITIVES.

3. DISTRIBUTED BY LIMEWORKS.US OR APPROVED EQUAL.

2.2 AGGREGATES

A. SHARP-WASHED SAND:

1. CLEAN, ANGULAR, SILICEOUS OR CALCAREOUS SAND PER ASTM C897.

2. FREE OF FINES, CLAY, MICA, ORGANIC MATTER, AND SALTS.

3. MATCH HISTORICAL PARTICLE SIZE AND TEXTURE.

2.3 MIX DESIGN

A. MIX: 1 PART NHL 3.5 TO 2.5 PARTS SHARP-WASHED SAND BY VOLUME.

B. WATER: CLEAN, POTABLE, ADDED AS NECESSARY FOR WORKABILITY.

C. ADMIXTURES: NOT PERMITTED.

2.4 OTHER MATERIALS

A. NO METAL LATH OR REINFORCEMENT ALLOWED.

B. NO CHEMICAL BONDING AGENTS PERMITTED.

PART 3 – EXECUTION

53.01 3.1 EXAMINATION

A. CONFIRM MASONRY IS SOUND, CLEAN, AND FREE OF COATINGS OR EFFLORESCENCE.

B. ENSURE ADEQUATE TEXTURE/SUCTION FOR BONDING.

3.2 SURFACE PREPARATION

A. REMOVE LOOSE OR DETERIORATED STUCCO OR INCOMPATIBLE COATINGS USING HAND TOOLS.

B. DAMPEN SURFACE 12–24 HOURS IN ADVANCE AND AGAIN BEFORE PLASTERING.

3.3 PLASTER APPLICATION

A. APPLY IN THREE COATS:

1. SCRATCH COAT: 3/8–1/2 INCH, SCORED WHILE PLASTIC. CURE 5–7 DAYS.

2. BROWN COAT: 1/4–3/8 INCH, FLOATED ROUGH. CURE 7+ DAYS.

3. FINISH COAT: 1/8 INCH OR LESS, MATCH APPROVED TEXTURE.

3.4 CURING

A. PROTECT FROM WIND, SUN, AND DRYING.

B. MIST DAILY FOR 3–7 DAYS POST-APPLICATION.

3.5 FINISHES

A. MATCH EXISTING OR HISTORICALLY APPROPRIATE TEXTURE.

B. NO PIGMENTS OR SURFACE COATINGS UNLESS DOCUMENTED.

3.6 CLEANING AND PROTECTION

A. CLEAN EXCESS FROM ADJACENT SURFACES WITH SOFT BRUSHES.

B. PROTECT FINISHED WORK FROM DAMAGE DURING CONSTRUCTION.

3.7 REPAIR OF DEFECTS

A. USE SAME NHL MIX. FEATHER INTO ADJACENT AREAS.

B. RE-CURE AS WITH NEW WORK.

END OF SECTION 092523

SECTION 099113
EXTERIOR PAINTING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Surface preparation.

B. Field application of paints.

C. Scope: Finish exterior surfaces exposed to view, unless fully factory-finished and unless otherwise indicated, including the following:

D. Do Not Paint or Finish the Following Items:
   1. Items factory-finished unless otherwise indicated; materials and products having factory-applied primers are not considered factory finished.
   2. Items indicated to receive other finishes.
   3. Items indicated to remain unfinished.
   4. Fire rating labels, equipment serial number and capacity labels, and operating parts of equipment.
   5. Floors, unless specifically indicated.
   6. Glass.
   7. Concealed pipes, ducts, and conduits.

1.02 REFERENCE STANDARDS

A. MPI (APSM) - Master Painters Institute Architectural Painting Specification Manual; Current Edition.

1.03 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide complete list of products to be used, with the following information for each:
   1. Manufacturer's name, product name and/or catalog number, and general product category (e.g. "alkyd enamel").
   2. MPI product number (e.g. MPI #47).
   3. Cross-reference to specified paint system(s) product is to be used in; include description of each system.

C. Samples: Submit three paper "draw down" samples, 8-1/2 by 11 inches in size, illustrating range of colors available for each finishing product specified.
   1. Where sheen is specified, submit samples in only that sheen.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.

B. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.

C. Paint Materials: Store at minimum ambient temperature of 45 degrees F and a maximum of 90 degrees F, in ventilated area, and as required by manufacturer's instructions.

1.05 FIELD CONDITIONS

A. Do not apply materials when surface and ambient temperatures are outside the paint product manufacturer's temperature ranges.

B. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.

C. Provide lighting level of 80 ft candles measured mid-height at substrate surface.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Provide paints and finishes used in any individual system from the same manufacturer; no exceptions.

2.02 PAINTS AND FINISHES - GENERAL

A. Paints and Finishes: Ready-mixed, unless required to be a field-catalyzed paint.
   1. Provide paints and finishes of a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
   2. Supply each paint material in quantity required to complete entire project's work from a single production run.
   3. Do not reduce, thin, or dilute paint or finishes or add materials unless such procedure is described explicitly in manufacturer's product instructions.

2.03 PAINT SYSTEMS - EXTERIOR

A. Exterior Surfaces to be Painted, Unless Otherwise Indicated: Including stucco and plaster.
   1. Two top coats and one coat primer.
   2. Top Coat(s): Exterior Latex; MPI #10, 11, 15, 119, or 214.
      a. Products:
         1) Pittsburgh Paints Speedhide Exterior Latex, 6-610XI Series, Flat. (MPI #10)
         2) or equal.

2.04 PRIMERS

A. Primers: Provide the following unless other primer is required or recommended by manufacturer of top coats.

2.05 ACCESSORY MATERIALS

A. Accessory Materials: Provide primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials as required for final completion of painted surfaces.

B. Patching Material: Latex filler.

C. Fastener Head Cover Material: Latex filler.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that surfaces are ready to receive work as instructed by the product manufacturer.

B. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.

C. Test shop-applied primer for compatibility with subsequent cover materials.

D. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces are below the following maximums:
   1. Exterior Plaster and Stucco: 12 percent.

3.02 PREPARATION

A. Clean surfaces thoroughly and correct defects prior to application.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

C. Remove or mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces for finishing.

D. Seal surfaces that might cause bleed through or staining of topcoat.

E. Remove mildew from impervious surfaces by scrubbing with solution of tetra-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.

F. Exterior Plaster: Fill hairline cracks, small holes, and imperfections with exterior patching plaster. Make smooth and flush with adjacent surfaces. Wash and neutralize high alkali surfaces.

3.03 APPLICATION

A. Apply products in accordance with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual".

B. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.

C. Apply each coat to uniform appearance.

D. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.

E. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

END OF SECTION 099113

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SECTION 313116
TERMITE CONTROL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Soil-applied chemical treatment.

B. Soil-applied control barriers.

C. Termite barrier sheet.

D. Site-applied termiticide for wood, steel, and concrete.

1.02 REFERENCE STANDARDS

A. ASTM C128 - Standard Test Method for Relative Density (Specific Gravity) and Absorption of Fine Aggregate; 2025.

B. ASTM C136/C136M - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates; 2025.

C. ASTM E1643 - Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs; 2024.

D. ASTM E1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs; 2017 (Reapproved 2023).

E. Title 7, United States Code, 136 through 136y - Federal Insecticide, Fungicide and Rodenticide Act; 2022.

1.03 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Submit manufacturers' data on manufactured products showing compliance with specified requirements.

C. Manufacturer's Instructions: Indicate caution requirement.

1.04 WARRANTY

A. See Section 017800 - Closeout Submittals for additional warranty requirements.

B. Installer Warranty: Provide 2-year warranty for termite control commencing on Date of Substantial Completion. Complete forms in Owner's name and register with installer.

C. Termite-Resistant Vapor Barrier Sheet: Provide five year manufacturer's limited warranty.

PART 2 PRODUCTS

2.01 MATERIALS

A. Soil-Applied Chemical Treatment:
   1. Toxicant: Comply with Title 7, United States Code, 136 through 136y.
   2. Color: Synthetically dyed for visual identification of treated soil.
   3. Diluent: Recommended by toxicant manufacturer.

B. Soil-Applied Control Barriers:
   1. Material: Basalt rock.
   2. Graded in accordance with ASTM C136/C136M; within the following limits:
      a. No.4 Sieve: 100 percent passing.
      b. No.8 Sieve: 95 to 100 percent passing.
      c. No.10 Sieve: 75 to 95 percent passing.
      d. No.12 Sieve: 35 to 50 percent passing.
      e. No.16 Sieve: 1 to 10 percent passing.
   3. Specific Gravity: 2.80 in accordance with ASTM C128.
   4. Silica: 45 percent.

2.02 TERMITE BARRIER SHEET

A. Manufacturers:
   1. Stego Technology LLC; Pango Wrap with Pango Tape: www.stegoindustries.com/#sle.

B. Termite-Resistant Vapor Barrier Sheet: Plastic sheet, complying with ASTM E1745, Class C; stated by manufacturer as suitable for installation in contact with soil or granular fill under concrete slabs, and for exclusion of subterranean termites.

C. Accessory Products: Vapor retarder manufacturer's recommended tape, adhesive, prefabricated boots, etc., for sealing seams and penetrations in vapor retarder.

PART 3 EXECUTION

3.01 APPLICATION

A. Comply with manufacturer's written instructions.

B. Soil-Applied Chemical Treatment:
   1. Comply with requirements of U.S. EPA and applicable state and local codes.
   2. Spray-apply toxicant in accordance with manufacturer's instructions.

C. Soil-Applied Control Barrier:
   1. Initial Lift: 6 inches, maximum, placed in equal continuous layer.
   2. Successive Lift: 4 inches, maximum, placed in equal continuous layer.
   3. Compaction: Each lift prior to successive lift placement and final lift.

3.02 INSTALLATION

A. Termite Barrier Sheet:
   1. Comply with ASTM E1643.
   2. Lap joints minimum 6 inches. Seal joints, seams and penetrations watertight with manufacturer's recommended products and follow manufacturer's written instructions.

END OF SECTION 313116

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SECTION 22 05 00
COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

1. Motors.
2. Packless expansion joints.
3. Alignment guides and anchors.
4. Sleeves without waterstop.
5. Grout.
6. Silicone sealants.
7. Thermometers, filled system, lead free.
8. Thermometers, liquid in glass, lead free.
9. Thermometers, light activated, lead free.
10. Thermowells, lead free.
11. Pressure gauges, dial type, lead free.
12. Gauge attachments, lead free.

B. Related Requirements:

1. Section 221119 "Domestic Water Piping Specialties" for water meters.
2. Section 221513 "General-Service Compressed-Air Piping" for compressed air gauges.
3. Section 331415 "Site Water Distribution Piping" for domestic water meters and combined domestic and fire-protection water-service meters outside the building.

1.2 DEFINITIONS

A. Existing Piping to Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product, excluding motors which are included in Part 1 of the plumbing equipment Sections.

a. Include construction details, material descriptions, and dimensions of individual components, and finishes.
b. Include operating characteristics and furnished accessories.

B. Delegated Design Submittals: For each anchor and alignment guide, including analysis data, signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate requirements for thermal expansion of piping

systems and for selecting and designing expansion joints, loops, and swing connections.

2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
3. Alignment Guide Details: Detail field assembly and attachment to building structure.
4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

C. Sustainable Design Submittals:

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of [expansion joint,][and][gauge] to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.

B. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators in accordance with 2021 ASME Boiler and Pressure Vessel Code, Section IX.

1.7 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Domestic water[expansion fittings and loops] for plumbing piping intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act, with requirements of authorities having jurisdiction, and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-

accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

B. Compatibility: Provide products suitable for piping service fluids, materials, working pressures, and temperatures.

C. Capability: Provide products and installations to accommodate maximum axial movement as scheduled or indicated on Drawings.

2.2 MOTORS

A. Motor Requirements, General:

1. Content includes motors for use on alternating-current power systems of up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.
2. Comply with requirements in this Section except when stricter requirements are specified in equipment schedules or Sections.
3. Comply with NEMA MG 1 unless otherwise indicated.
4. Comply with IEEE 841 for severe-duty motors.

B. Motor Characteristics:

1. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 ft. above sea level.
2. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

C. Polyphase Motors:

1. Description: NEMA MG 1, Design B, medium induction motor.
2. Efficiency: Premium Efficient, as defined in NEMA MG 1.
3. Service Factor: 1.15.
4. Multispeed Motors: Variable torque.
    a. For motors with 2:1 speed ratio, consequent pole, single winding.
    b. For motors with other than 2:1 speed ratio, separate winding for each speed.
5. Multispeed Motors, Two Winding: Separate winding for each speed.
6. Rotor: Random-wound, squirrel cage.
7. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
8. Temperature Rise: Match insulation rating.
9. Insulation: [Class F]<Insert class>.
10. Code Letter Designation:
    a. Motors 15 HP and Larger: NEMA starting Code F or Code G.

b. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.

11. Enclosure Material: Cast iron for motor frame sizes [324T]<Insert number> and larger; rolled steel for motor frame sizes smaller than [324T]<Insert number>.

D. Additional Requirements for Polyphase Motors:

1. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
2. Motors Used with Variable-Frequency Controllers:[Ratings, characteristics, and features coordinated with and approved by controller manufacturer.]

a. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time-rise pulses produced by pulse-width-modulated inverters.
b. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
c. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
d. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

3. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

E. Single-Phase Motors:

1. Motors larger than 1/20 hp must be one of the following, to suit starting torque and requirements of specific motor application:

a. Permanent-split capacitor.
b. Split phase.
c. Capacitor start, inductor run.
d. Capacitor start, capacitor run.

2. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
3. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
4. Motors 1/20 HP and Smaller: Shaded-pole type.
5. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device will automatically reset when motor temperature returns to normal range.

F. Electronically Commutated Motors:

1. Microprocessor-Based Electronic Control Module: Converts [120 V][or][240 V] single-phase AC power to three-phase DC power to operate the brushless DC motor.
2. Three-phase power motor module with permanent magnet rotor.
3. [Circuit board][or][digital speed controller/LED display].
4. Building Automation System Interface: Via [AC voltage signal][DC voltage

signal][or][Digital Serial Interface (DSI)].

2.3 EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

A. Performance Requirements:

1. Compatibility: Provide products suitable for piping service fluids, materials, working pressures, and temperatures.
2. Capability: Provide products and installations that will accommodate maximum axial movement as scheduled or indicated on Drawings.

B. Alignment Guides and Anchors:

1. Anchor Materials:

a. Steel Shapes and Plates: ASTM A36/A36M.
b. Bolts and Nuts: ASME B18.10 or ASTM A183, steel hex head.
c. Washers: ASTM F844, steel, plain, flat washers.
d. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.

1) Stud: Threaded, [zinc-coated carbon][stainless] steel.
2) Expansion Plug: [Zinc-coated carbon][Stainless] steel.
3) Washer and Nut: [Zinc-coated carbon][Stainless] steel.

e. Chemical Fasteners: Insert-type stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.

1) Bonding Material: ASTM C881/C881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
2) Stud: ASTM A307, [zinc-coated carbon][stainless] steel with continuous thread on stud unless otherwise indicated.
3) Washer and Nut: [Zinc-coated carbon][Stainless] steel.

2.4 SLEEVES AND SLEEVE SEALS

A. Sleeves without Waterstop:

1. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron, with plain ends.
2. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, hot-dip galvanized, with plain ends.
3. Steel Sheet Sleeves: ASTM A653/A653M, 24 gauge minimum thickness; hot-dip galvanized, round tube closed with welded longitudinal joint.
4. PVC Pipe Sleeves: ASTM D1785, Schedule 40.
5. Molded-PVC Sleeves: With nailing flange.

6. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange.

B. Grout:

1. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.
2. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
3. Design Mix: 5000 psi, 28-day compressive strength.
4. Packaging: Premixed and factory packaged.

2.5 METERS AND GAUGES FOR PLUMBING PIPING

A. Thermowells, Lead Free:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: Lead-free copper <Insert material>.
4. Material for Use with Steel Piping: [Type 304 stainless steel][Type 316 stainless steel]<Insert material>.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, or as required to match threaded opening in pipe.
7. Internal Threads: Size and thread type as required to match thermometer mounting threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length to extend [a minimum of 2 inches into fluid][one-third of pipe diameter][to center of pipe][to match thermometer stem length].
10. Lagging Extension: Include on thermowells for insulated piping and tubing. Extension is to be of sufficient length to extend beyond finished insulation surface.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.
12. Heat-Transfer Medium: [Mixture of graphite and glycerin]<Insert material>.

B. Gauge Attachments, Lead Free:

1. Snubbers: ASME B40.100, lead-free brass; with [NPS 1/4][NPS 1/4 or NPS 1/2][NPS 1/2], ASME B1.20.1 pipe threads and [piston][porous-metal]-type surge-dampening device. Include extension for use on insulated piping.
2. Valves: [Lead-free brass ball][Lead-free brass or stainless steel needle], with [NPS 1/4][NPS 1/4 or NPS 1/2][NPS 1/2], ASME B1.20.1 pipe threads.

PART 3 - EXECUTION

3.1 INSTALLATION OF EXPANSION JOINTS, GENERAL

A. Install expansion joints of sizes matching sizes of piping in which they are installed.

3.2 INSTALLATION OF PACKLESS EXPANSION JOINTS

A. Install metal-bellows expansion joints in accordance with EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."

B. Install rubber packless expansion joints in accordance with FSA-PSJ-703.

3.3 INSTALLATION OF GROOVED-JOINT EXPANSION JOINTS

A. Install grooved-joint expansion joints to grooved-end steel piping.

3.4 INSTALLATION OF ALIGNMENT GUIDES AND ANCHORS

A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.

B. Install [one][two] guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than [four]<Insert number> pipe diameters from expansion joint.

C. Attach guides to pipe, and secure guides to building structure.

D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

E. Anchor Attachments:

1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9.
2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-58, Type 24; U bolts bolted to anchor.

F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.

1. Anchor Attachment to Steel Structural Members: Attach by welding.
2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
3. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

3.5 INSTALLATION OF PIPE LOOP AND SWING CONNECTIONS

A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.

B. Connect risers and branch connections to mains with at least [five]<Insert number> pipe fittings, including tee in main.

C. Connect risers and branch connections to terminal units with at least [four]<Insert number> pipe fittings, including tee in riser.

D. Connect mains and branch connections to terminal units with at least [four]<Insert number> pipe fittings, including tee in main.

3.6 INSTALLATION OF SLEEVES - GENERAL

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide [1-inch][2-inch]<Insert dimension> annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas [2 inches]<Insert dimension> above finished floor level.

3. Using [grout][or][silicone sealant], seal the space outside of sleeves in floors/slabs/walls without sleeve-seal system. Select to maintain fire resistance of floor/slab/wall.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants that joint sealant manufacturer's literature indicates is appropriate for size, depth, and location of joint.

E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions,

ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.7 INSTALLATION OF SLEEVES WITH WATERSTOP

A. Install sleeve with waterstop as new walls and slabs are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange centered across width of concrete slab or wall.

C. Secure nailing flanges to wooden concrete forms.

D. Using [grout][or][silicone sealant], seal space around outside of sleeves. Select to maintain fire resistance of floor/slab/wall.

3.8 INSTALLATION OF STACK-SLEEVE FITTINGS

A. Install stack-sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
5. Using silicone sealant, seal space between top hub of stack-sleeve fitting and pipe.

B. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.9 INSTALLATION OF SLEEVE-SEAL SYSTEMS

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building, and passing through exterior walls.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.10 INSTALLATION OF METERS AND GAUGES

A. Install thermometer with thermowell at each required thermometer location.

B. Install thermowells in vertical position in piping tees.

C. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

D. Install thermowells with extension on insulated piping.

E. Fill thermowells with heat-transfer medium.

F. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

G. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks.

H. Install direct-mounted pressure gauges in piping tees with pressure gauge located on pipe at most readable position.

I. Install remote-mounted pressure gauges on panel.

J. Install valve and snubber in piping for each pressure gauge for fluids.

K. Install test plugs in piping tees.

L. Install thermometers in the following locations:

1. Inlet and outlet of each water heater.
2. Inlets and outlets of each domestic water heat exchanger.
3. Inlet and outlet of each domestic hot-water storage tank.
4. Inlet and outlet of each remote domestic water chiller.
5. Outlet side of hot-water-balancing valve.
6. Each main hot-water-recirculating line return pipe.
7. <Insert location>.

M. Install pressure gauges in the following locations:

1. Building water service entrance into building.
2. Inlet and outlet of each pressure-reducing valve.
3. Suction and discharge of each domestic water pump.
4. <Insert location>.

3.11 CONNECTIONS

A. Install meters and gauges adjacent to machines and equipment to allow space for service and maintenance of meters, gauges, machines, and equipment.

3.12 ADJUSTING

A. After installation, calibrate meters according to manufacturer's written instructions.

B. Adjust faces of meters and gauges to proper angle for best visibility.

3.13 FIELD QUALITY CONTROL

A. Sleeves and Sleeve Seals:

1. Perform the following tests and inspections:

a. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
b. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

2. Prepare test and inspection reports.

B. Escutcheons:

1. Using new materials, replace broken and damaged escutcheons and floor plates.

3.14 SLEEVES APPLICATION

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above and below Grade:

a. Sleeves with waterstops.

1) Select sleeve size to allow for [1-inch]<Insert dimension> annular clear space between piping and sleeve for installing sleeve-seal system.

2. Concrete Slabs-on-Grade:

a. Sleeves with waterstops.

1) Select sleeve size to allow for [1-inch]<Insert dimension> annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs above Grade:

a. [Sleeves with waterstops][or][stack-sleeve fittings].

4. Interior Wall and Partitions:

a. Sleeves without waterstops.

3.15 THERMOMETER, LEAD FREE, APPLICATION

A. Thermometers at inlet and outlet of each domestic water heater are to be the following:

1. [Liquid-filled][Sealed], bimetallic-actuated type.
2. [Direct][Remote]-mounted, [metal][plastic]-case, vapor-actuated type.
3. [Metal][Plastic] case, [compact][industrial]-style, liquid-in-glass type.
4. [Direct][Remote]-mounted, light-activated type.
5. Test plug with [chlorosulfonated polyethylene synthetic][EPDM] self-sealing rubber inserts.

B. Thermometers at inlets and outlets of each domestic water heat exchanger are to be the following:

1. [Liquid-filled][Sealed], bimetallic-actuated type.
2. [Direct][Remote]-mounted, [metal][plastic]-case, vapor-actuated type.
3. [Metal][Plastic] case, [compact][industrial]-style, liquid-in-glass type.
4. [Direct][Remote]-mounted, light-activated type.
5. Test plug with [chlorosulfonated polyethylene synthetic][EPDM] self-sealing rubber inserts.

C. Thermometers at inlet and outlet of each domestic hot-water storage tank are to be the following:

1. [Liquid-filled][Sealed], bimetallic-actuated type.
2. [Direct][Remote]-mounted, [metal][plastic]-case, vapor-actuated type.
3. [Metal][Plastic] case, [compact][industrial]-style, liquid-in-glass type.
4. [Direct][Remote]-mounted, light-activated type.
5. Test plug with [chlorosulfonated polyethylene synthetic][EPDM] self-sealing rubber inserts.

D. Thermometers at inlet and outlet of each remote domestic water chiller are to be the following:

1. [Liquid-filled][Sealed], bimetallic-actuated type.
2. [Direct][Remote]-mounted, [metal][plastic]-case, vapor-actuated type.
3. [Metal][Plastic] case, [compact][industrial]-style, liquid-in-glass type.
4. [Direct][Remote]-mounted, light-activated type.
5. Test plug with [chlorosulfonated polyethylene synthetic][EPDM] self-sealing rubber inserts.

E. Thermometer stems are to be of length to match thermowell insertion length.

3.16 THERMOMETER, LEAD FREE, SCALE-RANGE APPLICATION

A. Scale Range for Domestic Cold-Water Piping:

1. [0 to 100 deg F][0 to 100 deg F and minus 20 to plus 50 deg C].
2. [0 to 150 deg F][0 to 150 deg F and minus 20 to plus 70 deg C].
3. [30 to 240 deg F][30 to 240 deg F and 0 to plus 115 deg C].

B. Scale Range for Domestic Hot-Water Piping:

1. [0 to 250 deg F][0 to 250 deg F and 0 to 150 deg C].
2. [20 to 240 deg F][20 to 240 deg F and 0 to 150 deg C].
3. [30 to 240 deg F][30 to 240 deg F and 0 to plus 115 deg C].

C. Scale Range for Domestic Cooled-Water Piping:

1. [0 to 100 deg F][0 to 100 deg F and minus 20 to plus 50 deg C].
2. [0 to 150 deg F][0 to 150 deg F and minus 20 to plus 70 deg C].

D. Insert additional paragraphs for thermometer scale ranges and applications.

3.17 PRESSURE-GAUGE APPLICATION

A. Pressure gauges at discharge of each water service into building are to be the following:

1. [Liquid filled][Sealed][Open front, pressure relief][Solid front, pressure relief]<Insert type>, [direct][remote] mounted, metal case.
2. [Sealed]<Insert type>, [direct][remote] mounted, plastic case.
3. Test plug with [chlorosulfonated polyethylene synthetic][EPDM] self-sealing rubber inserts.

B. Pressure gauges at inlet and outlet of each water pressure-reducing valve are to be the following:

1. [Liquid filled][Sealed][Open front, pressure relief][Solid front, pressure relief]<Insert type>, [direct][remote] mounted, metal case.
2. [Sealed]<Insert type>, [direct][remote] mounted, plastic case.
3. Test plug with [chlorosulfonated polyethylene synthetic][EPDM] self-sealing rubber inserts.

C. Pressure gauges at suction and discharge of each domestic water pump are to be the following:

1. [Liquid filled][Sealed][Open front, pressure relief][Solid front, pressure relief]<Insert type>, [direct][remote] mounted, metal case.
2. [Sealed]<Insert type>, [direct][remote] mounted, plastic case.
3. Test plug with [chlorosulfonated polyethylene synthetic][EPDM] self-sealing rubber inserts.

3.18 PRESSURE-GAUGE SCALE-RANGE APPLICATION

A. Scale Range for Water Service Piping:

1. [0 to 100 psi][0 to 100 psi and 0 to 600 kPa].
2. [0 to 160 psi][0 to 160 psi and 0 to 1100 kPa].
3. [0 to 200 psi][0 to 200 psi and 0 to 1400 kPa].

B. Scale Range for Domestic Water Piping:

1. [0 to 100 psi][0 to 100 psi and 0 to 600 kPa].
2. [0 to 160 psi][0 to 160 psi and 0 to 1100 kPa].
3. [0 to 200 psi][0 to 200 psi and 0 to 1400 kPa].
4. [0 to 300 psi][0 to 300 psi and 0 to 2500 kPa].

C. Insert additional paragraphs for pressure-gauge scale ranges and applications.

END OF SECTION 22 05 00

SECTION 22 13 16
SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 SUMMARY

1. Specialty pipe fittings.
2. Encasement for underground metal piping.

B. Related Requirements:

1. Section 221329 "Sanitary Sewerage Pumps" for effluent and sewage pumps.
2. Section 226600 "Chemical-Waste Systems for Laboratory and Healthcare Facilities" for chemical-waste and vent piping systems.
3. Section 333115 "Site Sanitary Sewerage Piping" for sanitary sewerage piping and structures outside the building.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

C. Shop Drawings: For hubless, single-stack drainage system. Include plans, elevations, sections, and details.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and elevations, or Building Information Model (BIM) drawn to scale, showing items described in this Section and coordinated with all building trades.

B. Seismic Qualification Certificates: For waste and vent piping, 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. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.4 FIELD CONDITIONS

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service in accordance with requirements

indicated:

1. Notify [Architect][Construction Manager][Owner] no fewer than [two]<Insert number> days in advance of proposed interruption of sanitary waste service.
2. Do not proceed with interruption of sanitary waste service without [Architect's][Construction Manager's][Owner's] written permission.

1.5 WARRANTY

A. Listed manufacturers to provide labeling and warranty of their respective products.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Components and installation are capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Soil, Waste, and Vent Piping: [10 ft. head of water]<Insert pressure>.
2. Waste, Force-Main Piping: [50 psig][100 psig][150 psig]<Insert pressure>.

B. Seismic Performance: Soil, waste, and vent piping and support and installation to withstand the effects of earthquake motions determined in accordance with [ASCE/SEI 7]<Insert requirement>. See Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment":

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[and the unit will be fully operational after the seismic event]."
2. Component Importance Factor: [1.5][1.0].

C. <Insert requirements for Component Amplification Factor and Component Response Modification Factor>.

2.2 PIPING MATERIALS

A. Piping materials to bear label, stamp, or other markings of specified testing agency.

B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.3 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in ODs or of different materials. Include end connections of same size as and

compatible with pipes to be joined.

2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

B. Dielectric Fittings:

1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

2.4 ENCASEMENT FOR UNDERGROUND METAL PIPING

A. Standard: ASTM A674 or AWWA C105/A 21.5.

B. Material: [Linear low-density polyethylene film of 0.008-inch][or][high-density, cross-laminated polyethylene film of 0.004-inch] minimum thickness.

C. Form: [Sheet][or][tube].

D. Color: [Black][or][natural]<Insert color>.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.2 INSTALLATION OF PIPING

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.

1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
2. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in [Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment"][Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment"].

K. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.

1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.
2. Use long-turn, double Y-branch, and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe.

    a. Straight tees, elbows, and crosses may be used on vent lines.

3. Do not change direction of flow more than 90 degrees.
4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.

    a. Reducing size of waste piping in direction of flow is prohibited.

L. Lay buried building waste piping beginning at low point of each system.

1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
3. Maintain swab in piping and pull past each joint as completed.

M. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:

1. Building Sanitary Waste: Two percent downward in direction of flow for piping NPS 3 and smaller; [1][2]<Insert number> percent downward in direction of flow for piping NPS 4 and larger.
2. Horizontal Sanitary Waste Piping: [Two]<Insert number> percent downward in direction of flow.
3. Vent Piping: [One]<Insert number> percent down toward vertical fixture vent or toward vent stack.

N. Install cast-iron soil piping in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Install encasement on underground piping in accordance with ASTM A674 or AWWA C105/A 21.5.

O. Install steel piping in accordance with applicable plumbing code.

P. Install stainless steel piping in accordance with ASME A112.3.1 and applicable plumbing code.

Q. Install aboveground copper tubing in accordance with CDA's "Copper Tube Handbook."

R. Install aboveground ABS piping in accordance with ASTM D2661.

S. Install aboveground PVC piping in accordance with ASTM D2665.

T. Install underground [ABS][and][PVC] piping in accordance with ASTM D2321.

U. Install engineered soil and waste and vent piping systems as follows:

1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
2. Hubless, Single-Stack Drainage System: Comply with ASME B16.45 and hubless, single-stack aerator fitting manufacturer's written installation instructions.
3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.

V. Install underground, ductile-iron, force-main piping according to AWWA C600.

1. Install buried piping inside building between wall and floor penetrations and connection to sanitary sewer piping outside building with restrained joints.
2. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
3. Install encasement on piping in accordance with ASTM A674 or AWWA C105/A 21.5.

W. Install underground, copper, force-main tubing in accordance with CDA's "Copper Tube Handbook."

1. Install encasement on piping in accordance with ASTM A674 or AWWA C105/A 21.5.

X. Install force mains at elevations indicated.

Y. Plumbing Specialties:

1. Install backwater valves in sanitary waster gravity-flow piping.

    a. Comply with requirements for backwater valves specified in Section 221319 "Sanitary Waste Piping Specialties."

2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.

a. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.
b. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."

3. Install drains in sanitary waste gravity-flow piping.

a. Comply with requirements for drains specified in Section 221319 "Sanitary Waste Piping Specialties."

Z. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

AA. Install sleeves for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for sleeves specified in Section 220500 "Common Work Results for Plumbing."

BB. Install sleeve seals for piping penetrations of concrete walls and slabs.

1. Comply with requirements for sleeve seals specified in Section 220500 "Common Work Results for Plumbing."

CC. Install escutcheons for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for escutcheons specified in Section 220500 "Common Work Results for Plumbing."

3.3 JOINT CONSTRUCTION

A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Hub-and-Spigot, Cast-Iron Soil Piping Caulked Joints: Join in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum caulked joints.

C. Hubless, Cast-Iron Soil Piping Coupled Joints:

1. Join hubless, cast-iron soil piping in accordance with CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

D. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1.

1. Cut threads full and clean using sharp dies.
2. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
b. Damaged Threads: Do not use pipe or pipe fittings with threads that are

corroded or damaged.

c. Do not use pipe sections that have cracked or open welds.

E. Join stainless steel pipe and fittings with gaskets in accordance with ASME A112.3.1.

F. Join copper tube and fittings with soldered joints in accordance with ASTM B828. Use ASTM B813, water-flushable, lead-free flux and ASTM B32, lead-free-alloy solder.

G. Grooved Joints: Cut groove ends of pipe in accordance with AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

H. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

I. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings in accordance with the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join in accordance with ASTM D2235 and ASTM D2661 appendixes.
3. PVC Piping: Join in accordance with ASTM D2855 and ASTM D2665 appendixes.

J. Joint Restraints and Sway Bracing:

1. Provide joint restraints and sway bracing for storm drainage piping joints to comply with the following conditions:

a. Provide axial restraint for pipe and fittings [5 inches]<Insert dimensions> and larger, upstream and downstream of all changes in direction, branches, and changes in diameter greater than two pipe sizes.
b. Provide rigid sway bracing for pipe and fittings [4 inches]<Insert dimensions> and larger, upstream and downstream of all changes in direction 45 degrees and greater.
c. Provide rigid sway bracing for pipe and fittings [5 inches]<Insert dimensions> and larger, upstream and downstream of all changes in direction and branch openings.

3.4 INSTALLATION OF SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in ODs.
2. In Waste Drainage Piping: [Unshielded][Shielded], nonpressure transition couplings.
3. In Aboveground Force Main Piping: Fitting-type transition couplings.

4. In Underground Force Main Piping:

    a. NPS 1-1/2 (DN 40) and Smaller: Fitting-type transition couplings.
    b. NPS 2 (DN 50) and Larger: Pressure transition couplings.

B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric [nipples][unions].
3. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric [flanges][flange kits][nipples].
4. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.5 INSTALLATION OF VALVES

A. General valve installation requirements for general-duty valve installation are specified in Section 220523 "General-Duty Valves for Plumbing Piping."

B. Shutoff Valves:

1. Install shutoff valve on each sewage pump discharge.
2. Install [gate][full-port ball] valve for piping NPS 2 and smaller.
3. Install [gate]<Insert type> valve for piping NPS 2-1/2 and larger.

C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

D. Backwater Valves: Install backwater valves in piping subject to backflow.

1. Horizontal Piping: Horizontal backwater valves.[Use normally closed type unless otherwise indicated.]
2. Floor Drains: Drain outlet backwater valves unless drain has integral backwater valve.
3. Install backwater valves in accessible locations.
4. Comply with requirements for backwater valve specified in Section 221319 "Sanitary Waste Piping Specialties."

3.6 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger and support devices and installation specified in [Section 220529 "Hangers and Supports for Plumbing Piping and Equipment"][Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment"].

1. Install [carbon-steel]<Insert material> pipe hangers for horizontal piping in noncorrosive environments.

2. Install [stainless steel][fiberglass] pipe hangers for horizontal piping in corrosive environments.
3. Install [carbon-steel]<Insert material> pipe support clamps for vertical piping in noncorrosive environments.
4. Install stainless steel pipe support clamps for vertical piping in corrosive environments.
5. Vertical Piping: MSS Type 8 or Type 42 clamps.
6. Install individual, straight, horizontal piping runs:

    a. 100 Ft. (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Ft. (30 m): MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Ft. (30 m) if Indicated: MSS Type 49, spring cushion rolls.

7. Multiple, Straight, Horizontal Piping Runs 100 Ft. (30 m) or Longer: MSS Type 44 pipe rolls. Support pipe rolls on trapeze.
8. Base of Vertical Piping: MSS Type 52 spring hangers.

C. Install hangers for [cast-iron][steel][stainless steel][and][copper] soil piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Install hangers for [ABS][and][PVC] piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Support horizontal piping and tubing within 12 inches of each fitting[, valve,] and coupling.

F. Support vertical runs of [cast-iron][steel][stainless steel][and][copper] soil piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

G. Support vertical runs of [ABS][and][PVC] piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect waste and vent piping to the following:

1. Plumbing Fixtures: Connect waste piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes

indicated, but not smaller than required by authorities having jurisdiction.

3. Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
5. Install horizontal backwater valves [with cleanout cover flush with floor][in pit with pit cover flush with floor]<Insert description>.
6. Comply with requirements for [backwater valves][cleanouts][and][drains] specified in Section 221319 "Sanitary Waste Piping Specialties."
7. Equipment: Connect waste piping as indicated.

    a. Provide shutoff valve if indicated and union for each connection.
    b. Use flanges instead of unions for connections NPS 2-1/2 and larger.

D. Connect force-main piping to the following:

1. Sanitary Sewer: To exterior force main.
2. Sewage Pump: To sewage pump discharge.

E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

F. Make connections in accordance with the following unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.8 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping.

B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.9 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary waste and vent piping in accordance with procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.

    a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.

    a. Expose work that was covered or concealed before it was tested.

3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.

    a. Close openings in piping system and fill with water to point of overflow, but not less than 10 ft. head of water.
    b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
    c. Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.

    a. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1 inch wg.
    b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
    c. Air pressure must remain constant without introducing additional air throughout period of inspection.
    d. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

E. Test force-main piping in accordance with procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved.

    a. Expose work that was covered or concealed before it was tested.

2. Cap and subject piping to static-water pressure of 50 psig above operating

pressure, without exceeding pressure rating of piping system materials.

a. Isolate test source and allow to stand for four hours.
b. Leaks and loss in test pressure constitute defects that must be repaired.

3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

3.10 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect sanitary waste and vent piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

D. Exposed Plastic Piping: Protect [ABS][PVC] plumbing vents exposed to sunlight with two coats of water-based latex paint.

E. Repair damage to adjacent materials caused by waste and vent piping installation.

3.11 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil and waste piping NPS 4 (DN 100) and smaller are to be the following:

1. Service cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings[and hubless, single-stack aerator fittings]; [CISPI][heavy-duty] hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.
4. Stainless steel pipe and fittings, sealing rings, and gasketed joints.
5. Copper Type DWV tube, copper drainage fittings, and soldered joints.
6. [Solid-wall][Cellular-core] ABS pipe, ABS socket fittings, and solvent-cemented joints.
7. [Solid-wall][Cellular-core] PVC pipe, PVC socket fittings, and solvent-cemented joints.
8. Dissimilar Pipe-Material Couplings: [Unshielded][Shielded], nonpressure transition couplings.

C. Aboveground, soil and waste piping NPS 5 (DN 125) and larger are to be the following:

1. Service cast iron, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings [and hubless, single-stack aerator fittings]; [CISPI][heavy-duty] hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.

4. Stainless steel pipe and fittings, sealing rings, and gasketed joints.
5. [Solid-wall][Cellular-core] PVC pipe, PVC socket fittings, and solvent-cemented joints.
6. Dissimilar Pipe-Material Couplings: [Unshielded][Shielded], nonpressure transition couplings.

D. Aboveground, vent piping NPS 4 (DN 100) is to be the following:

1. Service cast iron, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; [CISPI][heavy-duty] hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.
4. Stainless steel pipe and fittings gaskets, and gasketed joints.
5. Copper Type DWV tube, copper drainage fittings, and soldered joints.

    a. Option for Vent Piping, NPS 2-1/2 and NPS 3-1/2 (DN 65 and DN 90): Hard copper tube, Type M; copper pressure fittings; and soldered joints.

6. [Solid-wall][Cellular-core] ABS pipe, ABS socket fittings, and solvent-cemented joints.
7. [Solid-wall][Cellular-core] PVC pipe, PVC socket fittings, and solvent-cemented joints.
8. Dissimilar Pipe-Material Couplings: [Unshielded][Shielded], nonpressure transition couplings.

E. Aboveground, vent piping NPS 5 (DN 125) and larger is to be the following:

1. Service cast iron, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; [CISPI][heavy-duty] hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.
4. [Solid-wall][Cellular-core] PVC pipe, PVC socket fittings, and solvent-cemented joints.
5. Dissimilar Pipe-Material Couplings: [Unshielded][Shielded], nonpressure transition couplings.

F. Underground, soil, waste, and vent piping NPS 4 (DN 100) and smaller are to be the following:

1. [Extra-heavy][Service] cast-iron soil piping; [gaskets; and gasketed][caulking materials; and caulked] joints.
2. Hubless, cast-iron soil pipe and fittings; [CISPI][heavy-duty][cast-iron] hubless-piping couplings; and coupled joints.
3. Stainless steel pipe and fittings, gaskets, and gasketed joints.
4. [Solid-wall][Cellular-core] ABS pipe, ABS socket fittings, and solvent-cemented joints.
5. [Solid-wall][Cellular-core] PVC pipe, PVC socket fittings, and solvent-cemented joints.
6. Dissimilar Pipe-Material Couplings: [Unshielded][Shielded], nonpressure transition couplings.

G. Underground, soil and waste piping NPS 5 (DN 125) and larger are to be the following:

1. [Extra-heavy][Service], cast-iron soil piping; [gaskets; and gasketed][caulking materials; and caulked] joints.
2. Hubless, cast-iron soil pipe and fittings; [CISPI][heavy-duty][cast-iron] hubless-piping couplings; coupled joints.
3. [Solid-wall][Cellular-core] PVC pipe, PVC socket fittings, and solvent-cemented joints.
4. Dissimilar Pipe-Material Couplings: [Unshielded][Shielded], nonpressure transition couplings.

H. Aboveground sanitary-sewage force mains NPS 1-1/2 and NPS 2 (DN 40 and DN 50) are to be the following:

1. Hard copper tube, Type L; copper pressure fittings; and soldered joints.
2. Galvanized-steel pipe, pressure fittings, and threaded joints.

I. Aboveground sanitary-sewage force mains NPS 2-1/2 to NPS 6 (DN 65 to DN 150) are to be the following:

1. Hard copper tube, Type L; copper pressure fittings; and soldered joints.
2. Galvanized-steel pipe, pressure fittings, and threaded joints.
3. Grooved-end, galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.

J. Underground sanitary-sewage force mains NPS 4 (DN 100) and smaller are to be the following:

1. [Hard][Soft] copper tube, Type L; [wrought-]copper pressure fittings; and soldered joints.
2. Ductile-iron, mechanical-joint piping and mechanical joints.
3. Ductile-iron, push-on-joint piping and push-on joints.
4. Ductile-iron, grooved-joint piping and grooved joints.
5. Fitting-type transition coupling for piping smaller than NPS 1-1/2 and pressure transition coupling for NPS 1-1/2 and larger if dissimilar pipe materials.

K. Underground sanitary-sewage force mains NPS 5 (DN 125) and larger are to be the following:

1. Hard copper tube, Type L; [wrought-]copper pressure fittings; and soldered joints.
2. Ductile-iron, mechanical-joint piping and mechanical joints.
3. Ductile-iron, push-on-joint piping and push-on joints.
4. Ductile-iron, grooved-joint piping and grooved joints.
5. Pressure transition couplings if dissimilar pipe materials.

END OF SECTION 22 13 16

SECTION 22 13 19
SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Related Requirements:

1. Section 076200 "Sheet Metal Flashing and Trim" for metal roof flashing assemblies.
2. Section 077200 "Roof Accessories" for preformed flashings.
3. Section 078413 "Penetration Firestopping" for through-penetration firestop assemblies.
4. Section 221323 "Sanitary Waste Interceptors" for metal and concrete interceptors outside the building, grease interceptors, grease-removal devices, oil interceptors, and solids interceptors.
5. Section 221423 "Storm Drainage Piping Specialties" for trench drains for storm water, channel drainage systems for storm water, roof drains, and catch basins.
6. Section 224300 "Healthcare Plumbing Fixtures" for plaster sink interceptors.
7. Section 334200 "Stormwater Conveyance" for storm drainage piping and piping specialties outside the building.

1.2 DEFINITIONS

A. ABS: Acrylonitrile butadiene styrene.

B. PVC: Polyvinyl chloride.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Show fabrication and installation details for frost-resistant vent terminals.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sanitary waste piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTIONS

A. Sanitary waste piping specialties shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14 for plastic sanitary waste piping specialty components.

2.2 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains <**Insert drawing designation, if any**>:

1. Description: Shop or field fabricate from ASTM A74, Service Class, hub-and-spigot, cast-iron soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C564 rubber gaskets.
2. Size: Same as connected waste piping[**with increaser fitting of size indicated**].

B. Deep-Seal Traps <**Insert drawing designation, if any**>:

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.

a. **NPS 2**: **4-inch-** minimum water seal.
b. **NPS 2-1/2** and Larger: **5-inch-** minimum water seal.

C. Floor-Drain, Trap-Seal Primer Fittings <**Insert drawing designation, if any**>:

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with **NPS 1/2** side inlet.

D. Air-Gap Fittings <**Insert drawing designation, if any**>:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.
5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

E. Sleeve Flashing Device <**Insert drawing designation, if any**>:

1. Description: Manufactured, cast-iron fitting, with clamping device that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend [**1 inch**][**2 inches**]<**Insert dimension**> above finished floor and galvanized-steel pipe extension in bottom

of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

F. Stack Flashing Fittings <**Insert drawing designation, if any**>:

1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

G. Vent Caps <**Insert drawing designation, if any**>:

1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
2. Size: Same as connected stack vent or vent stack.

H. Frost-Resistant Vent Terminals <**Insert drawing designation, if any**>:

1. Description: Manufactured or shop-fabricated assembly constructed of copper, lead-coated copper, or galvanized steel.
2. Design: To provide **1-inch** enclosed air space between outside of pipe and inside of flashing collar extension, with counterflashing.

I. Expansion Joints <**Insert drawing designation, if any**>:

1. Standard: ASME A112.6.4.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected soil, waste, or vent piping.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install backwater valves in building drain piping.

1. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.

B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to **NPS 4**. Use **NPS 4** for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of **50 feet** for piping **NPS 4** and smaller and **100 feet** for larger piping.
4. Locate at base of each vertical soil and waste stack.

C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

E. Install fixture air-admittance valves on fixture drain piping.

F. Install stack air-admittance valves at top of stack vent and vent stack piping.

G. Install air-admittance-valve wall boxes recessed in wall.

H. Assemble open drain fittings and install with top of hub [**1 inch**][**2 inches**]<**Insert dimension**> above floor.

I. Install deep-seal traps on floor drains and other waste outlets, if indicated.

J. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.

1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
2. Size: Same as floor drain inlet.

K. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

L. Install sleeve and sleeve seals with each riser and stack passing through floors with waterproof membrane.

M. Install vent caps on each vent pipe passing through roof.

N. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain **1-inch** clearance between vent pipe and roof substrate.

O. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

P. Install frost-proof vent caps on each vent pipe passing through roof. Maintain **1-inch** clearance between vent pipe and roof substrate.

Q. Install wood-blocking reinforcement for wall-mounting-type specialties.

R. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 PIPING CONNECTIONS

A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment, to allow service and maintenance.

3.3 LABELING AND IDENTIFYING

A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit.

1. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221319

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SECTION 22 14 14
STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

1. Specialty pipe fittings.
2. Encasement for underground metal piping.

B. Related Requirements:

1. Section 221429 "Sump Pumps" for storm drainage pumps.
2. Section 334200 "Stormwater Conveyance" for storm drainage piping outside the building.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Hub-and-spigot, cast-iron soil pipe and fittings.
2. Hubless, cast-iron soil pipe and fittings.
3. Galvanized-steel pipe and fittings.
4. Copper tube and fittings.
5. ABS pipe and fittings.
6. PVC pipe and fittings.
7. Specialty pipe fittings.

B. Sustainable Design Submittals:

C. Shop Drawings: For controlled-flow roof drainage system. Include calculations, plans, sections, elevations, and details.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and elevations, or Building Information Model (BIM) drawn to scale, showing items described in this Section and coordinated with all building trades.

B. Seismic Qualification Certificates: For storm drainage piping, 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. Detailed description of piping anchorage devices on which the certificate is based and their installation requirements.

C. Field Quality-Control Reports: Inspection reports signed by authorities having jurisdiction.

1.4 QUALITY ASSURANCE

A. Provide materials bearing label, stamp, or other markings of specified testing agency.

1.5 FIELD CONDITIONS

A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify [Architect][Construction Manager][Owner] no fewer than [two]<Insert number> days in advance of proposed interruption of storm drainage service.
2. Do not proceed with interruption of storm drainage service without [Architect's][Construction Manager's][Owner's] written permission.

1.6 WARRANTY

A. Listed manufacturers to provide labeling and warranty of their respective products

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Components and installation are to be capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Storm Drainage Piping: [10-foot head of water]<Insert pressure>.
2. Storm Drainage, Force-Main Piping: [50 psig][100 psig][150 psig]<Insert pressure>.

B. Seismic Performance: Storm drainage piping and support and installation to withstand the effects of earthquake motions determined in accordance with [ASCE/SEI 7]<Insert requirement>. See Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

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 functional after the seismic event]."
2. Component Importance Factor: [1.5][1.0].
3. <Insert requirements for Component Amplification Factor and Component Response Modification Factor>

2.2 PIPING MATERIALS

A. Piping materials to bear label, stamp, or other markings of specified testing agency.

B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.3 GALVANIZED-STEEL PIPE AND FITTINGS

A. Cast-Iron Drainage Fittings: [Galvanized,]ASME B16.12, threaded.

B. Steel-Pipe Pressure Fittings:

1. Steel Pipe Nipples: [Galvanized,]ASTM A733, made of ASTM A53/A53M or ASTM A106/A106M, Schedule 40, seamless steel pipe. Include ends matching joining method.
2. Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.
3. Gray-Iron, Threaded Fittings: [Galvanized,]ASME B16.4, Class 125, standard pattern.

C. Cast-Iron Flanges: ASME B16.1, Class 125.

1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

2.4 COPPER TUBE AND FITTINGS

A. Solder: ASTM B32, lead free with ASTM B813, water-flushable flux.

2.5 ABS PIPE AND FITTINGS

A. Solvent Cement: ASTM D2235.

2.6 PVC PIPE AND FITTINGS

A. Adhesive Primer: ASTM F656.

B. Solvent Cement: ASTM D2564.

2.7 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in ODs or of different materials. Include end connections of same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified-piping-system fitting.

B. Dielectric Fittings:

1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

2.8 ENCASEMENT FOR UNDERGROUND METAL PIPING

A. Standard: ASTM A674 or AWWA C105/A 21.5.

B. Material: [High-density, crosslaminated polyethylene film of 0.004-inch][or][linear low-density polyethylene film of 0.008-inch] minimum thickness.

C. Form: [Sheet][or][tube].

D. Color: [Black][or][natural]<Insert color>.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.2 INSTALLATION OF PIPING

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.

B. Install piping as indicated unless deviations from layout are approved on coordination drawings.

C. Install piping in concealed locations.

1. Piping installed in equipment rooms, service areas, and where indicated may be exposed.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

L. Make changes in direction for piping using appropriate branches, bends, and long-sweep bends.

1. Do not change direction of flow more than 90 degrees.
2. Use proper size of standard increasers and reducers if pipes of different sizes are connected.

a. Reducing size of drainage piping in direction of flow is prohibited.

M. Lay buried building piping beginning at low point of each system.

1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
3. Maintain swab in piping and pull past each joint as completed.

N. Install piping at the following minimum slopes unless otherwise indicated.

1. Building Storm Drain: [1/4 inch per foot]<Insert number> downward in direction of flow for piping NPS 3 and smaller; [1/8 inch per foot][1/4 inch per foot]<Insert number> downward in direction of flow for piping NPS 4 and larger.
2. Horizontal Storm Drainage Piping: [1/4 inch per foot]<Insert number> downward in direction of flow.

O. Install cast-iron soil piping in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Ch IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Install encasement on underground piping in accordance with ASTM A674 or AWWA C105/A 21.5.

P. Install steel piping in accordance with applicable plumbing code.

Q. Install aboveground copper tubing in accordance with CDA's "Copper Tube Handbook."

R. Install aboveground ABS piping in accordance with ASTM D2661.

S. Install aboveground PVC piping in accordance with ASTM D2665.

T. Install underground [ABS][and][PVC] piping in accordance with ASTM D2321.

U. Install engineered controlled-flow drain specialties and storm drainage piping in locations indicated.

1. Install encasement on piping in accordance with ASTM A674 or AWWA C105/A 21.5.

V. Install force mains at elevations indicated.

W. Plumbing Specialties:

1. Install backwater valves in storm drainage gravity-flow piping.

a. Comply with requirements for backwater valves specified in Section 221423 "Storm Drainage Piping Specialties."

2. Install cleanouts in storm drainage gravity-flow piping in accessible locations.

a. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping.
b. Comply with requirements for cleanouts specified in Section 221423 "Storm Drainage Piping Specialties."

3. Install drains in storm drainage gravity-flow piping.

a. Comply with requirements for drains specified in Section 221423 "Storm Drainage Piping Specialties."

X. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

Y. Install sleeves for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for sleeves specified in Section 220500 "Common Work Results for Plumbing."

Z. Install sleeve seals for piping penetrations of concrete walls and slabs.

1. Comply with requirements for sleeve seals specified in Section 220500 "Common Work Results for Plumbing."

AA. Install escutcheons for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for escutcheons specified in Section 220500 "Common Work Results for Plumbing."

3.3 JOINT CONSTRUCTION

A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Hub-and-Spigot, Cast-Iron Soil Piping Caulked Joints: Join in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum caulked joints.

C. Hubless, Cast-Iron Soil Piping Coupled Joints: Join in accordance with CISPI 310 and

CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

D. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1.

1. Cut threads full and clean using sharp dies.
2. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

    a. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
    b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
    c. Do not use pipe sections that have cracked or open welds.

E. Join copper tube and fittings with soldered joints in accordance with ASTM B828. Use ASTM B813, water-flushable, lead-free flux and ASTM B32, lead-free-alloy solder.

F. Grooved Joints: Cut groove ends of pipe in accordance with AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fittings. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

G. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

H. Plastic, Nonpressure-Piping, Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings in accordance with the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join in accordance with ASTM D2235 and ASTM D2661 appendices.
3. PVC Piping: Join in accordance with ASTM D2855 and ASTM D2665 appendices.

I. Joint Restraints and Sway Bracing:

1. Provide joint restraints and sway bracing for storm drainage piping joints to comply with the following conditions:

    a. Provide axial restraint for pipe and fittings [5 inches]<Insert dimensions> and larger, upstream and downstream of all changes in direction, branches, and changes in diameter greater than two pipe sizes.
    b. Provide rigid sway bracing for pipe and fittings [4 inches]<Insert dimensions> and larger, upstream and downstream of all changes in direction 45 degrees and greater.
    c. Provide rigid sway bracing for pipe and fittings [5 inches]<Insert dimensions> and larger, upstream and downstream of all changes in direction and branch openings.

3.4 INSTALLATION OF SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in ODs.
2. In Drainage Piping: [Unshielded][Shielded], nonpressure transition couplings.
3. In Aboveground Force-Main Piping: Fitting-type transition couplings.

B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric [nipples][unions].
3. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric [flanges][flange kits][nipples].
4. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.5 INSTALLATION OF VALVES

A. General valve installation requirements for general-duty valve installations are specified in Section 220523 "General-Duty Valves for Plumbing Piping."

B. Shutoff Valves:

1. Install shutoff valve on each sump pump discharge.
2. Install [gate][full port ball valve] for piping NS 2 and smaller.
3. Install [gate][butterfly]<Insert type> valve for piping NPS 2-1/2 and larger.

C. Check Valves: Install swing-check valve, between pump and shutoff valve, on each sump pump discharge.

D. Backwater Valves: Install backwater valves in piping subject to backflow.

1. Horizontal Piping: Horizontal backwater valves.[Use normally closed type unless otherwise indicated.]
2. Install backwater valves in accessible locations.
3. Comply with requirements for backwater valves specified in Section 221423 "Storm Drainage Piping Specialties."

3.6 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for hangers, supports, and anchor devices specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

1. Install [carbon-steel]<Insert material> pipe hangers for horizontal piping in noncorrosive environments.
2. Install [stainless steel][fiberglass] pipe hangers for horizontal piping in corrosive

environments.

3. Install [carbon-steel]<Insert material> pipe support clamps for vertical piping in noncorrosive environments.
4. Install stainless steel pipe support clamps for vertical piping in corrosive environments.
5. Vertical Piping: MSS Type 8 or Type 42, clamps.
6. Install individual, straight, horizontal piping runs:

    a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet (30 m) if Indicated: MSS Type 49, spring cushion rolls.

7. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
8. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Install hangers for [cast-iron][galvanized-steel][and][copper] soil [tubing][and][piping], with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Install hangers for [ABS][and][PVC] piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Support horizontal piping and tubing within 12 inches of each fitting[, valve,] and coupling.

F. Support vertical [cast-iron][galvanized steel][and][copper][tubing][and][piping] to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent, but as a minimum at base and at each floor.

G. Support vertical [ABS][and][PVC] piping with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.

C. Connect storm drainage piping to roof drains and storm drainage specialties.

1. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.

2. Install horizontal backwater valves [with cleanout cover flush with floor][in pit with pit cover flush with floor]<Insert description>.
3. Comply with requirements for [backwater valves][cleanouts][and][drains] specified in Section 221423 "Storm Drainage Piping Specialties."

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

E. Make connections in accordance with the following unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.8 IDENTIFICATION

A. Identify exposed storm drainage piping.

B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.9 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test storm drainage piping in accordance with procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.

a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved.

a. Expose work that was covered or concealed before it was tested.

3. Test Procedure:

a. Test storm drainage piping[, except outside leaders,] on completion of roughing-in.
b. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water.
c. From 15 minutes before inspection starts until completion of inspection, water level must not drop.
d. Inspect joints for leaks.

4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved.

a. Expose work that was covered or concealed before it was tested.

2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials.

a. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.

3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

3.10 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

3.11 PROTECTION

A. Protect piping and drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

B. Place plugs in ends of uncompleted piping at end of day and when work stops.

C. Repair damage to adjacent materials caused by storm drainage piping installation.

3.12 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground storm drainage piping [NPS 6 and smaller]<Insert pipe size range> is to be[any of] the following:

1. Service weight, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; [CISPI,][heavy-duty,] hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.
4. Copper Type DWV tube, copper drainage fittings, and soldered joints.
5. [Solid-wall][Cellular-core] ABS pipe, ABS socket fittings, and solvent-cemented joints.
6. [Solid-wall][Cellular-core] PVC pipe, PVC socket fittings, and solvent-cemented joints.
7. Dissimilar Pipe-Material Couplings: [Unshielded][Shielded], nonpressure transition couplings.

C. Aboveground, storm drainage piping [NPS 8 and larger]<Insert pipe size range> is to be[any of] the following:

1. Service weight, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; [CISPI,][heavy-duty,] hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.
4. Copper Type DWV tube, copper drainage fittings, and soldered joints.
5. [Solid-wall][Cellular-core] PVC pipe, PVC socket fittings, and solvent-cemented joints.
6. Dissimilar Pipe-Material Couplings: [Unshielded][Shielded], nonpressure transition couplings.

D. Underground storm drainage piping [NPS 6 and smaller]<Insert pipe size range> shall be[any of] the following:

1. [Extra heavy][Service weight], cast-iron soil pipe and fittings; [gaskets; and gasketed][caulking materials; and caulked] joints.
2. Hubless, cast-iron soil pipe and fittings; [CISPI,][heavy-duty,][cast-iron,] hubless-piping couplings; and coupled joints.
3. [Solid-wall][Cellular-core] ABS pipe, ABS socket fittings, and solvent-cemented joints.
4. [Solid-wall][Cellular-core] PVC pipe, PVC socket fittings, and solvent-cemented joints.
5. Dissimilar Pipe-Material Couplings: [Unshielded][Shielded], nonpressure transition couplings.

E. Underground, storm drainage piping [NPS 8 and larger]<Insert pipe size range> is to be[any of] the following:

1. [Extra heavy][Service weight], cast-iron soil pipe and fittings; [gaskets; and

gasketed][caulking materials; and caulked] joints.

2. Hubless, cast-iron soil pipe and fittings; [CISPI,][heavy-duty,][cast-iron,] hubless-piping couplings; and coupled joints.
3. [Solid-wall][Cellular-core] PVC pipe, PVC socket fittings, and solvent-cemented joints.
4. Cellular-core, sewer and drain series, PVC pipe; PVC socket fittings; and solvent-cemented joints.
5. Dissimilar Pipe-Material Couplings: [Unshielded][Shielded], nonpressure transition couplings.

F. Aboveground storm drainage force mains [NPS 1-1/2 and NPS 2]<Insert pipe size range> is to be[any of] the following:

1. Hard copper tube, Type L copper pressure fittings, and soldered joints.
2. Galvanized-steel pipe, pressure fittings, and threaded joints.

G. Aboveground storm drainage force mains [NPS 2-1/2 to NPS 6]<Insert pipe size range> is to be[any of] the following:

1. Hard copper tube, Type L copper pressure fittings, and soldered joints.
2. Galvanized-steel pipe, pressure fittings, and threaded joints.
3. Grooved-end, galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.
4. Fitting-type transition couplings if dissimilar pipe materials.

END OF SECTION 22 14 14

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SECTION 22 14 23
STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. General-purpose roof drains.

B. Promenade roof drains.

C. Deck roof drains.

D. Cleanouts.

E. Backwater valves.

F. Cured in Place Pipe (CIPP)

G. Related Requirements:

1. Section 076200 "Sheet Metal Flashing and Trim" for penetrations of roofs.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 GENERAL-PURPOSE ROOF DRAINS

2.2 PROMENADE ROOF DRAINS

2.3 DECK ROOF DRAINS

2.4 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

A. Downspout Adapter:

1. Description: Manufactured, gray-iron casting, for attaching to horizontal-outlet,parapet roof drain and to exterior sheet metal downspout.
2. Size: Inlet size to match parapet drain outlet.

B. Cured in Place Pipe (CIPP):

1. Description: Provide and install a cured in place pipe (CIPP) for rehabilitation of sanitary sewer mains.
2. Materials:

a. Flexible Tube. Provide a flexible tube manufactured and fabricated under quality controlled conditions set by the process manufacturer. Use a tube sized so that, when installed, the tube will snugly fit the internal circumference of the sewer pipe and produce the specified thickness and physical properties when the resin cures.
b. Use a tube length necessary to fully span the distance between manholes. Include sufficient amount of material for sealing at manholes and product sampling, when required.
c. Fabric tube must have a minimum tensile strength of 750 psi in both the longitudinal and transverse directions when tested in accordance to ASTM D5035.
d. The tube may consist of one or more layers of flexible needled felt or an equivalent non-woven or woven material or a combination of non-woven and woven materials that are compatible with the resin system used and are capable of supporting and carrying resin, and capable of withstanding installation pressures and curing temperatures. The tube must be capable of withstanding installation procedures and curing temperatures. Longitudinal and circumferential joints between multiple layers of a tube must be staggered to not overlap. The tube must be fabricated to fit its final in-place position in the existing pipe, with allowance for stretch as recommended by the tube manufacturer. The elongation or expansion of the flexible tube during installation is limited to a 5 to 10% minimum reduction of the finished wall thickness, both longitudinally and circumferentially.
e. The tube may consist of a seamless, spirally wound glass fiber that is flexible and has strain values (expandable) between five 5 to 10% . The fiberglass liner must not have a longitudinal seam. The impregnated liner must have a uniform thickness that, when compressed at installation pressures will meet or exceed the design thickness. Fiberglass materials must be “direct sized” to enhance the fiberglass/resin bond.
f. Resin. Provide a liquid thermosetting resin to saturate the tube and produce a properly cured liner which is resistant to abrasion due to soils, grit, and sand. Use virgin polyester, vinyl ester, or epoxy resin complying with the following requirements. All recycled polyethylene terephthalate (PET) resins are prohibited.
g. Polyester Resin. A resin created by reaction products between isophthalic/tetrathalic acid, maleic anhydride, and a glycol characterized by reactive unsaturation located along the molecular chain. This resin is compounded with a reactive styrene monomer and reacted together with initiators/promoters to produce cross-linked copolymer matrices.
h. Vinyl Ester Resin. A resin created by reaction products of epoxy resins with methacrylic acid and characterized by reactive unsaturation located in terminal positions of the molecular chain. This resin is compounded with a reactive styrene monomer and reacted together with initiators/promoters to produce cross linked copolymer matrices.
   Preparation. A resin created by reaction products ob biphenyl A and epichlorohydrin producing glycidyl ether reactive sites in the terminal position of the molecular chain. This resin is cross-linked with the reactive equivalent of a curing agent suitable for the cured-in-place process.
i. Polyvinyl Chloride Pipe (PVC). Diameters 4 in. through 15 in., provide SDR 26, ASTM 3034 PVC gravity sewer pipe. Diameters 18 in. through 48 in., provide PS115, ASTM 679 PVC gravity sewer pipe.

3. Equipment:
    a. Cleaning Equipment. Select cleaning equipment and methods based on the condition of the sanitary sewer mains at the time work begins. More than one method or type of equipment may be required on a single project or at a single location.
    b. When requested by the City Engineer, demonstrate at the performance capabilities of cleaning equipment and methods proposed for use on the project. If results obtained by demonstration are not satisfactory, provide other equipment that will clean the sewer line.
    c. For high-velocity cleaning use a water jet capable of producing a minimum volume of 50 gpm with a pressure of 1,500 psi at the pump. Install a gauge to indicate working pressure on the discharge of high-pressure water pumps. In addition to conventional nozzles, use a nozzle which directs the cleaning force to the bottom of the pipe for sewers 18 in. and larger.
    d. When hydraulic or high-velocity cleaning equipment is used, install a suitable sand trap, weir, dam or suction device in the downstream manhole so that solids and debris are trapped for removal.
    e. Cleaning Accessories. When an additional quantity of water from the public water supply is needed to meet the cleaning requirements of the equipment and the sewer, obtain transient water meters from the City for installation on trucks or at fire hydrants.
    f. All cleaning equipment must be equipped with backflow preventers (air gap or RPZ) to prevent contamination to the public water supply.
    g. Video Equipment. Select and use video equipment that will produce color digital video discs.
    h. Pipe Inspection Camera. Produce a video using a pan-and-tilt, radial-viewing, pipe inspection camera that pans ± 275 degrees and rotates 360 degrees. Use a camera with an accurate footage counter which displays on the monitor the exact distance of the camera from the centerline of the starting manhole. Use a camera with camera height adjustment so that the camera lens is always centered at one-half the inside diameter, or higher, in the pipe to be clearly seen. A reflector in front of the camera may be required to enhance lighting in dark or large-diameter pipe.
    i. Two labels are required, one on the digital video disc case and the other on the face of the disc.
    j. Disc must show only one basin. Only line segments from the same basin will be included on a single video disc.
    k. Up to 5 (maximum) line segments may be included on the same DVD if they are in the same basin.

4. CONSTRUCTION
    a. Preparation.
    b. Cleaning. Take precautions to protect sanitary sewer mains and manholes from damage that might be inflicted by the improper selection of cleaning processes or improper use of equipment. When using hydraulically-propelled devices, take precautions to ensure that the water pressure created does not cause damage to or flooding of public or private property. Do not surcharge any sanitary sewer to an elevation that could cause overflow of sewage into area waterways, homes, buildings, or onto the surface.

c. Do not use or obstruct a fire hydrant when there is a fire in the area. Remove water meters, fittings, and piping from fire hydrants at the end of each working day.
d. Exercise care to prevent contamination of the potable water system. Use an appropriately sized backflow preventer as required by the City of Victoria Utilities Department when drawing water from a public hydrant.
e. Do not waste water from the public water supply through poor connections, hydrants left open or any other cause.
f. Use collapsible dams for hydraulically propelled devices which require a head of water to operate. Dam must be easily collapsible to prevent damage to the sewer, public, and private property.
g. Operate high-velocity cleaning equipment so that the pressurized nozzle moves continuously. Turn off or reduce the flow to the nozzle to prevent damage to the line any time the nozzle becomes stationary.
h. In addition to normal cleaning equipment, perform mechanical cleaning when required and approved using equipment and accessories as defined in this Section.
i. Remove sludge, soil, sand, rocks, grease, roots, and other solid or semi-solid material resulting from the cleaning operation at the downstream manhole of the section being cleaned. Passing debris from any sewer section to any other sewer section is not allowed. Load debris from the manholes into an enclosed container permitted by the City of Victoria for liquid waste hauling. Remove solids and semi-solids resulting from cleaning operations from the site and dispose them lawfully at the end of each work day. Do not accumulate debris, liquid waste, or sludge on the site except in totally enclosed containers approved by the City Engineer. Contractor may choose to provide and store debris from the cleaning process in an enclosed container (roll-off container) as permitted by the City of Victoria for liquid waste hauling, or the Contractor may choose to leave the debris in the vacuum truck and haul directly to the disposal site.
j. Dispose of waste at a lawfully-permitted disposal site using a transporter having a valid City Liquid Waste Transporter Permit.
k. Televising. Immediately after cleaning, video the sanitary sewer line to document the condition of the line and to locate existing service connections. Notify the City Engineer 24 hr. in advance of any television inspection so that the City Engineer may observe inspection operations.
l. Perform television inspection of sanitary sewers as follow:
m. Perform a survey television inspection on sanitary sewers within the boundary of the project, as directed by the City Engineer. After reviewing survey digital video discs, the City Engineer will determine which sanitary sewers will be rehabilitated or need additional work.
n. Perform pre-installation television inspection immediately after line cleaning and before line rehabilitation work. Pre-installation video is not required for sewer lines designated to be removed and replaced. Verify that the line is clean and ready to accept the line rehabilitation. Prepare. Television Inspection Report forms.
o. Maintain copies of discs and reports for reference by the City Engineer for the duration of the project.
p. Videos must pan beginning and ending manholes to show that all debris has been removed. Camera operator must slowly pan each service connection, clamped joint and pipe material transition from one material

to another. Complete and submit a Television Inspection Report for every sewer segment video submitted to the City Engineer.

q. Perform post-installation television inspection to confirm completion of rehabilitation work, including removal and replacement. Verify that rehabilitation work conforms to the requirements of the Drawings and

r. Specifications. Provide a color digital video disc showing the completed work, including the condition of restored service connections. Prepare and submit Television Inspection Report forms providing location of service connections along with location of any discrepancies. Post-Installation video of completed manholes may be substituted for photographic documentation, as described in Section 02768 – Corrosion Protection Liner and Rehabilitation of Manholes. Manhole work, including benches, inverts and pipe penetrations into manhole, must be complete prior to post-installation video work.

s. Survey television inspection discs must be continuous for pipe segments between manholes. Do not leave gaps in the videotaping of a segment between manholes and do not show a single segment on more than one video, unless specifically allowed by the City Engineer.

t. Perform survey TV inspection on one manhole section at a time. Adequately control the flow in the section being taped. Do not exceed the depth of wastewater in accordance with Table 1.

Table 1

Pipe Diameter (in.)	Depth of Flow (percent of pipe diameter)
6–10	10
12–24	15
Over 24	20

u. If during survey television inspection of a manhole section, the wastewater flow depth exceeds the maximum allowable, reduce the flow depth to an acceptable level by performing the survey television inspection during minimum flow hours, by diversion pumping, or by pulling a camera with swab, high-velocity jet nozzle, or another acceptable dewatering device. Video made while floating the camera is not acceptable unless approved by the City Engineer.

v. Minimize flow in the line while performing pre-installation television inspection.

w. No flow is allowed in the line while performing post-installation television inspection.

x. Passage of TV Camera. Do not pull or propel the video camera through the line at a speed greater than 30 ft. per minute.

y. If during survey television inspection of a manhole section, the camera is unable to pass an obstruction even though flow is unobstructed, televise the manhole section from the other direction (reverse setup) in order to obtain a complete video of the line. Whenever such a condition arises, notify the City Engineer to determine whether an obstruction removal or point repair is necessary. If a point repair is authorized, repair the pipe at the designated location and then re-televise the manhole section to verify completion of the point repair, unless waived by the City Engineer.

z. When the camera is being pulled from the other direction in order to survey on either side of an obstruction and a second obstruction or repair location is encountered away from the first obstruction, notify the City Engineer and request a review of the digital video disc. The City Engineer may direct the Contractor to make one or both point repairs. No downtime will be allowed.

aa. If two-point repairs are allowed and completed, re-tape the manhole section. Generally, up to 20 ft. of the sewer pipe from the finished end of the first point repair to the starting end of the second point repair may be lamped or physically inspected to verify the condition of the sewer without further television inspection.

bb. The City makes no guarantee that the sanitary sewer designated for survey television after cleaning is clear for the passage of the camera set-up. Select the appropriate equipment, tools, and methods for securing safe passage of the camera.

cc. During pre-installation television inspection, camera passage must show the line is ready for rehabilitation. Report to the City Engineer any variations between previous reported (existing data) conditions and the actual conditions encountered.

dd. For post-installation television inspection, exercise the full capabilities of the camera equipment to document the completion of the rehabilitation work and the conformance of the work to the Drawings and Specifications. Provide a full 360-degree view of pipe, joints, and service connections.

ee. For each television inspection video provide a completed Television Inspection Report, as attached at the end of this section. The Report is a written narrative log of pipe defects, sags, service connection locations, and conditions, indexed to the footage counter.

ff. Fill out the Television Inspection Report as follows:

gg. Digital Video Disc: Provide first generation digital video disc in a format that can be read by computer and by all DVD players. Permanently label each disc with the following information:

Project No.: _____ Contractor's Name: _____
Inspection Type: [ ] Survey [ ] Pre-Installation [ ] Post-Installation
Disc No.: _____ Date Taped: _____ Date Submitted: _____
Address: UPS: _____ DWN: _____
Pipe Diameter: _____ Pipe Length: _____
Manhole No.: From: _____ To: _____

hh. Television inspection report must note deficiencies in the existing main, as well as the location for cracks, damaged joints, laterals roots, debris,

alignment problems, (sags, etc.) and any other abnormality.

ii. Obstruction Removals.

jj. Remote Device. Remove obstructions identified on video tape of a sanitary line segment which could cause a non-uniform liner pipe installation or obstruction of the liner during installation. Obtain approval from the ENGINEER for obstruction removal with a remote device before proceeding.

kk. Use a power driven cutting device (Robotic cutter) to remove protruding taps. Cut the protruding tap so that the protrusion is no greater than ¾- in. If the cutting device cannot remove the protruding tap, then point repair may be performed at the direction of the ENGINEER.

ll. To remove other obstructions, use a remove device. Pull or drive the devices from manhole to manhole using a solid steel mandrel, porcupine, root saw, bucket, robotic cutter or similar devices to remove the obstruction. Select a device that is adequately sized to remove the obstruction.

mm. Point Repairs. Verify location of point repair obtained from televising the main. Excavate repair location. Minimum length for repair to be one standard joint of PVC pipe (20-ft.). Remove and replace failed pipe and connected to existing pipe with shielded flexible adapters. Backfill repair location in accordance with standard bedding details.

nn. Provide Trench Excavation Protection in accordance with Item 402, if required.

oo. Diversion Pumping. Perform diversion pumping as required to install CIPP.

pp. Diversion Pumping Requirements.

qq. The pump and diversion pumping lines must be of adequate capacity and size to handle the peak flow conditions. All piping, joints, and accessories must be designed to withstand at least twice the maximum system pressure, or a minimum of 50 psi, whichever is greater.

rr. Internal and external diversion pumping operations must use 100% leak proof pipe such as yellow mine of HDPE with positive, restrained joints. Discharge hose will only be allowed in short sections and by specific permission from the engineer.

ss. All pumps must be fully automatic and solids handling, self-priming or submersible pumps in good working order with a working pressure gauge on the discharge. Self-priming pumps should not require the use of foot-valves or vacuum pumps in the priming system. All pumps used must be constructed to allow dry running for long periods of time to accommodate the cyclical nature of effluent flows. Provide the necessary stop and start controls for each pump. A back-up pump of the same capacity as the primary pump must be maintained on site at all times to be used in the event that the primary pump fails. No wastewater should be allowed to drain or stand in earthen sump pits.

tt. Demonstrate that the pumping system is in good working order and is sufficiently sized to successfully handle flows by performing a test run for a period of 24 hr. before beginning the work.

uu. Have all materials, equipment, and labor necessary to complete the repair or replacement on the job site prior to isolating the wastewater manhole or line segment and beginning diversion-pumping operations.

vv. Maintain sewage flow to prevent back up or overflow onto streets, yards, and unpaved areas or into buildings, adjacent ditches, storm sewers, and waterways. Do not divert sewage outside of the sanitary sewer system. Take all necessary steps to prevent flooding of public or private property. Maintaining flow inside the existing pipe during rehabilitation operations is preferred.

ww. Any time the diversion pumps are operating, an experienced operator must be on site to monitor the operations: adjust pump speed, valves, etc.; maintain and make minor repairs to the system; and report problems.

xx. Where work requires diverting beyond working hours, operate diversion pumping and man the system 24 hr. per day.

yy. Ensure that no damage will be caused to private property as a result of diversion pumping operations. Access to adjacent properties must be maintained at all times. Ramps, steel plates or other methods must be employed by the Contractor to facilitate traffic over surface piping. High traffic commercial properties may require alternate methods.

zz. Complete the work as quickly as possible and satisfactorily pass all tests, inspections and repair all deficiencies prior to discontinuing diversion pumping operations and returning flow to the sewer manhole or line segment.

aaa. During diversion pumping, do not allow sewage to be leaked, dumped or spilled in or onto any area outside of the existing sanitary sewer system.

bbb. In the event of accidental spill of overflow, immediately stop the discharge and take action to clean up and disinfect the spill. Promptly notify the Engineer so that required reporting can be made to the Texas Commission on Environmental Quality (TCEQ) by the Department.

ccc. In the event of accidental spill of overflow, the Contractor is responsible for any damages that may have occurred to public or private property including cleaning, disinfection and other corrections to the satisfaction of the Engineer at no cost to the Department.

ddd. Do not intentionally damage, alter or remove portions of the existing sewer system structures for the purpose of installing a diversion pumping system without specific approval from the Engineer or Inspector. If a structure is damaged, it must be reconstructed or replaced to the satisfaction of the Engineer at no additional cost to the Department.

eee. The Contractor must be responsible for any and all damage that results directly or indirectly from the interference of storm water runoff to diverting equipment, piping and appurtenances.

fff. When diversion pumping operations are complete, piping must be drained into the sanitary sewer prior to disassembly and all pumps and lines must be flushed with clean water until all discharge is clear.

ggg. Felt Liner/Thermal Cured CIPP. Notification: Inform the Engineer of work schedules for CIPP installation: Provide 24-hr. notice for the Engineer to witness the “wet-out” procedure. Provide 24-hr. notice to Engineer prior to inversion and curing of liner.

hhh. Conduct operations in accordance with applicable OSHA standards, including those safety requirements involving work on an elevated platform and entry into a confined space. Make suitable precautions to eliminate hazards to personnel near construction activities when pressurized air is being used.

iii. Wet-Out: Designate a location where the flexible tube will be impregnated with resin. Thoroughly saturate flexible tube prior to installation. A catalyst system or additive, compatible with the resin and flexible tube, must be used in accordance with manufacturer's recommendations. Handle the resin-impregnated flexible tube to retard or prevent resin setting until it is ready for insertion.

jjj. Insertion: Insert flexible tube through an existing manhole or access structure by means of inversion, pull-in or other approved procedure.

kkk. Curing Follow. Manufacturer's recommended cure schedule in curing on liner.

lll. After insertion is completed, apply a suitable recirculation system capable of delivering steam or water uniformly throughout the section to achieve a consistent cure of the resin. Maintain the curing temperature as recommended by the resin/catalyst system manufacturer.

mmm. Provide suitable monitors near the heat source to gauge the temperature of incoming and outgoing water or steam supply. Place additional temperature sensors between the impregnated tube and invert of the original pipe at each manhole to monitor the outside temperature of the liner while curing.

nnn. Continue uninterrupted heating until the required curing temperature is achieved. Accurately measure temperatures at both ends of the CIPP. Initial cure is considered complete when exposed portions of the flexible tube pipe appear to be cured and the remote temperature sensors have achieved the external temperature recommended by the resin/catalyst system manufacturer.

ooo. Cool Down: Initiate a controlled cool down of the hardened pipe to a temperature below 100°F, in accordance with the cure schedule. Take care in release of the water column so that a vacuum will not develop that could damage the newly installed pipe. Do not discharge water in excess of 100°F into the sanitary sewer system.

ppp. Finished Pipe: Provide a finished CIPP which is continuous and free as commercially practicable from visual defects such as foreign inclusions, dry spots, pinholes, lifts and delamination, and areas which have not cured sufficiently.

qqq. If a point repair is required after the liner has cured, use a tube segment to splice across the point repair. The overlap on each end must be twice the diameter, or 12- in., whichever is greater. Cure the segment using the same process as used for the original liner.

rrr. Fiberglass/UV Cure CIPP Installation.

sss. Installation of the impregnated liner must be by insertion as specified by the manufacturer. All equipment, labor, materials, and processes that are required to complete the work must be ready on-site before installation begins.

ttt. The first segment must be lined, completed, and accepted to become the "job standard" against which all- subsequent work is judged.

uuu. Pre-Installation. Prior to installation of the liner, the following activities are required:

- Receipt and approval of pre-installation submittals. Verification of line condition and any obstructions by video inspection.
- Verification of existing taps in service by flowing water, dye test, or visually with a pan and tilt head camera or other means.

vvv. Cleaning of line (recorded on videotape).

www. Point Repairs: Construct and complete any and all point repairs deemed necessary. Approval from the Engineer before reworking the lines and liner installation is required..

xxx. Set-up. Prior to installation all necessary traffic control measures must be put into place and the diversion pumping system, including back-up pumps, must be tested and running. Make every effort to protect the environment from any sewer contamination. Provide 24-hr. notice for the Engineer to witness set-up.

yyy. Outer Film. To control resin loss, liner thickness and contamination of the resin by water or other contaminants an outer film material must be manufactured on the exterior surface of the liner. This outer film material must be fabricated from a styrene barrier material, which is specified by the manufacturer. This outer film must remain in-place after UV curing of the liner has been completed. The installation must be witnessed by the City Engineer.

zzz. Slip Sheet Insertion. A plastic slip-sheet must be installed in the bottom half of the pipe prior to liner insertion. The slip-sheet is used to protect the outer film from damage during insertion from offset joints, broken pipe, or slightly protruding taps. In addition, it will increase flow characteristics and reduce friction during the pull-in process.

aaaa. A double capstan, constant tension winch must be used to pull the glass fiber liner into position in the pipe. Once inserted, end plugs or packers must be used to cap each end of the fiberglass liner to prepare for pressurizing the liner. The packers must be secured with straps to prevent them from being expelled due to pressure.

bbbb. The spiral wound fiberglass liner must be cured with UV light sources at a constant inner pressure. When inserting the curing equipment in the liner, care must be taken to not damage the inner film material.

cccc. The UV light sources must be assembled according to the manufacturer's specifications for the liner diameter. For the liner to achieve the required water tightness and specified mechanical properties, the following parameters must be controlled during the entire curing process, giving the Engineer a record of the curing parameters over every segment of the entire length of the liner. This demonstrates that the entire liner is cured properly. The recording will include:

- Curing Speed,
- Light source working & wattage,
- Inner air pressure,
- Exothermic (curing) temperatures,
- Date and time, and
- Length of liner.

dddd. This will be accomplished using a computer and database that are tamper proof. During the curing process, infrared sensors will be used to record curing data that will be submitted to the Engineer with a post CCTV inspection on DVD.

eeee. The parameters for curing speed, inner air pressure and wattage are defined in the Quality Tracker UV curing protocol issued by the manufacturer. The optimal curing speed, or travel speed of the energized UV light sources, is determined for each length of liner based on liner

diameter, liner thickness, and exothermic reaction temperature.

ffff. The UV light train must be capable of curing the fiberglass liner at a curing rate of up to 10 LF (liner feet) per minute.

gggg. The inner film material must be removed and discarded after curing to provide optimal quality of the final product.

hhhh. After the CIPP has been cured in place, reopen the service connections. This must be done without excavation. In the case of non-man entry pipe from the interior of the pipeline, provide entry by means of a television camera and a cutting device that re-establishes the service connection to not less than 100% capacity. A water pressure devise must not be used since they may cause wicking at lateral openings. Lateral opening edges must be sealed with a resin mixture compatible with the tube resin. Certify (or Assure) there is a minimum of 2 complete working cutter units plus spare key components on the site before each inversion. No additional payment will be made for excavation for the purpose of reopening connections and the Contract will be responsible for all costs and liability associated with such excavation and restoration work.

iiii. Form a tight seal between the CIPP and the manhole wall at the pipe penetration. Do not leave any annular gaps. Seal the annular space with a ¼-in. diameter activated Oakum band soaked in chemical sealant. Seal any annular spaces greater than ¼-in. with manhole wall repair material. Finish off the seal with a non-shrink grout or cementitious liner material placed around the pipe opening from inside the manhole in a band at least 4 in. wide. Complete the sealing procedure for each liner segment immediately after the liner is cured.

jjjj. Post Installation Inspection. Provide a video tape showing the completed work including all restored connections.

kkkk. Final Cleanup. Upon completion of the rehabilitation work and testing, clean and restore project area affected by the work.

5. Measurement:

   a. Rehab Sanitary Sewer with CIPP" will be measured by the foot for the installed liner. "Point Repair Sanitary Sewer Main" will be measured as each by diameter.

6. Payment:

   a. The work performed and materials furnished under this Item and measured as provided under measurement will be paid for at the unit price bid for "Rehab Sanitary Sewer with CIPP" of the size installed. This Item includes all preliminary inspection, cleaning, debris removal, diversion pumping, liner materials and installation, service reopening, post installation video, and cleanup.

   b. The work performed and materials furnished under this Item and measured as provided under measurement will be paid for at the unit price bid for "Point Repair Sanitary Sewer Main" of the size installed. This Item includes removing a 20-ft. section of sewer main and installing a new PVC sewer main including flexible connections, excavation, backfill, and diversion pumping.

2.5 CLEANOUTS

2.6 BACKWATER VALVES

PART 3 - EXECUTION

3.1 INSTALLATION OF GENERAL-PURPOSE ROOF DRAINS

A. Install general-purpose roof drains in accordance with roof membrane manufacturer's written installation instructions at low points of roof areas.

1. Install flashing collar or flange of roof drain to maintain integrity of waterproof membranes where penetrated.
2. Install expansion joints, if indicated, in roof drain outlets.
3. Position roof drains for easy access and maintenance.

B. Fabricate flashing from single piece of metal unless large pans, sumps, or other drainage shapes are required.

C. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

D. Set flashing on roofs in solid coating of bituminous cement.

E. Secure flashing into sleeve and specialty clamping ring or device.

F. Install through-penetration firestop assemblies for penetrations of fire- and smoke-rated assemblies.

1. Comply with requirements in Section 078413 "Penetration Firestopping."

3.2 INSTALLATION OF PROMENADE ROOF DRAINS

A. Install promenade roof drains in accordance with roof membrane manufacturer's written installation instructions at low points of roof areas.

1. Install flashing collar or flange of roof drain to maintain integrity of waterproof membranes where penetrated.
2. Install expansion joints, if indicated, in roof drain outlets.
3. Position roof drains for easy access and maintenance.

B. Fabricate flashing from single piece of metal unless large pans, sumps, or other drainage shapes are required.

C. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

D. Set flashing on roofs in solid coating of bituminous cement.

E. Secure flashing into sleeve and specialty clamping ring or device.

F. Install through-penetration firestop assemblies for penetrations of fire- and smoke-rated assemblies.

1. Comply with requirements in Section 078413 "Penetration Firestopping."

3.3 INSTALLATION OF DECK ROOF DRAINS

A. Install deck roof drains in accordance with roof membrane manufacturer's written installation instructions at low points of roof areas.

1. Install flashing collar or flange of roof drain to maintain integrity of waterproof membranes where penetrated.
2. Install expansion joints, if indicated, in roof drain outlets.
3. Position roof drains for easy access and maintenance.

B. Fabricate flashing from single piece of metal unless large pans, sumps, or other drainage shapes are required.

C. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

D. Set flashing on roofs in solid coating of bituminous cement.

E. Secure flashing into sleeve and specialty clamping ring or device.

F. Install through-penetration firestop assemblies for penetrations of fire- and smoke-rated assemblies.

1. Comply with requirements in Section 078413 "Penetration Firestopping."

3.4 INSTALLATION OF CLEANOUTS

A. Install cleanouts in aboveground piping and building drain piping in accordance with the following instructions unless otherwise indicated:

1. Use cleanouts the same size as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
3. Locate cleanouts at minimum intervals of [50 ft.]<Insert dimension> for piping NPS 4 and smaller and 100 ft. for larger piping.
4. Locate cleanouts at base of each vertical storm piping conductor.

B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

D. Install wall cleanouts in vertical conductors. Install access door in wall if indicated.

E. Install test tees in vertical conductors and near floor.

3.5 INSTALLATION OF BACKWATER VALVES

A. Install horizontal backwater valves in floor with cover flush with floor.

B. Install drain-outlet backwater valves in outlet of drains.

3.6 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 221414 "Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

3.7 CLEANING

A. Clean piping specialties of dirt and superfluous materials.[Flush with potable water.]

3.8 PROTECTION

A. Protect piping specialties during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic and construction work.

B. Place plugs in ends of uncompleted piping at end of each day and when work stops.

END OF SECTION 22 14 23

SECTION 235133
INSULATED SECTIONAL CHIMNEYS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. UL-listed chimney liners.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles and finishes for product.

B. Shop Drawings: For chimneys and stacks.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of hangers and seismic restraints.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Sample Warranty: For special warranty.

1.4 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:

1. AWS D1.1/D1.1M for hangers and supports.
2. AWS D9.1/D9.1M for shop and field welding of joints and seams in stacks.

B. Certified Sizing Calculations: Manufacturer to certify venting system sizing calculations.

PART 2 - PRODUCTS

2.1 UL-LISTED CHIMNEY LINERS

A. UL-Listed Chimney Liners:

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. Bernard Dalsin Manufacturing Company
    b. DuraVent
    c. Hart & Cooley, LLC
    d. Industrial Chimney Company
    e. Jeremias Inc.
    f. Selkirk Corporation; DuraVent
    g. Insert Manufacturers Name

2. Description, Solid-Fuel-Fired: Rigid orFlexible, single-wall chimney liner tested, listed, and labeled in accordance with UL 1777 and rated for **1000 deg F** continuously and for **2100 deg F** for 10 minutes for solid-fuel-fired appliances with negative or positive flue pressure complying with NFPA 54 and NFPA 211.
3. Rigid Liner Materials: ASTM A666/A666M, Type 304 Type 316 Type 430 or Type 446 stainless steel.
4. Flexible Liner Materials: ASTM A240/A240M, Type 321 ASTM A240/A240M, Type 430 or ASTM A959, Type 29-4C stainless steel.
5. Accessories:

    a. Fittings: Tees, elbows, increasers, draft-hood connectors, metal caps with bird barriers, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar or compatible materials and designs.
    b. Sealant: Manufacturer's standard high-temperature sealant.
    c. Insulating Fill: Manufacturer's standard high-temperature insulation fill material in annular space surrounding chimney liner, including high-temperature, ceramic-fiber insulation required to seal chimney at top and bottom.
    d. Termination:

        1) Vent cap designed to avoid downdrafts and entry of rain, snow, and animals in accordance with NFPA 54 and NFPA 211.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of Work.

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

3.2 APPLICATION

A. UL-Listed Chimney Liners: High-efficiency stacks in masonry chimney.

3.3 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.

B. Provide temporary closures at ends of chimneys and stacks that are not completed or connected to equipment.

END OF SECTION 23 51 33

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SECTION 26 00 01

BASIC REQUIREMENTS FOR ELECTRICAL

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.

B. Drawings and Specifications

1. Division 26 specifications are written in imperative and streamlined format. This imperative language is directed to the Contractor. The word “shall be” shall be included by inference where a colon (:) is used within sentences and phrases.

C. Codes, Permits and Standards

1. Comply with the most recently revised versions of applicable laws, rules, regulations, and ordinances of federal, state, and local utilities and authorities.
2. Obtain all applicable permits, licenses and inspections and pay all fees charged by above authorities.
3. Work shall comply with the local city codes and ordinances, the regulations of state authorities having lawful jurisdiction and the codes, statues and reference standards identified within these Specifications. None of the terms or provisions of the Drawings or specification shall be construed as waiving any of the rules, regulations or requirements of these authorities. In the event of conflict between the Contract Documents and the local enforcing authority, the latter shall rule.
4. Where alterations to and deviations from the Contract Documents are required to comply with interpretations of a Code Authority Having Jurisdiction (AHJ), report the requirements and secure approval before starting work. Contractor shall review any requested modifications with the Engineer and secure his approval before proceeding.
5. Where Contract Document requirements are in excess of Code requirements and are permitted under the Code, the Contract Documents shall govern.

1.2 DEFINITIONS & ABBREVIATIONS

A. Definitions

1. Contract Documents - Drawings and the project manual, including Specifications.
2. Install: to set in place in position for service.
3. Furnish: to supply.
4. Provide: to install and furnish.

5. City - When used in an otherwise non-specific reference anywhere in the Contract documents, City is defined to refer to the local municipal authority governing the project address or the City who's ETJ includes the project address.

B. Abbreviations

1. ANSI American National Standards Institute.
2. ASHRAE American Society of Heating, Refrigerating & Air-Conditioning Engineers
3. EIA Electronic Industry Association.
4. ETL Electrical Testing Laboratory.
5. ETJ Extra-Territorial Jurisdiction
6. FM Factory Mutual
7. IEEE Institute of Electrical and Electronics Engineers
8. IES Illuminating Engineering Society of North America
9. LPI Lightning Protection Institute.
10. NFPA National Fire Protection Association
11. NEC National Electric Code (NFPA-70)
12. NESC National Electric Safety Code
13. NECA National Electrical Contractor's Association
14. NEMA National Electrical Manufacturers Association
15. NETA InterNational Electrical Testing Association
16. NRTL Nationally Recognized Testing Laboratory
17. OSHA Occupational Safety Health Administration (US Department of Labor)
18. UL Underwriters Laboratories

1.3 SUMMARY ORGANIZATION

A. PART 1 of This Section Includes:

1. Electrical Utilities and Service
2. Electrical equipment coordination and installation.
3. Submittal requirements.

B. PART 2 of This Section Includes:

1. Substitution requirements.

C. PART 3 of This Section Includes:

1. Common Requirements for Electrical Installation
2. Electric wiring of motors and equipment
3. Vibration Isolation
4. Quality Assurance requirements.

1.4 ELECTRIC UTILITIES AND SERVICE

A. Utilities: The Contract Documents reflect the general location and routing of utilities required for this project. Visit the site, and coordinate and confirm the exact requirements for electrical services. Refer to Division 01. Electrical and utilities and service entrance equipment exist at the site and shall remain as installed.

1. [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:

   a. Notify the Owner's representative no fewer than (fourteen) (14) days in advance of proposed interruption of electric service.

   b. Indicate method of providing temporary electric service.

   c. Do not proceed with interruption of electric service without the Owner's representative's written permission.

2. Temporary Services:

   a. Provide temporary electrical service and electric power distribution and temporary lighting throughout the construction site. Install and maintain in accordance with National Electrical Code and OSHA requirements. Make arrangements with the serving utility for point of service for temporary electric service and pay costs for delivery to and use at the site.

   b. Existing electrical distributions systems at the site may be utilized for temporary construction power. Submit to the Owner in writing, documents identifying the locations and anticipated maximum demand at which power will be utilized, and obtain the Owner's approval, in writing, prior to connection and utilization.

1.5 ELECTRICAL EQUIPMENT COORDINATION AND INSTALLATION

A. General: Refer to Division 1 for general coordination requirements applicable to the entire work. It is recognized that the Contract Documents are diagrammatic in showing certain physical relationships which must be established within the electrical work, and in its interface with other work including utilities and mechanical work and that such establishment is the exclusive responsibility of the Contractor. The Drawings show diagrammatically the sizes and locations of the various conduit and raceway systems and equipment items and the sizes of the major interconnecting distribution, without showing exact details as to elevations, offsets, control lines, and installation details. All major feeders 1-1/2” diameter and over shall be shown on site and floor plans.

   1. Arrange electrical work in a neat, plumb and straight well organized and workmanlike manner with services running parallel with primary lines of the building construction and with a minimum of 7’ overhead clearance where possible. Maintain 4” clearance of other systems and 12” above ceiling.

   2. The Contractor shall carefully lay out his work at the site to conform to the architectural and structural conditions, to avoid obstructions and to provide proper grading of lines. Exact locations of outlets, apparatus and connections thereto shall be determined by reference to detail Drawings, equipment Drawings, roughing-in Drawings, etc., by measurements at the building and in cooperation with other Contractors and in all cases shall be subject to the approval of the Engineer. Relocations necessitated by the conditions at the site or directed by the Engineer shall be made without any additional cost to the Owner or Engineer.

3. All conduit and boxes, except those in the various equipment rooms, in unfinished spaces or where specifically designated herein, or on the Drawings, shall be run concealed in furrings, plenums and chases. Wherever conditions exist which would cause any of these items to be exposed in finished spaces, the Contractor whose work is involved shall immediately call the situation to the attention of the Engineer and shall stop work in those areas until the Owner's Representative or General Contractor directs the resumption of the work. Submit for approval a Shop Drawing for any change in equipment placement, etc.
4. Equipment has been chosen to fit within the available space with all required Code and maintenance clearances and shall be installed as shown. Every effort has been made to also accommodate equipment of other approved manufacturers, however since equipment and access space requirements vary, the final responsibility for installation access and proper fit of substituted equipment rests with the Contractor with approval from Author by having jurisdiction.

B. Pre-installation planning: Coordinate arrangement, mounting, and support of electrical equipment as follows:

1. Allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. Provide access for disconnecting means and working space for equipment with minimum interference to adjacent equipment.
3. The equipment shall be arranged to facilitate service, maintenance, and repair or replacement of components and equipment.
4. Electrical equipment shall not be installed below piping or ductwork.
5. System interferences shall be handled by giving precedence to pipe lines which require a stated grade for proper operation. Where space requirements conflict, the following hierarchy of precedence shall, in general, be observed:
    a. Building lines
    b. Structural members
    c. Piping and ductwork installed at required slope.
    d. Supply Ductwork
    e. Exhaust Ductwork
    f. Cable Tray
    g. Domestic water piping
    h. Feeder conduit
    i. Branch conduit
    j. Cabling not installed in raceway or cable trays
6. Coordination submittal requirements
    a. Provide electrical room layouts, scaled to 1/4" = 1' - 0" for all rooms or spaces containing electrical distribution equipment. These shall be provided with the associated electrical distribution equipment submittals.
    b. Floor plans shall show dimensioned layout, required working clearances, and required area above and around switchgear where pipe and ducts are prohibited. Show switchgear layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

1.6 DRAWINGS AND SPECIFICATIONS

A. General: The Drawings are schematic in nature and indicate approximate locations of the electrical systems, equipment, fixtures and devices, except where specific locations are noted and dimensioned on the Drawings. All items are shown to approximate scale with intent to depict how these items shall be integrated into the building. Locate all items by field measurements and in accordance with the Contract Documents. Cooperate with other trades to ensure project completion as indicated.

B. Location: Prior to locating electrical devices, light fixtures, and other items, obtain the Architect/ Engineer's approval as to exact location. Locations shall not be determined by scaling Drawings. Mount lighting fixtures and electrical devices at the heights directed by the Architect/Engineer. Where there is a question concerning the required location for items of electrical work, the Contractor shall submit a request for information to the Architect/Engineer requesting specific directions for locating the item. Contractor shall be responsible for costs of redoing work of trades necessitated by failure to comply with this requirement.

1. All electrical devices, lighting fixtures, and other devices shall be referenced to coordinated, established data points and shall be located to present symmetrical arrangements with these points and to facilitate the proper arrangements of building construction details, acoustical tile panels and other building features with respect to the mechanical and electrical outlets and devices. Electrical devices, fixtures, and outlets shall be referenced to such features as wall and ceiling furrings, balanced border widths, masonry joints, etc. Outlets in acoustical tile shall occur symmetrically in tile joints or in the centers of whole tiles and the exact location of each outlet and the arrangements to be followed shall be acceptable to the Architect/Engineer. Outlets in wall tile or masonry construction shall occur symmetrically in the centers of whole tiles, bricks, or blocks and the exact location of each outlet and the arrangement to be followed shall be acceptable to the Architect/Engineer.

2. The Drawings show diagrammatic locations of the various outlets and apparatus. Exact locations of these outlets and apparatus shall be determined by reference to the Architectural Drawings and to all detail Drawings, equipment Drawings, rough-in Drawings, etc., by measurements at the building, and in cooperation with the other trades. The Owner and Architect/Engineer reserve the right to make any reasonable change in location of any outlet or apparatus before installation, without additional cost to the Owner.

C. Specifications: The specifications are intended to supplement the Drawings and it is not in the scope of the specifications to mention any part of the work which the Drawings are competent to fully explain. Conversely, any part of the work which the specifications are competent to fully explain, may not be mentioned on the Drawings.

D. Disagreement: Disagreement between the Drawings or specifications or within the Drawings or specifications shall be estimated using the better quality or greater quantity of material or installation, and a request for information shall be made to the Engineer.

1.7 DISCREPANCIES

A. Clarification: Clarification shall be obtained before submitting a proposal for the Work under this Division as to discrepancies or omissions from the Contract Documents or questions as to the intent thereof.

B. Detailed Instructions: Should it appear that the work hereby intended to be done or any of the materials relative thereto, is not sufficiently detailed or explained in the Drawings or Specifications, then the Contractor shall submit a request for information to the Engineer for such further Drawings or explanations as may be necessary before proceeding, allowing a reasonable time for the Engineer to respond. The Contractor shall conform to this additional information as a part of the Contract without additional cost to the Owner or Engineer.

C. Interpretations: Should any doubt or question arise respecting the true meaning of Drawings or Specifications, reference shall be made to the Engineer, whose written decision shall be final and conclusive. Undocumented statements will not be accepted as an excuse for inferior work.

D. Contractor Agreement: Consideration will not be granted for misunderstanding of the amount of work to be performed. Submission of a bid conveys full Contractor agreement of the items and conditions specified, shown, scheduled, or required for completion of the project.

1.8 SUBMITTAL REQUIREMENTS

A. Provide all electrical shop drawing submittals at the same time.

B. Submittals shall be provided in binders and arranged in sequence by Specification section number. Provide submittals only for specification sections that list this requirement.

1. Provide tabs for each section, labeled to match the associated specification. The page after each tab section shall contain a typed list of any exceptions that the Contractor is proposing.

2. Each page of the submittal shall be a clear copy or scan, indicating items and options proposed for use in the project with a graphical arrow. Items included on a submittal page that are not proposed for use shall be deleted with strike-through or other acceptable method that clearly distinguishes the proposed from non-relevant information.

C. Subject to the requirements in Division 1, at the Contractor's option, submittals may be provided in PDF form.

1. All format and informational requirements for submittals in binders apply to PDF submittals.

2. Multiple files may be submitted, however, these must be organized into a consistent format.

3. PDF submittal shall include a table of contents with page numbers listed for the beginning of each section.

4. Additionally, the PDF shall be formatted to include tab or chapter shortcuts, labeled with the associated specification section. These shortcuts shall allow the reader to jump to a tab or chapter associated with beginning of each specification section with a single action.
5. At engineer's request, the contractor shall submit hard copy version in accordance with requirements outlined above.

D. Provide closeout submittals for all products used. Refer to related specification section for additional requirements.
1. Provide maintenance and warranty information with contact information for parts and service of equipment.

PART 2 - PRODUCTS

2.1 GENERAL MATERIALS AND EQUIPMENT REQUIREMENTS

A. Materials and equipment shall be new, of best grade and quality, and meet all requirements of the Contract Documents. Materials and equipment shall conform to National Electrical Code requirements and shall be listed by Underwriters Laboratories, Inc. (UL). UL listing will be accepted as evidence that the material or equipment conform to the standards of that agency. In lieu of this listing, submit a statement from a nationally recognized testing agency, indicating that products have been tested in accordance with UL criteria and that the materials and equipment comply with Contract requirements.

B. Materials and equipment shall be standard catalog products of manufacturers regularly engaged in the manufacture of products conforming to these Specifications. Custom fabricated items shall be fully described using Drawings and technical data sufficient to demonstrate compliance with the Contract Documents.

2.2 SUBSTITUTIONS

A. Basis of Design - For products specified in part 2.1 of the associated specification section, as "Basis of Design", that term is herein defined as the standard level of product that is required for the project.
1. The use of term Basis of Design in these specifications is intended to allow the Contractor to propose use of non-specified manufacturer's products, provided that the proposed substitute is of equal or greater construction material, workmanship, quality, performance, and manufacturer support. If the product's proposed location is not concealed, aesthetic considerations are also considered as a significant factor.
2. During the bid process, the Engineer will not evaluate products and provide approval prior to the bid date on proposed substitute products. If the Contractor wishes to propose substitutions, the Engineer will evaluate the successful Contractor's proposed alternates during the submittal review process. The Engineer will take no exception to the use of individual products determined to be equal. That decision may be the result of consultation and input from other

members of the design team. If a product is not determined to be equal, it will be rejected and another product that is equal to the basis of design shall be re-submitted by the Contractor. The Engineer will not evaluate more than two substitution attempts before the Contractor is required to submit the specified product.

3. If the Contractor proposes product substitutions that may not be equal to the specified product, and cost savings are associated with the use of the proposed substitute, then the Contractor should propose these as part of a VE (Value Engineering) process, with line item cost savings identified for each product substitution proposed. With information on line item costs, the design team may determine if the proposed substitutes, though not equal, represent a better value and these *may* be recommended for use.

B. Substitutions are generally not allowed for products specified in the associated specification section when listed as "Provide products by one of the following". If there is a concern about delivery schedules from the manufacturers listed or other factors, these special case substitutions will be considered individually during the submittal phase.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Workmanship: Work shall be executed and materials installed in accordance with the best practice of the trades in a thorough, substantial, workmanlike manner by competent, state licensed workmen, presenting a neat appearance when completed, straight and plumb.

B. Manufacturer's Recommendations: With exceptions as specified or indicated on the Drawings or in the Specifications, apply, install, connect, erect, use, clean, and condition manufactured articles, materials, and equipment per manufacturer's current printed recommendations. Copies of such printed recommendations shall be kept at the job site and made available as required.

3.2 SPACE REQUIREMENTS

A. General: Determine in advance of purchase that the equipment and materials proposed for installation will fit into the confines indicated, leaving adequate code clearances for adjustments, repair, or replacement and comply with code.

B. Clearance: Allow adequate space for clearance in accordance with requirements of the Code and local inspection department.

C. Scheduled Equipment: The design shown on the Drawings is based on the equipment scheduled.

D. Responsibility: Space requirements and equipment arrangement may vary for each manufacturer, the responsibility for ensuring initial access and suitability rests with the Contractor.

E. Review: Final arrangements of equipment to be installed shall be subject to the Architect's review.

3.3 SAFETY REGULATIONS

A. All electrical work, including work associated with temporary power, shall be performed in compliance with all applicable and governing safety regulations. All safety lights, guards, signs, and other safety materials and provisions required for the performance of the electrical work shall be provided by and operated by the Electrical contractor.

3.4 DELIVERY, STORAGE AND HANDLING OF MATERIALS

A. General: Protect all materials and equipment to be installed under this Division from physical and weather damage.

B. Scope: Work under this Division shall include, but not limited to:

1. Shipping from point of manufacture to job site.
2. Unloading, moving, and storage on site with proper safeguards as required to properly protect equipment from corrosion, drip, humidity, dust, and physical damage.
3. Hoisting and scaffolding of materials and equipment included in this Division.
4. Ensuring safety of employees, materials, and equipment using such hoisting equipment and scaffolding.

C. Coordination: All large pieces of equipment which are to be installed in the building and which are too large to permit access through doorways, stairways or shafts shall be brought to the job by the Contractor and shall be placed in the spaces before enclosing partitions and structure are completed. Contractor shall support equipment above floor slab and provide suitable, protective covering.

D. Install in accordance with approved, equipment submittal layouts.

E. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

F. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames." Coordinate location of access panels and doors with Architect prior to the associated equipment rough-in.

G. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping".

H. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.5 ELECTRIC WIRING OF MOTORS AND EQUIPMENT

A. The work of Division 26 includes:

1. Installation and power wiring of individually mounted motor controllers furnished under other Divisions.
2. Power wiring for individually mounted and group mounted motor controllers furnished and installed under Division 26.
3. Power wiring of motor controllers provided integral with equipment furnished under Division 26 and other Divisions.
4. Power and control wiring, of any voltage, of systems specified in Division 26.

B. The work of Division 26 does not include:

1. Control wiring associated with HVAC/EMCS control systems, including that which interfaces with fire detection and alarm systems, and motor control.
2. Remote control devices associated with HVAC/EMCS controller systems which interface with and execute control of motor control equipment.

3.6 VIBRATION ISOLATION

A. General: Warrant the electrical systems, and their component parts to operate without objectionable noise or vibration. Noise from systems or equipment which results in noise within occupied spaces above the recommended NC curves (refer to ASHRAE Standard) shall be considered objectionable. Vibration shall not be apparent to the senses in occupied areas of the building. Objectionable noise, vibration, or transmission thereof to the building shall be corrected.

B. Provide vibration isolation means for equipment and materials to prevent the transmission of perceptible vibration, structure borne or air borne noise. Items requiring vibration isolation include:

1. Switchgear, motor control centers, motor starter panelboards, motors, transformers and rotating and reciprocating equipment shall be mounted on cork, rubber or steel spring isolator units properly sized, spaced and loaded as recommended by manufacturer.
2. Electrical Conduit: Isolate from dry type transformers, rotating and reciprocating machinery using flexible conduit, 18" minimum length or 12" of flexible conduit per 1" of conduit diameter with maximum of 36”.

3.7 QUALITY ASSURANCE TESTING

A. Description of Work

1. General: Provide testing of electrical work installed under Divisions 26, 27 and 28, as specified herein and in other Division 26, 27 and 28 sections. Feeders and equipment shall not be placed in service until they have been checked out and tested, as applicable.

B. Personnel

1. Personnel: Submit evidence to show that the personnel who will actually test the systems are qualified and state certified.
2. The Engineer/Owner reserves the right to require that the originally approved personnel be replaced with other qualified personnel if, in his opinion, the original personnel are not qualified or are not properly conducting the system testing.

C. Submittals

1. Testing Procedures: Submit four copies of all proposed testing procedures to the Engineer for review at least 30 days prior to conducting any testing.
2. Reporting Forms: Submit four copies of proposed forms to be used in recording testing data and results to the Engineer for review at least 30 days prior to conducting any testing on the project.
3. Test Data and Results: Submit four copies of complete data and certified test results for each test performed, including, but not limited to:
    a. Test performed.
    b. Test procedure.
    c. System and area tested.
    d. Date(s) and time(s) of test.
    e. Weather conditions.
    f. Test criteria.
    g. Test results.
    h. Additional pertinent information.
4. Operational Certification: Submit four certified copies of an operational certification which documents that all equipment and systems have been fully tested to verify proper operation in accordance with the design shown in the Construction Documents and manufacturer's recommendations.
5. Certification: Certifications stating that submitted test data and results are true and correct shall be provided for all submittals under this Section. Certification shall be executed by an authorized officer if the Contractor is a corporation, by a partner if the Contractor is a partnership, by the Owner if the Contractor is a sole proprietorship or by the authorized representative if the Contractor is a joint venture.
6. Calibration List: Submit four copies of a listing of testing devices to be used for the project to the Engineer for approval. Listing shall include documentation that devices are properly and currently calibrated.
7. Prepare test and inspection reports, including a certified report that identifies electrical distribution equipment included and that describes scan results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
8. Test Log: The Contractor shall maintain a test log at the site to document the results of all successful and unsuccessful testing as it is performed. This log shall be available for review by the Engineer and a copy of the log shall be submitted to the Engineer and Owner’s Representative prior to the Substantial Completion inspection. A space shall be provided on the test log for signoff by the Owner’s Representative.

D. Notice

1. General: Notify the Engineer and the Owner's Representative in writing two weeks prior all scheduled testing to allow time for scheduling witness of testing, where elected by the Engineer and Owner's Representative.

E. Materials

1. General: Provide all materials and test equipment required for testing of specified electrical systems, including retesting until acceptable test results are obtained.

F. Manufacturer's Field Service

1. Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections, and to assist in testing.

G. Preparation

1. Perform visual mechanical inspection and electrical tests for field connections Test insulation resistance for each electrical distribution equipment bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

H. Testing

1. General: Tests shall be made during the course of construction as specified and as required by authorities having jurisdiction. Such tests shall be conducted by this Division as a part of the Work and shall include all personnel, material, and equipment required to perform tests until satisfactory results are obtained. Any defects detected during testing shall be satisfactorily repaired or the equipment involved shall be replaced and the tests re-executed.
2. Tests: Refer to the Table below for inspection and testing requirements associated with listed product specification sections:

Spec Section #	Title	Inspect connections	Torque connections	Test Continuity	Insulation resistance	Thermographic scan	Voltage to Gnd @ at termi-	Notes
260519	LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES	○		○	○			

260526	GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS	○	○	○			○	
260926	LIGHTING CONTROL PANELBOARDS	○	○	○	○	○		
262416	PANELBOARDS	○	○	○	○	○		
262913	ENCLOSED CONTROLLERS	○	○	○	○	○		

NOTES:

a. Refer to individual specification section for additional testing requirements

I. THERMOGRAPHIC TESTING:

1. Provide a thermographic scan to measure equipment temperature and detect significant deviations from normal values.
2. Conduct a thermographic test of the main distribution panels, panelboards, and other electrical distribution apparatus and connections using an infrared temperature scanning unit. The test shall be performed by an independent testing laboratory. Connections that are indicating higher temperature levels than acceptable shall be tightened, lugs replaced and/or OCPD replaced as required to eliminate the condition. Conduct test, using test reporting forms, between 6 and 8 months after beneficial occupancy, but in no case beyond the warranty period. Correct unacceptable conditions prior to end of the warranty period.
3. Prepare test and inspection reports, including a certified report that identifies electrical distribution equipment included with description of scan results. Provide calibration record for device. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

J. RESULTS AND DEFICIENCY CORRECTIONS:

1. Correct malfunctions on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
2. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
3. Any resultant delay as a result of such necessary retest, does not relieve the Contractor of his responsibility under this contract.
4. Equipment will be considered defective if it does not pass tests and inspections. Tested products which fail to provide acceptable test results shall be repaired or replaced with suitable materials as required to obtain acceptable test results.

3.8 CONTRACTOR WARRANTIES AND GUARANTEES

A. General: Contractor shall guarantee all material and equipment installed by him against defects in workmanship and material for a period of 24 months after final acceptance of the work by the Owner and he shall repair or replace any materials or equipment developing such defects within that time, promptly on due notice given him by the Owner and at Contractor's sole cost and expense.

B. Equipment: All equipment bearing a manufacturer's guarantee in excess of the time requirement above, such as electrical equipment, devices, components, and similar items, shall be considered to have that guarantee extended directly to the Owner by the manufacturer. Any such equipment that proves defective in materials or workmanship within the guarantee period is to be corrected by the Contractor in accordance with the manufacturer's guarantee.

C. Start-up: The Electrical Contractor shall provide instructions and equipment starting service on new equipment for two complete years after date of final acceptance of the work by the Owner, at Contractor's sole cost and expense.

END OF SECTION 260001

SECTION 26 05 19
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 078413 "Penetration Firestopping" specifies materials and methods for sealing penetrations of rated walls and partitions referenced by this Section.
5. Section 260513 "Medium-Voltage Cables" for single-conductor and multiconductor cables, cable splices, and terminations for electrical distribution systems with 601 to 35 000 V.
6. Section 260523 "Control-Voltage Electrical Power Cables" for control systems communications cables and Classes 1, 2, and 3 control cables.
7. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
8. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers, supports, and concrete bases referenced by this Section.
9. Section 260533.13 "Conduits for Electrical Systems" specifies installation of raceways referenced by this Section.
10. Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling" specifies installation of sleeves and sleeve seals referenced by this Section.
11. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
12. Section 271313 "Communications Copper Backbone Cabling" for twisted pair cabling used for data circuits.
13. Section 271513 "Communications Copper Horizontal Cabling" for twisted pair cabling used for data circuits.

1.2 DEFINITIONS

A. NICET: National Institute for Certification in Engineering Technologies; a division of the National Society of Professional Engineers (NSPE).

1.3 ACTION SUBMITTALS

A. Product Schedule: Indicate type, use, location, and termination locations.

B. Product Data: For each type of product.

C. Sustainable Design Submittals:

D. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

B. Field Reports:

1. Field reports for infrared scanning.

1.5 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures, to conduct tests of complex equipment, to analyze test and equipment data, to plan a job, and to lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; to evaluate tests, test equipment, test results, and power system performance; to recommend actions to maintain or improve system performance; and to lead multi-team projects.

C. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [III][IV] certification.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 THERMOPLASTIC-INSULATED WIRE

A. Description: Thermoplastic-insulated wire for use in accordance with Article 310 of NFPA 70.

2.3 THERMOSET-INSULATED WIRE

A. Description: Thermoset-insulated wire for use in accordance with Article 310 of NFPA 70.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders:

1. Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
2. Copper for feeders smaller than No. 4 AWG; copper, aluminum, or copper-clad aluminum for feeders No. 4 AWG and larger. Conductors must be solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits:

1. Material: Copper.

a. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
b. Solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.

C. ASD Output Circuits Cable: Extra-flexible stranded for all sizes.

D. PV Circuits: Copper; Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: [Type THHN/THWN-2, single conductors in raceway][Type XHHW-2, single conductors in raceway][Type USE, single conductor in raceway][Mineral-insulated, metal-sheathed cable, Type MI][Multiconductor cable, Type SE].

B. Exposed Feeders: [Type THHN/THWN-2, single conductors in raceway][Type XHHW-2, single conductors in raceway][Armored cable, Type AC][Metal-clad cable, Type MC][Mineral-insulated, metal-sheathed cable, Type MI][Nonmetallic-sheathed cable, Type NM].

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: [Type THHN/THWN-2, single conductors in raceway][Armored cable, Type AC][Metal-clad cable, Type MC][Mineral-insulated, metal-sheathed cable, Type MI][Nonmetallic-sheathed cable, Type NM].

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: [Type THHN/THWN-2, single conductors in raceway][Type XHHW-2, single conductors in raceway][Underground feeder cable, Type UF].

E. Exposed Branch Circuits, Including in Crawlspaces: [Type THHN/THWN-2, single

conductors in raceway][Armored cable, Type AC][Metal-clad cable, Type MC][Mineral-insulated, metal-sheathed cable, Type MI][Nonmetallic-sheathed cable, Type NM].

F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: [Type THHN/THWN-2, single conductors in raceway][Armored cable, Type AC][Metal-clad cable, Type MC][Mineral-insulated, metal-sheathed cable, Type MI][Nonmetallic-sheathed cable, Type NM].

G. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: [Type THHN/THWN-2, single conductors in raceway][Type XHHW-2, single conductors in raceway][Underground branch-circuit cable, Type UF].

H. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless steel, wire-mesh, strain relief device at terminations to suit application.

I. PV Circuits, Type USE-2: For PV source circuits rated at 600 V or less.

J. PV Circuits, Type PV: For PV source circuits rated at [600][1000][2000] V.

3.3 INSTALLATION OF LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B.
3. Electrical Safety: NFPA 70E.
4. Temporary Electric Power Work: NECA NEIS 200.
5. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
6. Work in Confined Spaces: NFPA 350.
7. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
8. Installation of Type AC and Type MC Cables: NECA NEIS 120.
9. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
2. Complete raceway installation between conductor and cable termination points prior to pulling conductors and cables.
3. 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.
4. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

5. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
6. Provide support for cables.
7. Complete cable tray systems installation prior to installing conductors and cables.
8. Connections:

    a. Tighten electrical connectors and terminals in accordance with manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
    b. Make splices, terminations, and taps that are compatible with conductor material[and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors].

        1) Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.

9. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

D. Interfaces with Other Work:

1. Identification:

    a. Identify and color-code conductors and cables.
    b. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

2. Sleeves and Sleeve Seals: Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.
3. Firestopping: Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

3.4 FIELD QUALITY CONTROL

A. Administrant for Electrical Power Tests and Inspections:

1. Owner will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections with assistance of factory-authorized service representative.

B. Acceptance Testing Preparation:

1. <Insert requirements>.

C. Field tests and inspections must be witnessed by Architect and authorities having jurisdiction.

D. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.
2. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
3. After installing conductors and cables and before electrical circuitry has been energized, test [service entrance and feeder conductors][and][conductors] feeding the following critical equipment and services for compliance with requirements:

    a. <Insert, in separate subparagraphs, critical equipment and services to be tested>.

4. Perform each of the following visual and electrical tests:

    a. Inspect exposed sections of conductor and cable for physical damage and correct connection in accordance with the single-line diagram.
    b. Test bolted connections for high resistance using one or more of the following:

        1) A low-resistance ohmmeter.
        2) Calibrated torque wrench.
        3) Thermographic survey.

    c. Inspect compression-applied connectors for correct cable match and indentation.
    d. Inspect for correct identification.
    e. Inspect cable jacket and condition.
    f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable for a one-minute duration.
    g. Continuity test on each conductor and cable.
    h. Uniform resistance of parallel conductors.

E. Nonconforming Work:

1. Wire or cable assembly will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

3.5 MAINTENANCE

A. Infrared Scanning of Splices: Two months after Substantial Completion, perform

infrared scan of splices, joints, and connections in conductors 3 AWG and larger. Remove covers so splices, joints, and connections are accessible to portable scanner. Take visible light photographs at same locations and orientations as infrared scans for documentation to ensure follow-on scans match same conditions for valid comparison. Correct deficiencies determined during the scan.

1. Follow-On Infrared Scanning: Perform follow-up infrared scan of splices at 11 months after Substantial Completion.
2. Instrument: Use infrared-scanning device designed to measure temperature or to detect significant deviations from normal values. Provide documentation of device calibration.
3. Field Reports for Infrared Scanning: Prepare certified report that identifies cables splices checked and that describes scanning results. Include notation of deficiencies detected, remedial actions taken, and scanning observations after remedial action.

END OF SECTION 260519

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SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs installed by this Section.
5. Section 270528 "Pathways for Communications Systems"[and Section 271100 "Communications Equipment Room Fittings"] specifies additional requirements for identification and grounding and bonding of communications equipment, raceways, boxes, and cable trays.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.

a. If listed manufacturer differs from selling manufacturer, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and fitness for purpose.
b. Listing criteria identified in approval letter must match specified listing criteria. UL label indicating approval of equipment's enclosure is not considered approval of equipment for intended application.
c. Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for discontinued or superseded products are unacceptable for submitted product.

B. Shop Drawings: Prepare and submit the following:

1. Plans showing dimensioned locations of grounding features described in "Field Quality Control for Grounding and Bonding" Article, including the following:

a. Grounding electrode access enclosures.
b. Grounding electrodes.

c. Grounding arrangements and connections for separately derived systems.

C. Sustainable Design Submittals:

1. Product data for sustainable design features for each type of product.

D. Field quality-control reports.

1.3 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:

1. In addition to items specified in Section 260010 "Supplemental Requirements for Electrical," include the following:

a. Plans showing locations of grounding features described in "Field Quality Control for Grounding and Bonding" Article, including the following:

1) Grounding electrode access enclosures.
2) Grounding electrodes.
3) Grounding arrangements and connections for separately derived systems.
4) <Insert items>.

b. Instructions for periodic testing and inspection of grounding features at [test wells][ring electrodes][grounding connections for separately derived systems]<Insert locations> based on [NETA MTS][NFPA 70B]<Insert reference>.

1) Tests must determine if ground-resistance or impedance values remain within specified maximums, and instructions must recommend corrective action if values do not.
2) Include recommended testing intervals.

1.5 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures, conduct tests of complex equipment, analyze test and equipment data, plan a job, and lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems, evaluate tests, test equipment, test results, and power system performance, recommend actions to maintain or improve system performance, and lead multi-team projects.

C. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [III][IV] certification.

1.6 SERVICE CONDITIONS FOR ELECTRICAL EQUIPMENT

A. Soil Resistivity: Grounding (earthing) Work on the Project must account for soil resistivity conditions specified in Section 018116 "Facility Environmental Requirements."

B. Electrical and ICT Equipment Grounding (Earthing): Do not exceed [25 Ω][10 Ω]<Insert resistance value> resistance to ground (earth).

1. Contact Architect for resolution if 25 Ω specified resistance to ground (earth) is not attained after complying with prescriptive requirements in Article 250 of NFPA 70.
2. Contact Architect for resolution if [10 Ω]<Insert resistance value> specified resistance to ground (earth) is not attained after second attempt to increase effectiveness of grounding (earthing) electrode.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. <Insert additional performance requirements for the Project>.

2.2 GROUNDING AND BONDING CONDUCTORS

A. Equipment Grounding Conductor:

1. Standard Features: 600 V, [THHN/THWN-2][or][THWN-2], [copper][or][tinned-copper] wire or cable, green color, in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Isolated Equipment Grounding Conductor:

1. Standard Features: 600 V, [THHN/THWN-2][or][THWN-2], [copper][or][tinned-copper] wire or cable, green color with one or more yellow stripes, in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

2.3 GROUNDING AND BONDING CLAMPS

A. Description: Clamps suitable for attachment of grounding and bonding conductors to grounding electrodes, pipes, tubing, and rebar. Grounding and bonding clamps specified in this article are also suitable for use with communications applications.

2.4 GROUNDING AND BONDING BUSHINGS

A. Description: Bonding bushings connect conduit fittings, tubing fittings, threaded metal conduit, and unthreaded metal conduit to metal boxes and equipment enclosures, and have one or more bonding screws intended to provide electrical continuity between bushing and enclosure. Grounding bushings have provision for connection of bonding or grounding conductor and may or may not also have bonding screws.

2.5 INTERSYSTEM BONDING BRIDGE GROUNDING CONNECTORS

A. Description: Devices that provide means for connecting communications systems grounding and bonding conductors at service equipment or at disconnecting means for buildings or structures.

2.6 GROUNDING AND BONDING BUSBARS

A. Description: Miscellaneous grounding and bonding devices that serve as common connection for multiple grounding and bonding conductors.

2.7 SIGNAL REFERENCE GRIDS

A. Description: Means for providing low-impedance path to ground over a large area, approximating an equipotential plan, while simultaneously mitigating large current spikes from faults or lightning.

2.8 GROUNDING ELECTRODE ENCLOSURES

A. Description: Enclosures designed to protect grounding electrodes from damage while providing access for inspection and testing of the grounding system.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine facility's grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of electrical system.

B. Inspect test results of grounding system measured at point of electrical service equipment connection.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with connection of electrical service equipment only after unsatisfactory conditions have been corrected.

3.2 SELECTION OF GROUNDING AND BONDING PRODUCTS

A. Grounding and Bonding Conductors:

1. Provide solid conductor for [8 AWG]<Insert wire size> and smaller, and stranded conductors for [6 AWG]<Insert wire size> and larger unless otherwise indicated.
2. Custom-Length Insulated Equipment Bonding Jumpers: 6 AWG, 19-strand, Type THHN.
3. Bonding Cable: 28 kcmil, 14 strands of 17 AWG conductor, 1/4 inch in diameter.
4. Bonding Conductor: 4 AWG or 6 AWG, stranded conductor.
5. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inch wide and 1/16 inch thick.
6. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inch wide and 1/16 inch thick.
7. Underground Grounding Conductors: Install bare [tinned-]copper conductor, [2/0 AWG]<Insert wire size> minimum.

B. Grounding and Bonding Connectors:

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.

C. Grounding and Bonding Busbars: Provide in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated on the Drawings.

D. Substation Signal Reference Grid:

1. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with IEEE C2.

    a. Install [8 AWG][6 AWG]<Insert wire size from fault calculation> bonding conductors below grade in a grid pattern on 2 ft centers. Bond grid conductors with exothermic welds where they cross each other.
    b. Grid must fill entire area inside equipment yard fence, and extend minimum 6.5 ft outside fence, so someone walking or running outside yard may not touch fence or open gate without first stepping inside grid.
    c. Bond each metal fence post and gate post to at least two grid conductors.
    d. Inside grid, bond equipment reinforcing steel inside bases and sidewalks to at least two grid conductors.
    e. Bond underground metal pipe and conduit passing under grid to nearest grid conductor at both ends.

E. Signal Reference Grid Tape Mesh:

1. Install tape mesh under floor finish with the following features:

a. Tape mesh, 2 inch by 16 mil solid copper, [12 inch][24 inch] spacing.

3.3 SELECTION OF GROUNDING AND BONDING PRODUCTS FOR COMMUNICATIONS

A. Comply with Section 270528 "Pathways for Communications Systems" and Section 271100 "Communications Equipment Room Fittings."

3.4 INSTALLATION OF GROUNDING AND BONDING

A. Comply with manufacturer's published instructions.

B. Reference Standards:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B.
3. Electrical Safety: NFPA 70E.
4. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
5. Communications Work: BICSI N1.
6. Work in ITE Rooms: NFPA 75.
7. Work in Health Care Facilities: NFPA 99 and Article 517 of NFPA 70.
8. Emergency and Standby Power Work: NFPA 110, NFPA 111, and NECA NEIS 416.
9. Work in Confined Spaces: NFPA 350.
10. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
11. Consult Architect for resolution of conflicting requirements.

C. Special Techniques:

1. Grounding and Bonding Conductors:

a. 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. Underground Grounding Conductors:

1) Bury at least 30 inch below grade.

2) Duct-Bank Grounding Conductor: Bury 12 inch above duct bank when indicated as part of duct-bank installation.

2. Grounding and Bonding Connectors: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.

a. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
b. Make connections with clean, bare metal at points of contact.
c. Make aluminum-to-steel connections with stainless steel separators and mechanical clamps.
d. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
e. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
f. 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 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 disconnect-type connection is required, use bolted clamp.

g. 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 bolted clamp connector or bolt lug-type connector to pipe flange by using one of lug bolts of flange. Where dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
    2) Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with bolted connector.
    3) Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

h. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install [tinned]bonding jumper to bond across flexible duct connections to achieve continuity.
i. Grounding for Steel Building Structure: Install driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 ft apart.

3. Grounding and Bonding Busbars:

a. Install busbar horizontally, on insulated spacers 2 inch minimum from wall, 6 inch above finished floor unless otherwise indicated.
b. Where busbars are indicated on both sides of doorways, route bonding conductor up to top of door frame, across top of doorway, and down; connect to continuation of horizontal busbar.

4. Electrodes:

    a. Ground Rods: Drive rods until tops are 2 inch 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) Use exothermic welds for below-grade connections.

    b. For grounding electrode system, install at least [three]<Insert number> rods spaced at least one-rod length from each other and located at least same distance from other grounding electrodes, and connect to 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 must be at least 12 inch deep, with cover.

        1) Install at least one test well for each service unless otherwise indicated. Install at ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

    d. Concrete-Encased Electrode (Ufer Ground):

        1) Fabricate in accordance with NFPA 70; use minimum of [20 ft]<Insert dimension> of bare copper conductor not smaller than [4 AWG]<Insert wire size>.

            a) If concrete foundation is less than [20 ft]<Insert dimension> long, coil excess conductor within base of foundation.
            b) 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.

        2) Fabricate in accordance with NFPA 70; using electrically conductive coated steel reinforcing bars or rods, at least 20 ft long. If reinforcing is in multiple pieces, connect together by usual steel tie wires or exothermic welding to create required length.

5. Grounding at Service:

    a. Equipment grounding conductors and grounding electrode conductors must be connected to ground busbar. Install main bonding jumper between neutral and ground buses.

6. Grounding Separately Derived Systems:

    a. Permanent Generators: Install grounding electrode(s) at location of permanent generators having switched neutral connections. Electrode

must be connected to equipment grounding conductor and to frame of generator.

7. Grounding Underground Distribution System Components:

   a. Duct-Bank Grounding Conductor: Bury 12 inch above duct bank when indicated as part of duct-bank installation.
   b. Comply with IEEE C2 grounding requirements.
   c. Grounding Manholes and Handholes: Install driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inch will extend above finished floor. If necessary, install ground rod before manhole is placed and provide 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inch above to 6 inch below concrete. Seal floor opening with waterproof, nonshrink grout.
   d. 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 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 in accordance with manufacturer's published instructions with splicing and termination kits.
   e. Pad-Mounted Transformers and Switches: Install two ground rods and ring electrode around 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 2 AWG for ring electrode and for taps to equipment grounding terminals. Bury ring electrode not less than 6 inch from foundation.

8. Equipment Grounding and Bonding:

   a. Install insulated equipment grounding conductors with 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.

   c. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install separate insulated equipment grounding conductor to each electric water heater and

heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

d. Isolated Grounding Receptacle Circuits: Install insulated equipment grounding conductor connected to receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of applicable derived system or service unless otherwise indicated.

e. Isolated Equipment Enclosure Circuits: For designated equipment supplied by branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of applicable derived system or service unless otherwise indicated.

f. Poles Supporting Outdoor Lighting Fixtures: Bond insulated equipment grounding conductor to equipment grounding terminal inside pole base.

g. Metallic Fences: Comply with requirements of IEEE C2.

1) Grounding Conductor: Bare[, tinned] copper, not less than [8 AWG]<Insert wire size>.
2) Gates: Must be bonded to grounding conductor with flexible bonding jumper.
3) Barbed Wire: Strands must be bonded to grounding conductor.

3.5 FIELD QUALITY CONTROL FOR GROUNDING AND BONDING

A. Administrant for Electrical Power Tests and Inspections:

1. [Owner][Tenant] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[with assistance of factory-authorized service representative].

B. Acceptance Testing Preparation:

1. <Insert requirements>.

C. Field tests and inspections must be witnessed by [Architect][Tenant][authorities having jurisdiction]<Insert names or titles of witnesses>.

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 calibrated torque wrench in accordance with manufacturer's published instructions.

3. Test completed grounding system at each location where maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal[, at ground test wells][, and at individual ground rods]. Make tests at ground rods before conductors are connected.

    a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by 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 in accordance with IEEE Std 81.
    c. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

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 record of tests and observations. Include 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. Nonconforming Work:

1. Grounding system will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective components and retest.

F. Collect, assemble, and submit test and inspection reports.

1. Report measured ground resistances that exceed the following values:

    a. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: [10 Ω]<Insert ohms>.
    b. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: [5 Ω]<Insert ohms>.
    c. Power Distribution Units or Panelboards Serving Electronic Equipment: [1 Ω][3 Ω]<Insert ohms>.
    d. Substations and Pad-Mounted Equipment: [5 Ω]<Insert ohms>.
    e. <Insert application and maximum ground-resistance>.

3.6 PROTECTION

A. After installation, protect grounding and bonding cables and equipment from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 260526

SECTION 26 05 29
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

1. Installation of fabricated metal supports.
2. Installation of concrete bases.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 033000 "Cast-in-Place Concrete" specifies concrete materials, reinforcement, and placement requirements referenced by this Section.
5. Section 055000 "Metal Fabrications" specifies site-fabricated metal supports referenced by this Section.
6. [Section 099113 "Exterior Painting"][Section 099123 "Interior Painting"][and][Section 099600 "High-Performance Coatings"] specify cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal referenced by this Section.
7. Section 260548 "Vibration and Seismic Controls for Electrical Systems" specifies vibration controls, seismic restraints, and wind restraints referenced by this Section.

1.2 DELEGATED DESIGN SERVICES

A. Delegated Design Professionals: Engage qualified structural professional engineer to design hangers and supports for electrical systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:

a. Slotted support systems, hardware, and accessories.
b. Clamps.
c. Hangers.
d. Sockets.
e. Eye nuts.

f. Fasteners.
g. Anchors.
h. Saddles.
i. Brackets.
j. <Insert product type>.

2. Include rated capacities and furnished specialties and accessories.

B. Shop Drawings: For fabrication and installation details for electrical hangers and support systems.

1. Hangers. Include product data for components.
2. Slotted support systems.
3. Equipment supports.
4. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated Design Submittals: For hangers and supports for electrical systems.

1. Include design calculations and details of hangers.
2. Include design calculations for seismic restraints.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.5 REGULATORY AGENCY APPROVALS

A. Delegated design submittals and shop drawings requiring approval by authorities having jurisdiction must be signed by qualified structural professional engineer responsible for their preparation. [Obtain approval by authorities having jurisdiction prior to submitting for action by Architect.][Submit for action by Architect prior to submitting for approval by authorities having jurisdiction.]

1.6 QUALIFICATIONS

A. Structural Professional Engineer: Professional engineer possessing active qualifications specified in Section 014000 "Quality Requirements," with expertise in structural engineering, including design of seismic and wind controls, equipment hangers and supports, and concrete foundations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Prepare design calculations in accordance with criteria specified in Section 260010 "Supplemental Requirements for Electrical" and Section 018123 "Facility Seismic and

Wind Criteria."

B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame Rating: Class 1.
2. Self-extinguishing according to ASTM D635.

2.2 SUPPORT SYSTEMS

A. Conduit and Cable Support Devices:

1. Standard Features: [Steel][Steel and malleable-iron][Stainless steel][Glass-fiber-resin] hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

B. Support for Conductors in Vertical Conduit:

1. Standard Features: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs must have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body must be made of malleable iron.

C. Structural Steel for Fabricated Supports and Restraints:

1. Standard Features: ASTM A36/A36M steel plates, shapes, and bars; black and galvanized.

2.3 MOUNTING, ANCHORING, AND ATTACHMENT COMPONENTS

A. Concrete Inserts:

1. Standard Features: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.

B. Clamps for Attachment to Steel Structural Elements:

1. Standard Features: MSS SP-58 units are suitable for attached structural element.

C. Through Bolts:

1. Standard Features: Structural type, hex head, and high strength. Comply with ASTM F3125/F3125M, Grade A325.

D. Toggle Bolts:

1. Standard Features: [All][Stainless] steel springhead type.

E. Hanger Rods:

1. Standard Features: Threaded steel.

PART 3 - EXECUTION

3.1 SELECTION OF HANGERS AND SUPPORTS

A. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and ERMC as [required by][scheduled in NECA NEIS 1, where its Table 1 lists maximum spacings that are less than those stated in] NFPA 70. Minimum rod size must be 1/4 inch in diameter.

B. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted [or other]support system, sized so capacity can be increased by at least [25]<Insert number> percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with [two-bolt conduit clamps][single-bolt conduit clamps][single-bolt conduit clamps using spring friction action for retention in support channel].

C. 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 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Hot Work: NFPA 51B.
3. Work in Confined Spaces: NFPA 350.
4. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
5. Installation of Steel Conduit: NECA NEIS 101.
6. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Raceway Support Methods: In addition to methods described in NECA NEIS 1, [EMT][IMC][and][ERMC] may be supported by openings through structure members, in accordance with NFPA 70.
2. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination must be weight of supported components plus 200 lb.
3. 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:

a. To Wood: Fasten with lag screws or through bolts.
b. To New Concrete: Bolt to concrete inserts.
c. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
d. To Existing Concrete: Expansion anchor fasteners.
e. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inch thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inch thick.
f. To Steel: [Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts][Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69][Spring-tension clamps].
g. To Light Steel: Sheet metal screws.
h. 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 comply with seismic-restraint strength and anchorage requirements].

4. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

D. Interfaces with Other Work:

1. Provide [vibration][and][seismic] controls with hangers and supports.
2. Touchup Finishes:

a. 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. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
c. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

3. Installation of Fabricated Metal Supports:

a. Provide 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. Submit welding certificates.

4. Installation of Concrete Bases:

a. Provide concrete bases of dimensions indicated, but not less than 4 inch 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]<Insert value>, 28-day compressive-strength concrete.
c. Anchor equipment to concrete base as follows:

1) Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2) Install anchor bolts to elevations required for proper attachment to supported equipment.
3) Install anchor bolts according to anchor-bolt manufacturer's written instructions.

END OF SECTION 260529

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SECTION 26 05 33.13
CONDUITS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies temperature, humidity, acoustical, and other field conditions applicable to the Work specified in this Section.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies seismic hazard, wind hazard, other structural load design conditions applicable to the Work specified in this Section.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional coordination, scheduling, sequencing, submittal, and installation requirements applicable to the Work for electrical, communications, and electronic safety and security systems on the Project, including wiring methods.
4. Section 078413 "Penetration Firestopping" specifies firestopping referenced by this Section.
5. Section 260519 "Low-Voltage for Electrical Power Conductors and Cables" specifies nonmetallic underground conductors (Type NUCC).
6. Section 260529 "Hangers and Supports for Electrical Systems" specifies conduit hangers and supports referenced by this Section.
7. Section 260543 "Underground Ducts and Raceways for Electrical Systems" specifies exterior duct banks, manholes, and underground utility construction.
8. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels.
9. Section 270528 "Pathways for Communications Systems"[and Section 271100 "Communications Equipment Room Fittings"] specifies additional requirements for installation of conduits for communications cabling.

1.2 REFERENCES

A. Abbreviations and Acronyms for Electrical Raceway Types:

1. EMT: Electrical metallic tubing.
2. EMT-S: Steel electrical metallic tubing.
3. ENT: Electrical nonmetallic tubing.
4. EPEC: Electrical HDPE underground conduit (thin wall).
5. EPEC-A: Type A electrical HDPE underground conduit.
6. EPEC-B: Type B electrical HDPE underground conduit.
7. ERMC: Electrical rigid metal conduit.
8. ERMC-S: Steel electrical rigid metal conduit.
9. ERMC-S-G: Galvanized-steel electrical rigid metal conduit.
10. ERMC-S-PVC: PVC-coated-steel electrical rigid metal conduit.
11. ERMC-SS: Stainless steel electrical rigid metal conduit.
12. FMC: Flexible metal conduit.

13. FMC-S: Steel flexible metal conduit.
14. FMT: Steel flexible metallic tubing.
15. FNMC: Flexible nonmetallic conduit. See "LFNC."
16. HDPE: HDPE underground conduit (thick wall).
17. HDPE-40: Schedule 40 HDPE underground conduit.
18. HDPE-80: Schedule 80 HDPE underground conduit.
19. IMC: Steel electrical intermediate metal conduit.
20. LFMC: Liquidtight flexible metal conduit.
21. LFMC-A: Aluminum liquidtight flexible metal conduit.
22. LFMC-S: Steel liquidtight flexible metal conduit.
23. LFMC-SS: Stainless steel liquidtight flexible metal conduit.
24. LFNC: Liquidtight flexible nonmetallic conduit.
25. LFNC-A: Layered (Type A) liquidtight flexible nonmetallic conduit.
26. LFNC-B: Integral (Type B) liquidtight flexible nonmetallic conduit.
27. LFNC-C: Corrugated (Type C) liquidtight flexible nonmetallic conduit.
28. PVC: Rigid PVC conduit.
29. PVC-40: Schedule 40 rigid PVC conduit.
30. PVC-80: Schedule 80 rigid PVC Conduit.
31. PVC-A: Type A rigid PVC concrete-encased conduit.
32. PVC-EB: Type EB rigid PVC concrete-encased underground conduit.
33. RGS: See ERMC-S-G.
34. RMC: See ERMC.
35. RTRC: Reinforced thermosetting resin conduit.
36. RTRC-AG: Low-halogen, aboveground reinforced thermosetting resin conduit.
37. RTRC-AG-HW: Heavy wall, low-halogen, aboveground reinforced thermosetting resin conduit.
38. RTRC-AG-SW: Standard wall, low-halogen, aboveground reinforced thermosetting resin conduit.
39. RTRC-AG-XW: Extra heavy wall, low-halogen, aboveground reinforced thermosetting resin conduit.
40. RTRC-BG: Low-halogen, belowground reinforced thermosetting resin conduit.

B. Definitions:

1. Conduit: A structure containing one or more duct raceways.
2. Direct Buried: Installed underground without encasement in concrete or other protective material.
3. Duct Bank: An arrangement of conduit providing one or more continuous duct raceways between two points.
4. Duct Raceway: A single enclosed raceway for conductors or cable.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product data for sustainable design features for each type of product.

C. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

1.5 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures; conduct tests of complex equipment; analyze test and equipment data; plan a job; and lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; evaluate tests, test equipment, test results, and power system performance; recommend actions to maintain or improve system performance; and lead multi-team projects.

C. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [III][IV] certification.

D. ERMC-S-PVC Installers: Installer possessing active qualifications specified in Section 014000 "Quality Requirements," and able to present unexpired certified Installer credentials issued by ERMC-S-PVC manufacturer prior to starting installation.

E. Communications Testing and Inspecting Agency: Entity possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site communications testing supervisor must have [BICSI Technician (TECH)]<Insert certification program> certification and documented training, and be experienced with testing communications equipment in accordance with [BICSI]<Insert code enforced by authorities having jurisdiction> testing standards.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. <Insert additional performance requirements for the Project>.

PART 3 - EXECUTION

3.1 SELECTION OF CONDUITS FOR ELECTRICAL SYSTEMS

A. Unless more stringent requirements are specified in the Contract Documents or manufacturer's published instructions, comply with NFPA 70 for selection of duct raceways. Consult Architect for resolution of conflicting requirements.

B. Special Instructions Regarding HDPE Conduits: Although Article 353 of NFPA 70 permits use of HDPE conduits where encased in concrete aboveground, UL CCN EAZX listing requirements state that HDPE[and EPEC] underground conduits are intended only for use where direct buried with or without being encased in concrete. Specified Type HDPE[and Type EPEC] underground conduits are not permitted to be used aboveground on the Project.

C. Outdoors:

1. Exposed and Subject to Severe Physical Damage: [ERMC][IMC].
2. Exposed and Subject to Physical Damage: [ERMC][IMC][Corrosion-resistant EMT].
3. Exposed and Not Subject to Physical Damage: [ERMC][IMC][Corrosion-resistant EMT][PVC-80][RTRC-AG].
4. Concealed Aboveground: [ERMC][IMC][EMT][PVC-80][PVC-40][RTRC-AG].
5. Direct Buried: [PVC-80][PVC-40][HDPE-80][HDPE-40][RTRC-BG].
6. Concrete Encased Not in Trench: [PVC-80][PVC-40][PVC-A][RTRC-BG].
7. Concrete Encased in Trench: [PVC-80][PVC-40][PVC-A][PVC-EB][HDPE-80][HDPE-40][EPEC-A][EPEC-B][RTRC-BG].
8. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): [LFMC][LFNC-A][LFNC-B].

D. Indoors:

1. Hazardous Classified Locations: [ERMC][IMC].
2. Exposed and Subject to Severe Physical Damage: [ERMC][IMC].
3. Exposed and Subject to Physical Damage: [ERMC][IMC][EMT].
4. Exposed and Not Subject to Physical Damage: [ERMC][IMC][EMT][PVC-80][RTRC-AG].
5. Concealed in Ceilings and Interior Walls and Partitions: [ERMC][IMC][EMT][PVC-80][PVC-40][RTRC-AG].
6. Damp or Wet Locations: [ERMC][IMC][RTRC-AG][Corrosion-resistant EMT].
7. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): [LFMC][FMC][LFNC-A][LFNC-B].
8. Circuits Operating Above 60 Hz: [EMT-A][ERMC-A][RTRC-AG]. Provide nonmetallic sleeve where aluminum duct raceways pass through concrete.

E. Duct Fittings: Select fittings in accordance with NEMA FB 2.10 guidelines.

1. ERMC and IMC: Provide threaded-type fittings unless otherwise indicated.

3.2 INSTALLATION OF CONDUITS FOR ELECTRICAL SYSTEMS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Safety: NFPA 70E.
3. Commissioning of Active and Passive Fire Protection Features: NFPA 3 and NFPA 4.
4. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
5. Communications Work: BICSI N1.
6. Life Safety and Means of Egress Work: NFPA 101.
7. Emergency and Standby Power Work: NFPA 110, NFPA 111, and NECA NEIS 416.
8. Work in Confined Spaces: NFPA 350.
9. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
10. Type EMT-A: Article 358 of NFPA 70 and NECA NEIS 102.
11. Type EMT-SS: Article 358 of NFPA 70 and NECA NEIS 101.
12. Type EMT-S: Article 358 of NFPA 70 and NECA NEIS 101.
13. Type ENT: Article 362 of NFPA 70 and NECA NEIS 102.
14. Type HDPE and Type EPEC: Article 353 of NFPA 70 and NECA NEIS 111.
15. Type ERMC-A: Article 344 of NFPA 70 and NECA NEIS 102.
16. Type ERMC-SS: Article 344 of NFPA 70 and NECA NEIS 101.
17. Type ERMC-S: Article 344 of NFPA 70 and NECA NEIS 101.
18. Type FMC-S: Article 348 of NFPA 70 and NECA NEIS 101.
19. Type FMC-A: Article 348 of NFPA 70 and NECA NEIS 102.
20. Type FMT: Article 360 of NFPA 70 and NECA NEIS 101.
21. Type IMC: Article 342 of NFPA 70 and NECA NEIS 101.
22. Type LFMC: Article 350 of NFPA 70 and NECA NEIS 101.
23. Type LFNC: Article 342 of NFPA 70 and NECA NEIS 111.
24. Type PVC: Article 356 of NFPA 70 and NECA NEIS 111.
25. Type RTRC: Article 355 of NFPA 70 and NECA NEIS 111.
26. Expansion Fittings: NEMA FB 2.40.
27. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. General Requirements for Installation of Duct Raceways:

    a. Complete duct raceway installation before starting conductor installation.
    b. Provide stub-ups through floors with coupling threaded inside for plugs, set flush with finished floor. Plug coupling until conduit is extended above floor to final destination or a minimum of 2 ft above finished floor.
    c. Install no more than equivalent of three 90-degree bends in conduit run[except for control wiring conduits, for which no more than equivalent of two 90-degree fewer bends are permitted]. Support within 12 inch of changes in direction.

d. Make bends in duct raceway using large-radius preformed ells except for parallel bends. Field bending must be in accordance with NFPA 70 minimum radii requirements. Provide only equipment specifically designed for material and size involved.
e. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
f. Support conduit within 12 inch of enclosures to which attached.
g. Install duct sealing fittings at accessible locations in accordance with NFPA 70 and fill them with listed sealing compound. For concealed duct raceways, install fitting in flush steel box with blank cover plate having finish similar to that of adjacent plates or surfaces. Install duct sealing fittings in accordance with NFPA 70.
h. Install devices to seal duct raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal interior of duct raceways at the following points:

    1) Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
    2) Where an underground service duct raceway enters a building or structure.
    3) Conduit extending from interior to exterior of building.
    4) Conduit extending into pressurized duct raceway and equipment.
    5) Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
    6) Where otherwise required by NFPA 70.

i. Do not install duct raceways or electrical items on "explosion-relief" walls or rotating equipment.
j. Do not install conduits within 2 inch of the bottom side of a metal deck roof.
k. Keep duct raceways at least 6 inch away from parallel runs of flues and steam or hot-water pipes. Install horizontal duct raceway runs above water and steam piping.
l. Cut conduit perpendicular to the length. For conduits metric designator 53 (trade size 2) and larger, use roll cutter or a guide to make cut straight and perpendicular to the length. Ream inside of conduit to remove burrs.
m. Install pull wires in empty duct raceways. Provide polypropylene or monofilament plastic line with not less than 200 lb tensile strength. Leave at least 12 inch of slack at both ends of pull wire. Cap underground duct raceways designated as spare above grade alongside duct raceways in use.
n. Install duct raceways square to the enclosure and terminate at enclosures without hubs with locknuts on both sides of enclosure wall. Install locknuts hand tight, plus one-quarter turn more.

    1) Termination fittings with shoulders do not require two locknuts.

o. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to metric designator 35 (trade size 1-1/4) and insulated throat metal bushings on metric designator 41 (trade size 1-1/2) and larger conduits terminated with

locknuts.[Install insulated throat metal grounding bushings on service conduits].

2. Types EMT-A, ERMC-A, and FMC-A: Do not install aluminum duct raceways or fittings in contact with concrete or earth.
3. Types ERMC and IMC:

    a. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound that maintains electrical conductivity to threads of duct raceway and fittings before making up joints. Follow compound manufacturer's published instructions.

4. Type ERMC-S-PVC:

    a. Follow manufacturer's installation instructions for clamping, cutting, threading, bending, and assembly.
    b. Provide PVC-coated sealing locknut for exposed male threads transitioning into female NPT threads that do not have sealing sleeves, including transitions from PVC couplings/female adapters to Type ERMC-S-PVC elbows in direct-burial applications. PVC-coated sealing locknuts must not be used in place of conduit hub. PVC-coated sealing locknut must cover exposed threads on Type ERMC-S-PVC duct raceway.
    c. Coat field-cut threads on PVC-coated duct raceway with manufacturer-approved corrosion-preventing conductive compound prior to assembly.

5. Types FMC, LFMC, and LFNC:

    a. Provide a maximum of [36 inch][72 inch] of flexible conduit for [recessed and semi-recessed luminaires,]equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

6. Types PVC, HDPE, and EPEC:

    a. Do not install Type PVC, Type HDPE, or Type EPEC conduit where ambient temperature exceeds [122 deg F]<Insert temperature>. Conductor ratings must be limited to 75 deg C except where installed in a trench outside buildings with concrete encasement, where 90 deg C conductors are permitted.
    b. Comply with manufacturer's published instructions for solvent welding and fittings.
    c. Join joints with solvent cement in accordance with manufacturer's published instructions and allowed to cure before handling. Joints to be bent, pushed, or pulled must set for minimum 24 h after joining.

7. Type RTRC: Do not install Type RTRC conduit where ambient temperature exceeds [230 deg F]<Insert temperature>.
8. Duct Raceways Embedded in Slabs:

    a. [Run duct raceways larger than metric designator 27 (trade size 1) below concrete slab][Run duct raceways larger than metric designator 27 (trade size) parallel or at right angles to main reinforcement. Where at right

angles to reinforcement, place duct raceway close to slab support. Secure duct raceways to reinforcement at maximum 10 ft intervals].

b. Arrange duct raceways to cross building expansion joints with expansion fittings at right angles to the joint.
c. Arrange duct raceways to ensure that each is surrounded by minimum of [1 inch][2 inch]<Insert dimension> of concrete without voids.
d. Do not embed threadless fittings in concrete unless locations have been specifically approved by Architect.
e. Change from ENT to [PVC-80][PVC-40][ERMC][or][IMC] before rising above floor.

9. Stub-ups to Above Recessed Ceilings:

a. Provide EMT, IMC, or ERMC for duct raceways.
b. Provide a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

10. Duct Raceway Terminations at Locations Subject to Moisture or Vibration:

a. Provide insulating bushings to protect conductors, including conductors smaller than 4 AWG.[Install insulated throat metal grounding bushings on service conduits].

11. Duct Fittings: Install fittings in accordance with NEMA FB 2.10 guidelines.

a. ERMC-S-PVC: Provide only fittings listed for use with this type of conduit. Patch and seal joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Provide sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
b. EMT: Provide [setscrew][compression], [steel][cast-metal] fittings. Comply with NEMA FB 2.10.
c. Flexible Conduit: Provide only fittings listed for use with flexible conduit type. Comply with NEMA FB 2.20.

12. Expansion-Joint Fittings:

a. Install in runs of aboveground PVC that are located where environmental temperature change may exceed 30 deg F and that have straight-run length that exceeds 25 ft. Install in runs of aboveground ERMC[and EMT] conduit that are located where environmental temperature change may exceed 100 deg F and that have straight-run length that exceeds 100 ft.
b. Install type and quantity of fittings that accommodate temperature change listed for the following locations:

1) Outdoor Locations Not Exposed to Direct Sunlight: [125 deg F]<Insert temperature> temperature change.
2) Outdoor Locations Exposed to Direct Sunlight: [155 deg F]<Insert temperature> temperature change.
3) Indoor Spaces Connected with Outdoors without Physical Separation: [125 deg F]<Insert temperature> temperature change.

4) Attics: [135 deg F]<Insert temperature> temperature change.
5) <Insert location and corresponding temperature change>.

c. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
d. Install expansion fittings at locations where conduits cross building or structure expansion joints.
e. Install expansion-joint fitting with position, mounting, and piston setting selected in accordance with manufacturer's published instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

13. Duct Raceways Penetrating Rooms or Walls with Acoustical Requirements: Seal duct raceway openings on both sides of rooms or walls with acoustically rated putty[or firestopping].
14. Identification: Provide labels for conduit assemblies, duct raceways, and associated electrical equipment.

a. Provide warning signs.

15. <Insert more stringent installation requirements that supplement or supersede listed standards and manufacturer's published instructions>.

D. Interfaces with Other Work:

1. Firestop penetrations of fire-rated floor and wall assemblies.
2. Provide conduit hangers and supports.
3. Coordinate installation of new products for <Insert system or product family/category> with existing conditions.

a. <Insert requirements for transition between new and existing>.

4. Coordinate with <Insert Section number and title> for <Insert description of interfacing related Work>.

a. <Insert requirements for transition between this Section and related Work>.

3.3 FIELD QUALITY CONTROL OF CONDUITS FOR ELECTRICAL SYSTEMS

A. Administrant for Electrical Power Tests and Inspections:

1. [Owner][Tenant] will engage qualified medium-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified medium-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations,

including connections.

4. Administer and perform tests and inspections[with assistance of factory-authorized service representative].

B. Administrant for Communications Tests and Inspections:

1. [Owner][Tenant] will engage qualified communications testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified communications testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[with assistance of factory-authorized service representative].

C. Acceptance Testing Preparation:

1. <Insert requirements>.

D. Field tests and inspections must be witnessed by [Architect][Tenant][authorities having jurisdiction]<Insert names or titles of witnesses>.

E. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.
2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide minimum 12 inch long mandrel equal to duct size minus 1/4 inch. If obstructions are indicated, remove obstructions and retest.
3. Conduit Placement:

    a. Verify that center-line location and offsets are in accordance with the Drawings.
    b. Verify that hangers and supports for conduits are attached to structure [in accordance with the Drawings][as directed by qualified structural engineer].
    c. Verify that nuts on bolts or hanger rods are secure.
    d. Verify that space between raceways and cored holes are filled with non-shrinking grout or other approved material indicated on the Drawings and the Specifications.
    e. Verify that expansion devices are installed at locations indicated on the Drawings and the Specifications.
    f. Verify that ends are cut square to provide flush-butting surfaces when spliced and inside edges are free of burrs that could impede installation of cables.
    g. Verify minimum separation of utilities, or that approved mechanical protection has been provided to surrounding conduit(s) where minimum separation cannot be achieved.

4. Document all changes on Record Drawings.

F. Nonconforming Work:

1. Conduit will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

G. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

3.4 CLEANING

A. Verify that bentonite or other drilling fluids are contained and removed, and site is restored to its original or improved condition.

3.5 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533.13

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SECTION 26 05 33.16
BOXES AND COVERS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies temperature, humidity, acoustical, and other field conditions applicable to the Work specified in this Section.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies seismic hazard, wind hazard, other structural load design conditions applicable to the Work specified in this Section.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional coordination, scheduling, sequencing, submittal, and installation requirements applicable to the Work for electrical, communications, and electronic safety and security systems on the Project, including wiring methods.
4. Section 078413 "Penetration Firestopping" specifies materials and methods for sealing penetrations of rated walls and partitions referenced by this Section.
5. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
6. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs installed by this Section.
7. Section 260573 "Power System Studies" specifies arc-flash hazard analysis and warning labels referenced by this Section.
8. Section 270528 "Pathways for Communications Systems"[and Section 271100 "Communications Equipment Room Fittings"] specifies additional requirements for identification of communications equipment and cabling.

1.2 DEFINITIONS

A. Communications Outlet: One or more communications jacks, or cables and plugs, mounted in a box or ring, with a suitable protective cover.

B. Enclosure: The case or housing of an apparatus, or the fence or wall(s) surrounding an installation, to prevent personnel from accidentally contacting energized parts or to protect the equipment from physical damage. Types of enclosures and enclosure covers include the following:

1. Cabinet: An enclosure that is designed for either surface mounting or flush mounting and is provided with a frame, mat, or trim in which a swinging door or doors are or can be hung.
2. Concrete Box: A box intended for use in poured concrete.
3. Conduit Body: A means for providing access to the interior of a conduit or tubing system through one or more removable covers at a junction or terminal point. In the United States, conduit bodies are listed in accordance with outlet box requirements.

4. Conduit Box: A box having threaded openings or knockouts for conduit, EMT, or fittings.
5. Cover Plate: A cover designed for protecting wiring devices installed in flush-mounted device boxes while permitting their safe operation; also called a faceplate or wallplate.
6. Cutout Box: An enclosure designed for surface mounting that has swinging doors or covers secured directly to and telescoping with the walls of the enclosure.
7. Device Box: A box with provisions for mounting a wiring device directly to the box.
8. Extension Ring: A ring intended to extend the sides of an outlet box or device box to increase the box depth, volume, or both.
9. Floor Box: A box mounted in the floor intended for use with a floor box cover and other components to complete the floor box enclosure.
10. Floor-Mounted Enclosure: A floor box and floor box cover assembly with means to mount in the floor that is sealed against the entrance of scrub water at the floor level.
11. Floor Nozzle: An enclosure used on a wiring system, intended primarily as a housing for a receptacle, provided with a means, such as a collar, for surface-mounting on a floor, which may or may not include a stem to support it above the floor level, and is sealed against the entrance of scrub water at the floor level.
12. Junction Box: A box with a blank cover that joins different runs of raceway or cable and provides space for connection and branching of the enclosed conductors.
13. Outlet Box: A box that provides access to a wiring system having pryout openings, knockouts, threaded entries, or hubs in either the sides or the back, or both, for the entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting an outlet box cover, but without provisions for mounting a wiring device directly to the box.
14. Pedestal Floor Box Cover: A floor box cover that, when installed as intended, provides a means for typically vertical or near-vertical mounting of receptacle outlets above the floor's finished surface.
15. Pull Box: A box with a blank cover that joins different runs of raceway and provides access for pulling or replacing the enclosed cables or conductors.
16. Raised-Floor Box: A floor box intended for use in raised floors.
17. Recessed Access Floor Box: A floor box with provisions for mounting wiring devices below the floor surface.
18. Recessed Access Floor Box Cover: A floor box cover with provisions for passage of cords to recessed wiring devices mounted within a recessed floor box.
19. Ring: A sleeve, which is not necessarily round, used for positioning a recessed wiring device flush with the plaster, concrete, drywall, or other wall surface.
20. Ring Cover: A box cover, with raised center portion to accommodate a specific wall or ceiling thickness, for mounting wiring devices or luminaires flush with the surface.
21. Termination Box: An enclosure designed for installation of termination base assemblies consisting of bus bars, terminal strips, or terminal blocks with provision for wire connectors to accommodate incoming or outgoing conductors, or both.

C. Receptacle: A fixed connecting device arranged for insertion of a power cord plug. Also called a power jack.

D. Receptacle Outlet: One or more receptacles mounted in a box with a suitable protective cover.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each type of product requiring samples for source quality control.

C. Shop Drawings: Prepare and submit the following:

1. Shop Drawings for Floor Boxes: Show that floor boxes are located to avoid interferences and are structurally allowable. Indicate floor thickness [at location]where boxes are embedded in concrete floors and underfloor clearances where boxes are installed in raised floors.

D. Sustainable Design Submittals:

1. Product data for sustainable design features for each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

1.5 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures; conduct tests of complex equipment; analyze test and equipment data; plan a job; and lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; evaluate tests, test equipment, test results, and power system performance; recommend actions to maintain or improve system performance; and lead multi-team projects.

C. Inspection and Testing of Fire-Alarm Systems (I&TFAS) Technician I: Possessing active NICET I&TFAS Level I certification. Able to perform periodic inspections and tests of basic fire-alarm systems and prepare related records and reports.

D. Inspection and Testing of Fire-Alarm Systems (I&TFAS) Technician II: Possessing active NICET I&TFAS Level II certification. Able to plan, perform, and coordinate periodic inspections and tests of complex fire-alarm systems (including one or more of suppression interfaces, networked control units, smoke control interfaces, air sampling systems, multi-zone voice evacuation systems, or high-rise applications) and prepare related records and reports.

E. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having

jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [III][IV] certification.

F. Communications Testing and Inspecting Agency: Entity possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site communications testing supervisor must have [BICSI Technician (TECH)]<Insert certification program> certification and documented training, and be experienced with testing communications equipment in accordance with [BICSI]<Insert code enforced by authorities having jurisdiction> testing standards.

G. Security Testing and Inspecting Agency: Entity possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site security testing supervisor must have [ASIS][PSP]<Insert organization> certification and documented training and experience with testing security equipment in accordance with [ASIS]<Insert organization> testing standards.

H. Fire-Alarm Testing Agency: Entity possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site fire-alarm testing supervisor must possess active NICET I&TFAS Technician [I][II] certification.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. <Insert additional performance requirements for the Project>.

2.2 METALLIC OUTLET BOXES, DEVICE BOXES, RINGS, AND COVERS

A. Source Quality Control:

1. Samples:

a. Floor Box Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors and flooring inserts for each type of floor box.
b. Raised Floor Box Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors and flooring inserts for each type of floor box.

c. Recessed Access-Floor Box Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors and flooring inserts for each type of floor box.
d. Concrete Box Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors and flooring inserts for each type of floor box.

2.3 NONMETALLIC OUTLET BOXES, DEVICE BOXES, RINGS, AND COVERS

A. Source Quality Control:

1. Samples:

a. Floor Box Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors and flooring inserts for each type of floor box.
b. Raised Floor Box Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors and flooring inserts for each type of floor box.
c. Recessed Access-Floor Box Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors and flooring inserts for each type of floor box.
d. Concrete Box Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors and flooring inserts for each type of floor box.

PART 3 - EXECUTION

3.1 SELECTION OF BOXES AND COVERS FOR ELECTRICAL SYSTEMS

A. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NFPA 70 for selection of boxes and enclosures. Consult Architect for resolution of conflicting requirements.

B. Degree of Protection:

1. Outdoors:

a. [Type 3][Type 3R][Type 4] unless otherwise indicated.
b. Locations Exposed to Hosedown: [Type 4][Type 4X][Type 6][Type 6P].
c. Locations Subject to Potential Flooding: Type 6P.
d. Locations Aboveground Where Mechanism Must Operate When Ice Covered: Type 3S.
e. Locations in-Ground or Exposed to Corrosive Agents: [Type 4X][Type 6P][Type 3RX].
f. Locations in-Ground or Exposed to Corrosive Agents Where Mechanism Must Operate When Ice Covered: Type 3SX.

2. Indoors:

a. Type 1 unless otherwise indicated.
b. Damp or Dusty Locations: [Type 12][Type 2][Type 4][Type 5].
c. Surface Mounted in Kitchens and Other Locations Exposed to Oil or Coolants: Type 12.
d. Flush Mounted in Kitchens and Other Locations Exposed to Oil or Coolants: [Type 12][Type 12K].
e. Locations Exposed to Airborne Dust, Lint, Fibers, or Flyings: [Type 4][Type 6].
f. Locations Exposed to Hosedown: [Type 4][Type 6][Type 6P].
g. Locations Exposed to Brief Submersion: [Type 6][Type 6P].
h. Locations Exposed to Prolonged Submersion: Type 6P.
i. Locations Exposed to Corrosive Agents: [Type 4X][Type 6P].
j. Locations Exposed to Spraying Oil or Coolants: Type 13.

C. Exposed Boxes Installed Less Than 2.5 m (8 ft) Above Floor:

1. [Provide cast-metal boxes][Boxes with knockouts or unprotected openings are prohibited].
2. Provide exposed cover. Flat covers with angled mounting slots or knockouts are prohibited.

3.2 INSTALLATION OF BOXES AND COVERS FOR ELECTRICAL SYSTEMS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Safety: NFPA 70E.
3. Commissioning of Active and Passive Fire Protection Features: NFPA 3 and NFPA 4.
4. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
5. Communications Work: BICSI N1.
6. Life Safety and Means of Egress Work: NFPA 101.
7. Emergency and Standby Power Work: NFPA 110, NFPA 111, and NECA NEIS 416.
8. Work in Confined Spaces: NFPA 350.
9. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
10. Outlet, Device, Pull, and Junction Boxes: Article 314 of NFPA 70.
11. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Provide boxes in wiring and raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures.
2. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with

height measured to [center][top][bottom] of box unless otherwise indicated.

3. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box, whether installed indoors or outdoors.
4. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
5. Locate boxes so that cover or plate will not span different building finishes.
6. Support boxes in recessed ceilings independent of ceiling tiles and ceiling grid.
7. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for purpose.
8. Fasten junction and pull boxes to, or support from, building structure. Do not support boxes by conduits.
9. Set metal floor boxes level and flush with finished floor surface.
10. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.
11. Do not install aluminum boxes, enclosures, or fittings in contact with concrete or earth.
12. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to ensure a continuous ground path.
13. Boxes and Enclosures in Areas or Walls with Acoustical Requirements:

    a. Seal openings and knockouts in back and sides of boxes and enclosures with acoustically rated putty.
    b. Provide gaskets for cover plates and covers.

14. <Insert more stringent installation requirements that supplement or supersede listed standards and manufacturers' published instructions>.

D. Interfaces with Other Work:

1. Identification: Provide labels for boxes and associated electrical equipment.

    a. Identify field-installed conductors, interconnecting wiring, and components.
    b. Label each enclosure with engraved metal or laminated-plastic nameplate.
    c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.

2. Coordinate installation of new products for <Insert system or product family/category> with existing conditions.

    a. <Insert requirements for transition between new and existing>.

3. Coordinate with <Insert Section number and title> for <Insert description of interfacing related Work>.

    a. <Insert requirements for transition between this Section and related Work>.

3.3 FIELD QUALITY CONTROL OF BOXES AND COVERS

A. Administrant for Electrical Power Tests and Inspections:

1. [Owner][Tenant] will engage qualified medium-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified medium-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[with assistance of factory-authorized service representative].

B. Administrant for Communications Tests and Inspections:

1. [Owner][Tenant] will engage qualified communications testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified communications testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[with assistance of factory-authorized service representative].

C. Administrant for Security Tests and Inspections:

1. [Owner][Tenant] will engage qualified security testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified security testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[with assistance of factory-authorized service representative].

D. Administrant for Fire-Alarm Tests and Inspections:

1. [Owner][Tenant] will engage qualified fire-alarm testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified fire-alarm testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[with assistance of factory-authorized service representative].

E. Acceptance Testing Preparation:

1. <Insert requirements>.

F. Field tests and inspections must be witnessed by [Architect][Tenant][authorities having jurisdiction]<Insert names or titles of witnesses>.

G. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.
2. Perform tests and inspections recommended by standards listed in "Reference Standards for Installation" Paragraph.

H. Nonconforming Work:

1. Boxes and covers will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

I. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

3.4 CLEANING

A. Remove construction dust and debris from boxes before installing cover plates, covers, and hoods.

3.5 PROTECTION

A. After installation, protect boxes from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 260533.16

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SECTION 26 05 33.23
SURFACE RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies temperature, humidity, acoustical, and other field conditions applicable to the Work specified in this Section.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies seismic hazard, wind hazard, and other structural design conditions applicable to the Work specified in this Section.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional coordination, scheduling, sequencing, submittal, and installation requirements applicable to the Work for electrical, communications, and electronic safety and security systems on the Project, including wiring methods.
4. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
5. Section 260553 "Identification for Electrical Systems" specifies warning signs referenced by this Section.
6. Section 270528 "Pathways for Communications Systems"[and Section 271100 "Communications Equipment Room Fittings"] specifies additional requirements for identification of communications equipment and cabling.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each type of product requiring samples for source quality control.

C. Sustainable Design Submittals:

1. Product data for sustainable design features for each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

1.4 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures; conduct tests of complex equipment; analyze test and equipment data; plan a job; and lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; evaluate tests, test equipment, test results, and power system performance; recommend actions to maintain or improve system performance; and lead multi-team projects.

C. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [III][IV] certification.

D. Communications Testing and Inspecting Agency: Entity possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site communications testing supervisor must have [BICSI Technician (TECH)]<Insert certification program> certification and documented training, and be experienced with testing communications equipment in accordance with [BICSI]<Insert code enforced by authorities having jurisdiction> testing standards.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 SURFACE METAL RACEWAYS AND FITTINGS

A. Source Quality Control:

1. Samples:

a. Surface Metallic Raceway Nonmetallic Cover Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type, [12 inch]<Insert dimension> long.

2.3 SURFACE NONMETALLIC RACEWAYS

A. Source Quality Control:

1. Samples:

a. Surface Nonmetallic Raceway Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type, [12 inch]<Insert dimension> long.

2.4 STRUT-TYPE CHANNEL RACEWAYS AND FITTINGS

A. Source Quality Control:

1. Samples:

a. Strut-Type Channel Raceway Nonmetallic Covers for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type, [12 inch]<Insert dimension> long.

2.5 WIREWAYS AND AUXILIARY GUTTERS

A. Source Quality Control:

1. Samples:

a. Nonmetallic Wireway and Auxiliary Gutter Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type, [12 inch]<Insert dimension> long.

PART 3 - EXECUTION

3.1 INSTALLATION OF SURFACE RACEWAYS FOR ELECTRICAL SYSTEMS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Safety: NFPA 70E.
3. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
4. Communications Work: BICSI N1.
5. Work in Confined Spaces: NFPA 350.
6. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
7. Auxiliary Gutters: Article 366 of NFPA 70.
8. Surface Metal Raceway: Article 386 of NFPA 70.
9. Surface Nonmetallic Raceway: Article 388 of NFPA 70.
10. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Install surface raceways only where indicated on Drawings.
2. Install surface raceway with a minimum 2 inch radius control at bend points.
3. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inch and with no less than two supports per straight raceway section. Support surface raceway in accordance with manufacturer's published instructions. Tape and glue are unacceptable support methods.

4. <Insert more stringent installation requirements that supplement or supersede listed standards and manufacturers' published instructions>.

D. Interfaces with Other Work:

1. Identification: Provide labels for surface raceways and associated electrical equipment.

a. Identify field-installed conductors, interconnecting wiring, and components.
b. Provide warning signs.

2. Coordinate installation of new products for <Insert system or product family/category> with existing conditions.

a. <Insert requirements for transition between new and existing>.

3. Coordinate with <Insert Section number and title> for <Insert description of interfacing related Work>.

a. <Insert requirements for transition between this Section and related Work>.

3.2 FIELD QUALITY CONTROL OF SURFACE RACEWAYS

A. Administrant for Electrical Power Tests and Inspections:

1. [Owner][Tenant] will engage qualified medium-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified medium-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[with assistance of factory-authorized service representative].

B. Administrant for Communications Tests and Inspections:

1. [Owner][Tenant] will engage qualified communications testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified communications testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[with assistance of factory-authorized service representative].

C. Field tests and inspections must be witnessed by [Architect][Tenant][authorities having jurisdiction]<Insert names or titles of witnesses>.

D. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.
2. Perform tests and inspections recommended by standards listed in "Reference Standards for Installation" Paragraph.

E. Nonconforming Work:

1. Boxes and covers will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

3.3 CLEANING

A. Remove construction dust and debris from surface raceways before installing covers.

3.4 PROTECTION

A. After installation, protect surface raceways from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 260533.23

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SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 284600 "Fire Detection and Alarm"[and Section 284614 "Single- and Multiple-Station Alarms"] specifies fire detection and alarm devices referenced in this Section.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each type of label and sign to illustrate composition, size, colors, lettering style, mounting provisions, and graphic features of identification products.

C. Identification Schedule: For each piece of electrical equipment and electrical system components to be index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

PART 2 - PRODUCTS

2.1 LABELS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN PGDQ2 for components; including UL 969.

2.2 EXTRUDED INSULATING TUBING

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN YDPU2 for components; including UL 224.

2.3 TAPES AND STENCILS

A. Concrete Cable Route Markers <Insert drawing designation>:

1. Description: Concrete markers visually aid tracing the route of electrical cables. Monument markers are typically installed at grade. Protective cover markers are typically installed above the cables at grade or below grade.
2. Product Characteristics:

    a. Material: Precast reinforced concrete.
    b. Marker Type:

        1) Above-Ground Monument Post:

            a) Nominal Dimensions (Height, Width, Depth): 30 inch, 6 inch, 3 inch.

        2) Above-Ground Monument Block:

            a) Nominal Dimensions (Height, Width, Depth): [12 inch, 12 inch, 6 inch][24 inch, 24 inch, 4 inch].

        3) In-Ground Protective Cover (Plank or Slab):

            a) Nominal Dimensions (Length, Width, Depth): [36 inch, 6 inch, 2 inch][36 inch, 9 inch, 2 inch][12 inch, 12 inch, 2 inch][24 inch, 12 inch, 2 inch][36 inch, 12 inch, 2 inch].

    c. Legend: ["DANGER - ELECTRICITY"]["ELECTRIC CABLES"]["ELECTRIC SPLICE"].
    d. Lettering: Approximately 1/8 inch deep, not less than [1 inch][1.5 inch] high, symmetrically spaced; marked on both sides to allow for reversal.

3. Required Product Options:

    a. Color: [Red]<Insert color> dye added to concrete during batching.
    b. Attach metal medallion or sign stamped with [feeder number]<Insert required information>.

B. Stenciled Legend: In nonfading, waterproof, [black]<Insert color> ink or paint. Minimum letter height must be [1 inch]<Insert dimension>.

PART 3 - EXECUTION

3.1 PREPARATION

A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 SELECTION OF COLORS AND IDENTIFICATION MARKINGS

A. Comply with 29 CFR 1910.144 for color identification of hazards, and the following:

1. Fire-protection[and fire-alarm] equipment[, including raceways,] must be finished, painted, or suitably marked safety red.
2. Ceiling-mounted hangers, supports, cable trays, and raceways must be finished, painted, or suitably marked safety yellow where less than [7.7 ft]<Insert height> above finished floor.

B. Pipe and Conduit Labeling: Comply with ASME A13.1[and IEEE C2].

C. Color-Coding for Phase- and Voltage-Level Identification, 1000 V or Less: Use colors listed below for ungrounded [service][feeder][and][branch-circuit] conductors.

1. Color must be factory applied[or field applied for sizes larger than 6 AWG when permitted by authorities having jurisdiction].
2. Colors for 208Y/120 V Circuits:

    a. Phase A: Black.
    b. Phase B: Red.
    c. Phase C: Blue.

3. Colors for 240 V Circuits:

    a. Phase A: Black.
    b. Phase B: Red.

4. Colors for 480Y/277 V Circuits:

    a. Phase A: Brown.
    b. Phase B: Orange.
    c. Phase C: Yellow.

5. Color for Neutral (Grounded Conductor): [White][or][gray].
6. Color for Equipment Ground: [Bare copper][Green][Green with yellow stripe].
7. Color for Isolated Ground: Green with two or more yellow stripes.

D. Color-Coding Raceways, Cable Trays, Junction Boxes, and Conductors for Intrinsically-Safe Circuits: Light blue. When used to identify intrinsically-safe circuits, Article 504 of NFPA 70 requires that the color light blue not be used for any other purpose.

E. Color-Coding Instructional Signs: Self-adhesive labels, including color code for grounded and ungrounded conductors.

F. Accessible Fittings for Raceways: Identify cover of junction and pull box of the following systems with wiring system legend and system voltage. System legends must be as follows:

1. "EMERGENCY POWER."
2. "POWER."
3. "UPS."

G. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.

H. Locations of Underground Lines: Underground-line warning tape for power and lighting.

I. Vaults, Manholes, Handholes, and Pull and Junction Boxes, More Than 1000 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use [write-on tags][nonmetallic preprinted tags colored and marked to indicate phase, and separate tag with circuit designation].

J. Concealed Raceways, Duct Banks, More Than 1000 V, within Buildings: Tape and stencil. Stencil legend "DANGER - CONCEALED HIGH-VOLTAGE WIRING" with 3 inch high, black letters on 20 inch centers.

1. Locate identification at changes in direction, at penetrations of walls and floors, and at [10 ft][30 ft] maximum intervals.
2. Identify system voltage[and system or service type] with black letters on orange field.
3. Apply floor marking tape to the following finished surfaces:

    a. Floor surface directly above conduits running beneath and within 12 inch of floor that is in contact with earth or is framed above unexcavated space.
    b. Wall surfaces directly external to raceways concealed within wall.
    c. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in building, or concealed above suspended ceilings.

K. Accessible Raceways, Armored and Metal-Clad Cables, More Than 1000 V: [Vinyl wraparound labels][Snap-around labels][Self-adhesive labels][Snap-around color-coding bands for raceway and cables].

1. Locate identification at changes in direction, at penetrations of walls and floors, at 50 ft maximum intervals in straight runs, and at 25 ft maximum intervals in congested areas.
2. Identify system voltage[and system or service type] with black letters on orange field.

L. Vaults, Manholes, Handholes, and Pull and Junction Boxes, 1000 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use [vinyl wraparound labels][self-adhesive wraparound labels][snap-around labels][snap-around color-coding bands][self-adhesive vinyl tape] to identify phase.

1. Locate identification at changes in direction, at penetrations of walls and floors, at 50 ft maximum intervals in straight runs, and at 25 ft maximum intervals in congested areas.
2. Identify system voltage[and system or service type] with [black letters on orange field]<Insert color scheme>.

M. Accessible Raceways and Metal-Clad Cables, 1000 V or Less, for Service, Feeder, and Branch Circuits, More Than [30]<Insert number> A and [120]<Insert number> V to Ground: Identify with self-adhesive [raceway labels][vinyl tape applied in bands].

1. Locate identification at changes in direction, at penetrations of walls and floors, at 50 ft maximum intervals in straight runs, and at 25 ft maximum intervals in congested areas.
2. Identify system voltage[and system or service type] with [black letters on orange field]<Insert color scheme>.

N. Conductors to Be Extended in Future: Attach [write-on tags][marker tape] to conductors[and list source].

O. Cover Plates: Label individual cover plates with self-adhesive labels. Place label at top of cover plate. Label cover plate with the following information, in the order listed:

1. Panelboard designation.
2. Colon or dash.
3. Branch circuit number.

P. Workspace Indication: Apply [floor marking tape][or][tape and stencil] to finished surfaces. Show working clearances in direction of access to live parts. Workspace must comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

Q. Equipment Identification Labels:

1. Black letters on white field.
2. Indoor Equipment: [Self-adhesive label][Baked-enamel signs][Metal-backed butyrate signs][Laminated acrylic or melamine plastic sign].
3. Outdoor Equipment: [Laminated acrylic or melamine sign][Stenciled legend 4 inch high].
4. Equipment to Be Labeled:

    a. Racks, Frames, and Enclosures: Identify front and rear of each with self-adhesive labels[containing equipment designation].
    b. Panelboards: Typewritten directory of circuits in location provided by panelboard manufacturer. Panelboard identification must be in form of [self-adhesive, engraved,][engraved,] laminated acrylic or melamine label.
    c. Enclosures and electrical cabinets.
    d. Access doors and panels for concealed electrical items.
    e. Switchgear.
    f. Switchboards.
    g. Transformers: Label that includes tag designation indicated on Drawings for transformer, feeder, and panelboards or equipment supplied by

secondary.
h. Substations.
i. Emergency system boxes and enclosures.
j. Motor-control centers.
k. Enclosed switches.
l. Enclosed circuit breakers.
m. Enclosed controllers.
n. Variable-speed controllers.
o. Push-button stations.
p. Power-transfer equipment.
q. Contactors.
r. Remote-controlled switches, dimmer modules, and control devices.
s. Uninterruptible power supplies.
t. Battery-inverter units.
u. Battery racks.
v. Power-generating units.
w. Monitoring and control equipment.

R. Cable Ties: General purpose, for attaching tags, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

3.3 SELECTION OF IDENTIFICATION PRODUCTS FOR COMMUNICATIONS, CONTROL, AUXILIARY, AND LIFE SAFETY SYSTEMS

A. Comply with Section 270528 "Pathways for Communications Systems" and Section 271100 "Communications Equipment Room Fittings."

3.4 INSTALLATION

A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes typical for electrical equipment environments specified in Section 018116 "Facility Environmental Requirements" and Section 260010 "Supplemental Requirements for Electrical."

C. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).

D. Fasteners for Labels and Signs: Self-tapping, stainless steel screws or stainless steel machine screws with nuts and flat and lock washers.

E. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

F. Install identifying devices before installing acoustical ceilings and similar concealment.

G. Verify identity of item before installing identification products.

H. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.

I. Apply identification devices to surfaces that require finish after completing finish work.

J. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.

K. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from floor.

L. Vinyl Wraparound Labels:

1. Secure tight to surface of raceway or cable at location with high visibility and accessibility.
2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to location and substrate.

M. Snap-Around Labels: Secure tight to surface at location with high visibility and accessibility.

N. Self-Adhesive Wraparound Labels: Secure tight to surface at location with high visibility and accessibility.

O. Snap-Around Color-Coding Bands: Secure tight to surface at location with high visibility and accessibility.

P. Heat-Shrink, Preprinted Tubes: Secure tight to surface at location with high visibility and accessibility.

Q. Marker Tapes: Secure tight to surface at location with high visibility and accessibility.

R. Self-Adhesive Vinyl Tape: Secure tight to surface at location with high visibility and accessibility.

1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for minimum distance of 6 inch where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.

S. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.

T. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's instructions.

U. Underground Line Warning Tape:

1. During backfilling of trenches, install continuous underground-line warning tape

not less than 12 inch directly above cables or raceways buried 18 inch or more below grade. Use multiple tapes where width of multiple lines installed in common trench [or concrete envelope]exceeds 16 inch overall.

2. Limit use of underground-line warning tape to direct-buried cables.
3. Install underground-line warning tape for direct-buried cables and cables in raceways.

V. Concrete Cable Route Markers: [As indicated on Drawings]<Insert Project-specific requirements>.

W. Metal Tags:

1. Place in location with high visibility and accessibility.
2. Secure using [general-purpose][UV-stabilized][plenum-rated] cable ties.

X. Nonmetallic Preprinted Tags:

1. Place in location with high visibility and accessibility.
2. Secure using [general-purpose][UV-stabilized][plenum-rated] cable ties.

Y. Write-on Tags:

1. Place in location with high visibility and accessibility.
2. Secure using [general-purpose][UV-stabilized][plenum-rated] cable ties.

Z. Baked-Enamel Signs: Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.

AA. Metal-Backed Butyrate Signs: Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.

BB. Laminated Acrylic or Melamine Plastic Signs: Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.

END OF SECTION 260553

SECTION 26 09 23
LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies temperature, humidity, acoustical, and other field conditions applicable to the Work specified in this Section.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies seismic hazard, wind hazard, other structural design conditions applicable to the Work specified in this Section.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional coordination, scheduling, sequencing, submittal, and installation requirements applicable to the Work for electrical, communications, and electronic safety and security systems on the Project, including wiring methods.
4. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding of lighting control devices referenced by this Section.
5. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers and supports referenced by this Section.
6. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
7. [Section 262726 "Wiring Devices"][Section 262726.11 "General-Use Switches, Dimmer Switches, and Fan-Speed Controller Switches"] for wall-box dimmers and manual light switches.

1.2 DEFINITIONS

A. BCELTS: Branch circuit emergency lighting transfer switch.

B. DPDT: Double pole double throw.

C. DPST: Double pole single throw.

D. N.C.: Normally closed.

E. N.O.: Normally open.

F. PIR: Passive infrared.

G. SPDT: Single pole double throw.

H. SPST: Single pole single throw.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.

a. If listed manufacturer differs from selling manufacturer, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and fitness for purpose.
b. Listing criteria identified in approval letter must match specified listing criteria. UL label indicating approval of equipment's enclosure is not considered approval of equipment for intended application.
c. Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for discontinued or superseded products are unacceptable for submitted product.

2. Include manufacturer's sample extended warranty language.

B. Shop Drawings: Prepare and submit the following:

1. Show installation details for the following:

a. Occupancy sensors.
b. Vacancy sensors.

2. Interconnection diagrams showing field-installed wiring.
3. Diagrams for power, signal, and control wiring.

C. Sustainable Design Submittals:

1. ASHRAE/IES 90.1 LPD Compliance Documentation: Prepare plans and calculations demonstrating that as-constructed lighting power density complies with mandatory provisions of ASHRAE/IES 90.1 and that as-constructed lighting, including daylighting and controls, improves on baseline energy performance. If included with Project, indicate locations of energy meters for lighting loads.
2. Lighting Control Documentation: Floor plans indicating the following information:

a. As-installed locations of switches and dimmers.
b. Lighting zones and control strategy for each switch or dimmer, including unoccupied time-delay setting for shut-off and override time-delay setting for shut-off.
c. Multilevel or dimming range capability for each switch or dimmer.
d. Which switches or dimmers are operated by occupancy sensors, vacancy sensors, daylighting sensors, or time clocks.

D. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

B. Field Reports:

1. Manufacturer's field reports for field quality-control support.
2. Field reports for software and firmware upgrades.

1.5 CLOSEOUT SUBMITTALS

A. Warranty documentation.

B. Software and firmware service agreement.

1.6 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures, conduct tests of complex equipment, analyze test and equipment data, plan a job, and lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; evaluate tests, test equipment, test results, and power system performance; recommend actions to maintain or improve system performance; and lead multiteam projects.

C. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [III][IV] certification.

D. Lighting Testing and Inspecting Agency: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" with documented training and experience with testing and inspecting lighting installations in accordance with applicable IES standards.

1.7 WARRANTY

A. Special Installer Extended Warranty: Installer warrants that installed lighting control devices perform in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period. Warranty must convey to Owner upon acceptance of the Work.

1. Extended-Warranty Period: [Two][Three][Four]<Insert number> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that lighting control

devices perform in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period. Warranty must convey to Owner upon acceptance of the Work.

1. Failures include, but are not limited to, the following:

    a. Faulty operation of lighting control software.
    b. Faulty operation of lighting control devices.

2. Initial Extended-Warranty Period: [Three][Four][Five]<Insert number> years from date of Substantial Completion; [full][prorated] coverage for labor, materials, and equipment.
3. Follow-On Extended-Warranty Period: [Eight]<Insert number> years from date of Substantial Completion; [full][prorated] coverage for materials only, free on board [origin][destination], freight prepaid.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements:

1. Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Must comply with CCR Title 24.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.

B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.

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

3.2 SELECTION OF CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than [18 AWG][22 AWG][24 AWG]. Comply with requirements in Section

260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than [14 AWG][16 AWG][18 AWG]. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 INSTALLATION OF LIGHTING CONTROL DEVICES

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B.
3. Electrical Safety: NFPA 70E.
4. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
5. Communications Work: BICSI N1.
6. Life Safety and Means of Egress Work: NFPA 101.
7. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
8. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
2. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's instructions.
3. Installation of Industrial Control Switches: Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration unless contactors are installed in an enclosure with factory-installed vibration isolators.
4. Installation of Wiring:

    a. Conduit: Minimum conduit size is 1/2 inch.
    b. Wiring within Enclosures: Separate power-limited and nonpower-limited conductors in accordance with conductor manufacturer's published instructions.
    c. Size conductors in accordance with lighting control device manufacturer's published instructions unless otherwise indicated.
    d. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, device, and outlet boxes; terminal cabinets; and equipment enclosures.

D. Interfaces with Other Work:

1. Identification: Provide labels for lighting control devices and associated electrical equipment.

    a. Identify field-installed conductors, interconnecting wiring, and components.
    b. Label each enclosure with engraved metal or laminated-plastic nameplate.
    c. Identify controlled circuits in lighting contactors.
    d. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.
    e. Label time switches and contactors with a unique designation.

3.4 FIELD QUALITY CONTROL

A. Administrant for Electrical Power Tests and Inspections:

1. [Owner][Tenant] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[with assistance of factory-authorized service representative].

B. Administrant for Lighting Tests and Inspections:

1. [Owner][Tenant] will engage qualified lighting testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified lighting testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[with assistance of factory-authorized service representative].

C. Field tests must be witnessed by [Architect][Tenant][authorities having jurisdiction]<Insert names or titles of witnesses>.

D. Tests and Inspections:

1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Nonconforming Work:

1. Lighting control devices will be considered defective if they do not pass tests and inspections.

2. Remove and replace defective units and retest.

F. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

G. Manufacturer Services: Engage factory-authorized service representative to [support][supervise] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.5 ADJUSTING

A. Occupancy Adjustments: When requested within [12]<Insert number> months from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to [two]<Insert number> visits to the Project site during other-than-normal occupancy hours for this purpose. Some of the Work may be required during hours of darkness.

1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

3.6 CLOSEOUT ACTIVITIES

A. Demonstration:

1. [With assistance from factory-authorized service representatives, demonstrate][Demonstrate] to Owner's maintenance and clerical personnel[and building occupants] how to operate the following systems and equipment:

a. Lighting control devices.

B. Training:

1. [With assistance from factory-authorized service representatives, train][Train] Owner's maintenance personnel on the following topics:

a. How to adjust, operate, and maintain lighting control devices.

3.7 MAINTENANCE

A. Software and Firmware Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software and firmware service agreement includes software support for [two]<Insert number>

years.

2. Upgrade Service: At Substantial Completion, update software and firmware to latest version. Install and program software upgrades that become available within [two]<Insert number> years from date of Substantial Completion. Verify upgrading software includes operating system and new or revised licenses for using software.

    a. Upgrade Notice: Not less than [30 days]<Insert duration>; to allow Owner to schedule and access the system[and to upgrade computer equipment if necessary].

3. Field Reports for Software and Firmware Upgrades: Prepare and submit report after each update, documenting upgrades installed.

END OF SECTION 260923

SECTION 26 24 16
PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Products Installed, but Not Furnished, under This Section:

1. <Insert products identified in "Existing Products to be Modified" Article or "Existing Products to be Removed and Reinstalled" Article>.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies temperature, humidity, acoustical, and other field conditions applicable to the Work specified in this Section.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies seismic hazard, wind hazard, other structural design conditions applicable to the Work specified in this Section.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional abbreviations, definitions, submittals, qualifications, testing agencies, and other requirements applicable to the Work for electrical, communications, and electronic safety and security systems on Project, including wiring methods.
4. Section 260529 "Hangers and Supports for Electrical Systems" specifies concrete bases and supports for panelboards installed by this Section.
5. Section 260548 "Vibration and Seismic Controls for Electrical Systems" specifies seismic control devices, mounting devices, and anchoring devices installed by this Section.
6. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs installed by this Section.
7. Section 260573 "Power System Studies" specifies short-circuit current studies, overcurrent protective device coordination studies, and arc-flash hazard analysis studies.
8. Section 260913 "Electrical Power Monitoring" specifies power monitoring and control systems installed by this Section.
9. Section 262813 "Fuses" specifies fuses and spare-fuse cabinets installed by this Section.
10. Section 264313 "Surge Protective Devices for Low-Voltage Electrical Power Circuits" specifies Type 1 and Type 2 surge protective devices installed by this Section.

1.2 DEFINITIONS

A. MCCB: Molded-case circuit breaker.

B. VPR: Voltage protection rating.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. In addition to information identified in Section 013300 "Submittal Procedures," submit the following:

1. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.
2. Include manufacturer's sample extended warranty language.

B. Shop Drawings: For each panelboard and related equipment:

1. Include dimensioned plans, elevations, sections, and details.
2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
4. Detail bus configuration, current, and voltage ratings.
5. Short-circuit current rating of panelboards and overcurrent protective devices.
6. Include evidence of listing, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for series rating of installed devices.
7. Include evidence of listing, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for SPD as installed in panelboard.
8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
9. Include wiring diagrams for power, signal, and control wiring.
10. Key interlock scheme drawing and sequence of operations.
11. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device. Include Internet link for electronic access to downloadable PDF of coordination curves.

C. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Panelboard Schedules: For installation in panelboards.[Submit final versions after load balancing.]

B. Manufacturer's published instructions.

C. Field Reports:

1. Manufacturer's field reports for field quality-control support.
2. Field reports for voltage monitoring and adjusting.
3. Field reports for infrared scanning.

1.5 CLOSEOUT SUBMITTALS

A. Warranty documentation.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Spare parts.

B. Special tools.

1.7 QUALIFICATIONS

A. Low-Voltage Electrical Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must have documented certification and experience with testing electrical equipment in accordance with NETA testing standards.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation in accordance with [NECA 407][NEMA PB 1].

1.9 WARRANTY

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed panelboards perform in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [Two]<Insert number> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that panelboards perform in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period.

1. Initial Extended-Warranty Period: [Three][Four]<Insert number> years from date of Substantial Completion; [full][prorated] coverage for labor, materials, and equipment.
2. Follow-On Extended-Warranty Period: [Five]<Insert number> years from date of Substantial Completion; [full][prorated] coverage for materials[that failed

because of transient voltage surges] only, free on board [origin][destination], freight prepaid.

PART 2 - PRODUCTS

2.1 EXISTING PRODUCTS TO BE MODIFIED

A. Basis for Pricing: <Insert name of manufacturer; model number or series for existing product>.

B. Description: <Insert description of existing product, including special features, options, and finishes that may impact the Work>.

1. Sustainable Design Features:

C. Accessories: <Insert accessories included with existing product>.

2.2 EXISTING PRODUCTS TO BE REMOVED AND REINSTALLED

A. Basis for Pricing: <Insert name of manufacturer; model number or series for existing product>.

B. Description: <Insert description of existing product, including special features, options, and finishes that may impact the Work>.

1. Sustainable Design Features:

C. Accessories: <Insert accessories included with existing product>.

2.3 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. Fabricate and test panelboards in accordance with IEEE 344 to withstand seismic forces specified in Section 018123 "Facility Seismic and Wind Criteria."

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. Comply with NEMA PB 1.

E. Enclosures: [Flush][and][Surface]-mounted, dead-front cabinets.

1. Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: UL 50E, [Type 1]<Insert type>.

b. Outdoor Locations: UL 50E, [Type 3R]<Insert type>.
c. Kitchen and Wash-Down Areas: UL 50E, [Type 4X]<Insert type>, [stainless steel]<Insert material>.
d. Other Wet or Damp Indoor Locations: UL 50E, [Type 4]<Insert type>.
e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: UL 50E, [Type 5][Type 12].

2. Height: 7 ft maximum.
3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims must cover live parts and may have no exposed hardware.
4. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims must cover live parts and may have no exposed hardware.
5. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
6. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
7. Finishes:

a. Panels and Trim: [Steel][and][galvanized steel], factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
b. Back Boxes: [Galvanized steel][Same finish as panels and trim].
c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.

F. Phase, Neutral, and Ground Buses:

1. Material: [Tin-plated aluminum][Hard-drawn copper, 98 percent conductivity].

a. Plating must run entire length of bus.
b. Bus must be fully rated for entire length.

2. Interiors must be factory assembled into unit. Replacing switching and protective devices may not disturb adjacent units or require removing main bus connectors.
3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

G. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: [Tin-plated aluminum][Hard-drawn copper, 98 percent conductivity].
2. Terminations must allow use of 75 deg C rated conductors without derating.
3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
4. Main and Neutral Lugs: [Compression][Mechanical] type, with lug on neutral bar for each pole in panelboard.
5. Ground Lugs and Bus-Configured Terminators: [Compression][Mechanical] type, with lug on bar for each pole in panelboard.

H. Quality-Control Label: Panelboards or load centers must be labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards or load centers must have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.

I. Future Devices: Panelboards or load centers must have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

1. Percentage of Future Space Capacity: [5][10][20]<Insert number> percent.

J. Panelboard Short-Circuit Current Rating:

1. Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by qualified electrical testing laboratory recognized by authorities having jurisdiction. Include label or manual with size and type of allowable upstream and branch devices listed and labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for series-connected short-circuit rating.

a. Panelboards rated 240 V or less must have short-circuit ratings as shown on Drawings, but not less than 10 000 A(rms) symmetrical.
b. Panelboards rated above 240 V and less than 600 V must have short-circuit ratings as shown on Drawings, but not less than 14 000 A(rms) symmetrical.

2. Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for 100 percent interrupting capacity.

a. Panelboards and overcurrent protective devices rated 240 V or less must have short-circuit ratings as shown on Drawings, but not less than 10 000 A(rms) symmetrical.
b. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V must have short-circuit ratings as shown on Drawings, but not less than 14 000 A(rms) symmetrical.

2.4 MAINTENANCE MATERIAL ITEMS

A. Spare Parts: Furnish to Owner spare parts, for repairing panelboards and related equipment, that are packaged with protective covering for storage on-site and identified with labels describing contents.[Include the following:]

1. Keys: [Two]<Insert number> spares for each type of panelboard cabinet lock.
2. Circuit Breakers Including GFCI and GFPE Types: [Two]<Insert number> spares for each panelboard.
3. 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.

4. 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.

B. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to panelboards and related equipment, that are packaged with protective covering for storage on-site and identified with labels describing contents.[Include the following:]

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

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.

B. Receive, inspect, handle, and store panelboards in accordance with [NECA 407][NEMA PB 1.1].

C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.

D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Reference Standards:

1. Panelboards: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with [NECA 407][NEMA PB 1.1].
2. Consult Architect for resolution of conflicting requirements.

C. Special Techniques:

1. Equipment Mounting:

a. Install floor-mounted panelboards on cast-in-place concrete equipment base(s).

b. Attach panelboard to vertical finished or structural surface behind panelboard.
c. Mount surface-mounted panelboards to steel slotted supports [5/8 inch][1-1/4 inch] in depth. Orient steel slotted supports vertically.
d. Provide seismic control devices.

2. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
3. Provide mounting and anchoring devices.
4. Mount top of trim [7.5 ft]<Insert height> above finished floor unless otherwise indicated.
5. Mount panelboard cabinet plumb and rigid without distortion of box.
6. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
7. Install overcurrent protective devices and controllers not already factory installed.

a. Set field-adjustable, circuit-breaker trip ranges.
b. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver in accordance with manufacturer's published instructions.

8. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.
9. Install filler plates in unused spaces.
10. Stub four 1 inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in future. Stub four 1 inch empty conduits into raised floor space or below slab not on grade.
11. Arrange conductors in gutters into groups and bundle and wrap with wire ties[after completing load balancing].
12. Mount spare fuse cabinet in accessible location.

D. Interfaces with Other Work:

1. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components.

B. Install warning signs.

C. Panelboard Nameplates: Label each panelboard with nameplate.

D. Device Nameplates: Label each branch circuit device in power panelboards with nameplate.

E. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles must be located on interior of panelboard door.

F. Breaker Labels: Faceplate must list current rating, UL and IEC certification standards, and AIC rating.

G. Circuit Directory:

1. Provide directory card inside panelboard door, mounted in [transparent card holder][metal frame with transparent protective cover].

a. Circuit directory must identify specific purpose with detail sufficient to distinguish it from other circuits.

2. Provide computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.

a. Circuit directory must identify specific purpose with detail sufficient to distinguish it from other circuits.

3. Create directory to indicate installed circuit loads[after balancing panelboard loads]; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.

3.4 FIELD QUALITY CONTROL

A. Administrant for Low-Voltage Electrical Tests and Inspections:

1. [Owner][Tenant] will engage qualified low-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified low-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[with assistance of factory-authorized service representative].

B. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Field tests and inspections must be witnessed by [Architect][Tenant][authorities having jurisdiction]<Insert names or titles of witnesses>.

D. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test for low-voltage

air circuit breakers[and low-voltage surge arrestors] stated in NETA ATS, Paragraph 7.6 Circuit Breakers[and Paragraph 7.19.1 Surge Arrestors, Low-Voltage]. [Do not perform][Perform] optional tests. 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 infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
    b. Follow-up Infrared Scanning: Perform additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
    c. Instruments and Equipment:

        1) Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

E. Nonconforming Work:

1. Panelboards will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

1. Include certified report that identifies panelboards included and that describes scanning results, with comparisons of two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

G. Manufacturer Services: Engage factory-authorized service representative to [support][supervise] field tests and inspections.

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.

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes. Prior to making circuit changes to achieve load balancing, inform Architect of effect on phase color coding.

1. Measure loads during period of normal facility operations.
2. Perform circuit changes to achieve load balancing outside normal facility operation schedule or at times directed by Architect. Avoid disrupting services

such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.

3. After changing circuits to achieve load balancing, recheck loads during normal facility operations. Record load readings before and after changing circuits to achieve load balancing.
4. Tolerance: Maximum difference between phase loads, within panelboard, may not exceed 20 percent.

3.6 PROTECTION

A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature in accordance with manufacturer's published instructions.

END OF SECTION 262416

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SECTION 26 27 26
WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Products Installed, but Not Furnished, under This Section:

1. <Insert products identified in "Existing Products to be Modified" Article or "Existing Products to be Removed and Reinstalled" Article>.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies temperature, humidity, acoustical, and other field conditions applicable to the Work specified in this Section.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies seismic hazard, wind hazard, and other structural load design conditions applicable to the Work specified in this Section.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional coordination, scheduling, sequencing, submittal, and installation requirements applicable to the Work for electrical, communications, and electronic safety and security systems on the Project, including wiring methods.
4. [Section 013100 "Project Management and Coordination"]<Insert Section number and title> for preinstallation conference procedures.
5. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
6. Section 260533.16 "Boxes and Covers for Electrical Systems" specifies covers and cover plates referenced by this Section.
7. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
8. Section 260923 "Lighting Control Devices" for occupancy sensors, timers, control-voltage switches, and control-voltage dimmers.
9. Section 260936 "Modular Dimming Controls" for multiscene and multipreset dimming controls.
10. Section 260943.16 "Addressable Luminaire Lighting Controls" for network lighting control solid-state devices.
11. Section 260943.23 "Relay-Based Lighting Controls" for network lighting control relay devices.
12. Section 262726.11 "General-Use Switches, Dimmer Switches, and Fan-Speed Controller Switches" for additional wiring device products.
13. Section 262726.31 "General-Grade Single Straight-Blade Receptacles" for additional wiring device products.
14. Section 262726.33 "General-Grade Duplex Straight-Blade Receptacles" for additional wiring device products.
15. Section 262726.35 "Hospital-Grade Straight-Blade Receptacles" for additional wiring device products.
16. Section 262726.37 "Receptacles with Arc-Fault and Ground-Fault Protective Devices" for additional wiring device products.

17. Section 262726.39 "Locking Receptacles" for additional wiring device products.
18. Section 262726.41 "Pin-and-Sleeve Receptacles" for additional wiring device products.
19. Section 262726.43 "Special-Purpose Power Outlet Assemblies" for additional wiring device products.
20. Section 262726.51 "Connectors, Cords, and Plugs" for additional wiring device products.
21. Section 270528 "Pathways for Communications Systems"[and Section 271100 "Communications Equipment Room Fittings"] specifies additional requirements for raceway materials, routing, locations, and identification of communications equipment and cabling.

1.2 DEFINITIONS

A. AFCI: Arc-Fault Circuit Interrupter.

B. Commercial/Industrial-Use Cord Reel: A cord reel subject to severe use in factories, commercial garages, construction sites, and similar locations requiring a harder service-type cord.

C. GFCI: Ground-Fault Circuit Interrupter.

D. UL 1472 Type I Dimmer: Dimmer in which air-gap switch is used to energize preset lighting levels.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [Project site]<Insert location>.

B. Preinstallation Coordination Meeting(s): For ceiling-mounted cable reels. Conduct meeting [as videoconference][or][at Project site]<Insert location> before <Insert construction activity>.

1. Attendees: Installers, fabricators, representatives of manufacturers, and administrants for field tests and inspections. Notify Architect[, Construction Manager][, and Owner's Commissioning Authority] of scheduled meeting dates.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.

a. If listed manufacturer differs from selling manufacturer, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and fitness for purpose.
b. Listing criteria identified in approval letter must match specified listing

criteria. UL label indicating approval of equipment's enclosure is not considered approval of equipment for intended application.

c. Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for discontinued or superseded products are not acceptable for submitted product.

2. Include manufacturer's sample extended warranty language.

B. Samples:

1. One for each kind of toggle switch[and cover plate accessory] specified, in each finish and color specified.
2. One for each kind of key lock switch[and cover plate accessory] specified, in each finish and color specified.
3. One for each kind of maintained-contact switch[and cover plate accessory] specified, in each finish and color specified.
4. One for each kind of momentary-contact switch[and cover plate accessory] specified, in each finish and color specified.
5. One for each kind of rocker switch[and cover plate accessory] specified, in each finish and color specified.
6. One for each kind of dimmer switch[and cover plate accessory] specified, in each finish and color specified.
7. One for each kind of fan-speed controller switch[and cover plate accessory] specified, in each finish and color specified.
8. One for each kind of single straight-blade receptacle[and cover plate accessory] specified, in each finish and color specified.
9. One for each kind of duplex straight-blade receptacle[and cover plate accessory] specified, in each finish and color specified.
10. One for each kind of duplex straight-blade receptacle with integral switching means[and cover plate accessory] specified, in each finish and color specified.
11. One for each kind of hospital-grade straight-blade receptacle[and cover plate accessory] specified, in each finish and color specified.
12. One for each kind of receptacle with AFCI device[and cover plate accessory] specified, in each finish and color specified.
13. One for each kind of receptacle with AFCI and GFCI devices[and cover plate accessory] specified, in each finish and color specified.
14. One for each kind of receptacle with GFCI device[and cover plate accessory] specified, in each finish and color specified.
15. One for each kind of locking receptacle[and cover plate accessory] specified, in each finish and color specified.
16. One for each kind of pin-and-sleeve receptacle specified, in each finish and color specified.
17. One for each kind of cord connector specified, in each finish and color specified.

C. Shop Drawings:

1. Wiring diagrams for duplex straight-blade receptacles with integral switching means.

D. Sustainable Design Submittals:

1. Product data for sustainable design features for each type of product.
2. Lighting Control Documentation: Floor plans indicating the following information:

    a. As-installed locations of switches and dimmers.
    b. Lighting zones and control strategy for each switch or dimmer, including unoccupied time-delay setting for shut-off and override time-delay setting for shut-off.
    c. Multilevel or dimming range capability for each switch or dimmer.
    d. Which switches or dimmers are operated by occupancy sensors, vacancy sensors, daylighting sensors, or time clocks.

3. Record floor plan Drawings indicating as-installed locations of switches and dimmers, indicating lighting zone's each device control, to verify extent of ability of the installed Work to provide occupant control for customizing environment.
4. Record floor plan Drawings indicating as-installed locations of uncontrolled and marked controlled receptacles superimposed on office furniture layout, to verify extent of ability of the installed Work to provide each occupant ability to select at least one uncontrolled receptacle and at least one controlled receptacle for powering workspace equipment. Indicate locations of UL-approved relocatable power taps and power strips, indicating means of securing protection from damage and accessibility for inspection. Indicate locations of temporary extension cords, indicating plan for replacing them with permanent wiring within 90 days.

E. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

B. Field Reports:

1. Manufacturer's field reports for field quality-control support.

1.6 CLOSEOUT SUBMITTALS

A. Warranty documentation.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Extra stock material.

B. Special tools.

1.8 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures, conduct tests of complex

equipment, analyze test and equipment data, plan a job, and lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; evaluate tests, test equipment, test results, and power system performance; recommend actions to maintain or improve system performance; and lead multi-team projects.

C. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [III][IV] certification.

1.9 WARRANTY FOR DEVICES

A. Special Installer Extended Warranty: Installer warrants that installed devices perform in accordance with specified requirements and agrees to repair or replace products that fail to perform as specified within extended-warranty period. Warranty must convey to Owner upon acceptance of the Work.

1. Extended-Warranty Period: [Two][Three][Four]<Insert number> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that devices perform in accordance with specified requirements and agrees to provide repair or replacement of devices that fail to perform as specified within extended warranty period.

1. Initial Extended Warranty Period: [Three][Four][Five]<Insert number> years from date of Substantial Completion; [full][prorated] coverage for labor, materials, and equipment.
2. Follow-On Extended Warranty Period: [Eight]<Insert number> years from date of Substantial Completion; [full][prorated] coverage for materials only, free on board [origin][destination], freight prepaid.

1.10 WARRANTY FOR CORD REELS

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed cord-reel power outlet assemblies perform in accordance with specified requirements and agrees to repair or replace assemblies that fail to perform as specified within extended warranty period.

1. Extended Warranty Period: [Two][Three][Four]<Insert number> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that components of cord-reel power outlet assemblies perform in accordance with specified requirements and agrees to provide repair or replacement of components that fail to perform as

specified within extended warranty period.

1. Initial Extended Warranty Period: [Three][Four][Five]<Insert number> years from date of Substantial Completion; [full][prorated] coverage for labor, materials, and equipment.
2. Follow-On Extended Warranty Period: [Eight]<Insert number> years from date of Substantial Completion; [full][prorated] coverage for materials only, free on board [origin][destination], freight prepaid.

PART 2 - PRODUCTS

2.1 EXISTING PRODUCTS TO BE MODIFIED

A. Basis for Pricing: <Insert name of manufacturer and model number or series for existing product>.

B. Description: <Insert description of existing product, including special features, options, and finishes that may impact the Work>.

C. Accessories: <Insert accessories included with existing product>.

2.2 EXISTING PRODUCTS TO BE REMOVED AND REINSTALLED

A. Basis for Pricing: <Insert name of manufacturer and model number or series for existing product>.

B. Description: <Insert description of existing product, including special features, options, and finishes that may impact the Work>.

C. Accessories: <Insert accessories included with existing product>.

2.3 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.4 SPECIAL-PURPOSE POWER OUTLET ASSEMBLIES

A. Power Outlet Cord Management Assembly <Insert drawing designation>:

1. Source Limitations: Obtain all components for each power outlet cord management assembly from single manufacturer.
2. General Characteristics: Provide the following specified products with fabricated power outlet cord management assembly:

    a. Cord Management System:

1) Spring-driven commercial/industrial-use cord reel, <Insert wire size> conductors <Insert drawing designation>.
2) Cord reel for use in Class I Group D hazardous location <Insert drawing designation>.

b. Termination Fitting:

1) Owner-furnished fitting.
2) Outdoor-use, watertight, sealed cord connector; <Insert NEMA configuration><Insert drawing designation>.
3) <Insert title of product><Insert drawing designation> specified in <Insert Section number and title>.

3. Accessories:

a. Mounting: [Ceiling][Wall][Floor] mounted.
b. <Insert required accessory>.

4. Seismic and Wind Performance: Installed product must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

a. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events[and unit must be fully operational after seismic events]."
b. Component Importance Factor (Ip): [1.0][1.5].
c. Component Amplification Factor (ap): [1.0][2.5]<Insert value>.
d. Component Response Modification Factor (Rp): [1.5][2.0][2.5][6.0]<Insert value>.
e. Component Overstrength Factor (Ωo): [1.5][2.5]<Insert value>.

2.5 MAINTENANCE MATERIAL ITEMS FOR STRAIGHT-BLADE RECEPTACLES

A. Extra Stock Material: Furnish to Owner extra materials[, from same production run,] that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.[Include the following:]

1. SPD Receptacles: Equal to [10]<Insert number> percent of quantity installed for each kind specified, but no fewer than [one]<Insert number> units.
2. Controlled Receptacles: Equal to [10]<Insert number> percent of quantity installed for each kind specified, but no fewer than [one]<Insert number> units.

B. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to controlled receptacles, that are packaged with protective covering for storage on-site and identified with labels describing contents.

2.6 MAINTENANCE MATERIAL ITEMS FOR CONNECTORS, CORDS, AND PLUGS

A. Extra Stock Material: Furnish to Owner extra materials[, from same production run,]

that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.[Include the following:]

1. Cord Connectors: [One]<Insert number> of each kind.

B. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to cord connectors, that are packaged with protective covering for storage on-site and identified with labels describing contents.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receptacles:

1. Verify that receptacles to be procured and installed for Owner-furnished equipment are compatible with mating attachment plugs on equipment.

B. Cord Reels:

1. Examine roughing-in for cord reel mounting and power connections to verify actual locations of mounts and power connections before cord reel installation.
2. Examine walls, floors, and ceilings for suitable conditions where cord reel will be installed.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SELECTION OF CONTROLLED AND UNCONTROLLED RECEPTACLES

A. Private and Open Office Spaces:

1. Uncontrolled Receptacles at Workstations: Coordinate final locations of receptacles with furniture plan such that at least one uncontrolled receptacle is selected for installation not greater than 6 ft. (1.8 m) from each workstation.
2. Controlled Receptacles at Workstations: Coordinate final locations of receptacles with furniture plan such that at least one controlled receptacle is selected for installation not greater than 6 ft. (1.8 m) from each workstation.
3. Contact Architect for resolution of discrepancies between these requirements and Drawings.

3.3 SELECTION OF GFCI RECEPTACLES

A. Healthcare Facilities: Unless protection of downstream branch-circuit wiring, cord sets, and power-supply cords is required by NFPA 70 or NFPA 99, provide non-feed-through GFCI receptacles.

3.4 INSTALLATION OF SWITCHES

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Safety: NFPA 70E.
3. Life Safety and Means of Egress Work: NFPA 101.
4. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
5. Wiring Devices: NECA NEIS 130.
6. Mounting Heights: NECA NEIS 1.
7. Consult Architect for resolution of conflicting requirements.

C. Interfaces with Other Work:

1. Identification:

a. Identify cover or cover plate for device with panelboard identification and circuit number.
b. Mark cover or cover plate using hot, stamped, or engraved machine printing with [black][white][red]-filled lettering, and provide durable wire markers or tags inside device box or outlet box.
c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.
d. Healthcare Facilities: Distinctively identify covers or cover plates of device boxes and outlet boxes that are supplied from life safety and critical branch power supplies following facility's standard practice.

2. Coordinate installation of new products for <Insert system or product group> with existing conditions.

a. <Insert requirements for transition between new and existing>.

3. Coordinate with <Insert Section number and title> for <Insert description of interfacing related Work>.

a. <Insert requirements for transition between this Section and related Work>.

3.5 INSTALLATION OF STRAIGHT-BLADE RECEPTACLES

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Safety: NFPA 70E.
3. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
4. Work in ITE Rooms: NFPA 75.
5. Work in Health Care Facilities: NFPA 99 and Article 517 of NFPA 70.
6. Work in Confined Spaces: NFPA 350.
7. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
8. Installing and Maintaining Wiring Devices: NECA NEIS 130.
9. Mounting Heights: Unless otherwise indicated in the Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
10. Receptacle Orientation: Unless otherwise indicated in the Contract Documents, orient receptacle to match configuration diagram in NEMA WD 6.

    a. Hospital-Grade Receptacle Orientation: Orient receptacle with ground pin or neutral pin at top.

11. Consult Architect for resolution of conflicting requirements.

C. Interfaces with Other Work:

1. Identification: Provide labels for receptacles and associated electrical equipment.

    a. Identify field-installed conductors, interconnecting wiring, and components.
    b. Label each enclosure with engraved metal or laminated-plastic nameplate.

        1) Identify cover or cover plate for device with panelboard identification and circuit number.
        2) Mark cover or cover plate using hot, stamped, or engraved machine printing with [black][white][red]-filled lettering, and provide durable wire markers or tags inside device box or outlet box.

    c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.
    d. Healthcare Facilities: Distinctively identify covers or cover plates of device boxes and outlet boxes that are supplied from life safety and critical branch power supplies following facility's standard practice.

2. Do not install Type 3 SPD, including surge-protected relocatable taps and power strips, on branch circuit downstream of GFCI device.
3. Coordinate installation of new products for <Insert system or product group> with existing conditions.

    a. <Insert requirements for transition between new and existing>.

4. Coordinate with <Insert Section number and title> for <Insert description of interfacing related Work>.

    a. <Insert requirements for transition between this Section and related Work>.

3.6 INSTALLATION OF CORD REELS AND FITTINGS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B.
3. Electrical Safety: NFPA 70E.
4. Hot Work: NFPA 51B.
5. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
6. Work in Confined Spaces: NFPA 350.
7. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.

C. Special Techniques:

1. <Insert more stringent installation requirements that supplement or supersede manufacturers' instructions>.

D. Interfaces with Other Work:

1. Coordinate installation of new products for <Insert system or product group> with existing conditions.
    a. <Insert requirements for transition between new and existing>.
2. Coordinate with <Insert Section number and title> for <Insert description of interfacing related Work>.
    a. <Insert requirements for transition between this Section and related Work>.

3.7 FIELD QUALITY CONTROL OF SWITCHES

A. Administrant for Electrical Power Tests and Inspections:

1. [Owner][Tenant] will engage qualified medium-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified medium-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[with assistance of factory-authorized service representative].

B. Acceptance Testing Preparation:

1. <Insert requirements>.

C. Field tests and inspections must be witnessed by [Architect][Tenant][authorities having

jurisdiction]<Insert names or titles of witnesses>.

D. Tests and Inspections:

1. Perform tests and inspections in accordance with manufacturers' published instructions.
2. <Insert tests and inspections>.

E. Nonconforming Work:

1. Unit will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

G. Manufacturer Services: Engage factory-authorized service representative to [support][supervise] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.8 FIELD QUALITY CONTROL OF STRAIGHT-BLADE RECEPTACLES

A. Administrant for Electrical Power Tests and Inspections:

1. [Owner][Tenant] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[with assistance of factory-authorized service representative].

B. Acceptance Testing Preparation:

1. <Insert requirements>.

C. Field tests and inspections must be witnessed by [Architect][Tenant][authorities having jurisdiction]<Insert names or titles of witnesses>.

D. Tests and Inspections:

1. Insert and remove test plug to verify that device is securely mounted.
2. Verify polarity of hot and neutral pins.
3. Measure line voltage.
4. Measure percent voltage drop.
5. Measure grounding circuit continuity; impedance must be not greater than 2

ohms.

6. Healthcare Facilities: Test straight-blade receptacles in patient care spaces with receptacle pin tension test instrument in accordance with NFPA 99. Retention force of ground pin must be not less than 115 g (4 oz).
7. Perform additional installation and maintenance inspections and diagnostic tests in accordance with NECA NEIS 130 and manufacturers' published instructions.

E. Nonconforming Work:

1. Device will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

G. Manufacturer Services: Engage factory-authorized service representative to [support][supervise] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.9 FIELD QUALITY CONTROL OF CORD REELS AND FITTINGS

A. Administrant for Electrical Power Tests and Inspections:

1. [Owner][Tenant] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[with assistance of factory-authorized service representative].

B. Acceptance Testing Preparation:

1. <Insert requirements>.

C. Field tests and inspections must be witnessed by [Architect][Tenant][authorities having jurisdiction]<Insert names or titles of witnesses>.

D. Tests and Inspections:

1. Perform tests and inspections indicated in manufacturer's published instructions.
2. <Insert Project-specific test or inspection>.

E. Nonconforming Work:

1. Components and assemblies will be considered defective if they do not pass tests and inspections.

2. Remove and replace defective units and retest.

F. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

G. Manufacturer Services: Engage factory-authorized service representative to [support][supervise] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.10 SYSTEM STARTUP FOR SWITCHES

A. Perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's published instructions.
2. <Insert startup steps if any>.

B. Manufacturer Services: Engage factory-authorized service representative to [support][supervise] system startup.

1. Manufacturer's Field Reports for System Startup Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.11 ADJUSTING

A. Occupancy Adjustments for Controlled Receptacles: When requested within [12]<Insert number> months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [two]<Insert number> visits to the Project during other-than-normal occupancy hours for this purpose.

B. Cord Reels and Fittings: Adjust spring mechanisms and moving parts of cord reels and fittings to function smoothly, and lubricate as recommended in writing by manufacturer.

3.12 PROTECTION

A. Devices:

1. Schedule and sequence installation to minimize risk of contamination of wires and cables, devices, device boxes, outlet boxes, covers, and cover plates by plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other materials.
2. After installation, protect wires and cables, devices, device boxes, outlet boxes, covers, and cover plates from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

B. Cord Reels and Fittings:

1. After installation, protect cord reels and fittings from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

C. Connectors, Cords, and Plugs:

1. After installation, protect connectors, cords, and plugs from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 26 27 26

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SECTION 26 43 13
SURGE PROTECTIVE DEVICES FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 SUMMARY

1. Type 3, Type 4, and Type 5 surge protective devices (SPDs).
2. Enclosures.
3. Conductors and cables.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3. Section 262413 "Switchboards" for integral SPDs installed by switchboard manufacturer.
4. Section 262416 "Panelboards" for integral SPDs installed by panelboard manufacturer.
5. Section 262726 "Wiring Devices" for integral SPDs installed by receptacle manufacturer.

1.2 DEFINITIONS

A. In: Nominal discharge current.

B. Maximum Continuous Operating Voltage (MCOV): The maximum designated RMS value of the power frequency voltage that may be continuously applied to the mode of protection of an SPD.

C. Metal-Oxide Varistor (MOV): An electronic component with a significant bidirectional, nonlinear current-voltage characteristic.

D. Mode(s), Modes of Protection, or Protection Modes: Electrical paths where the SPD offers defense against transient overvoltage. Examples include: line to neutral (L-N), line to ground (L-G), line to line (L-L), and neutral to ground (N-G).

E. SCCR: Short-circuit current rating.

F. Type 1 SPDs: Permanently connected SPDs intended for installation between the secondary of the service transformer and the line side of the service disconnect overcurrent device.

G. Type 2 SPDs: Permanently connected SPDs intended for installation on the load side of the service disconnect overcurrent device, including SPDs located at the branch panel.

H. Type 3 SPDs: Point of utilization SPDs.

I. Type 4 SPDs: Component SPDs, including discrete components, as well as assemblies.

J. Type 5 SPDs: Discrete component surge suppressors, such as MOVs that may be mounted on a printed wiring board, connected by its leads or provided within an enclosure with mounting means and wiring terminations.

K. Voltage Protection Rating (VPR): A rating selected from UL 1449 list of preferred values assigned to each mode of protection.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include electrical characteristics, specialties, and accessories for SPDs.
b. Certification of compliance with UL 1449 by qualified electrical testing laboratory recognized by authorities having jurisdiction including the following information:

1) Tested values for VPRs.
2) In ratings.
3) MCOV, type designations.
4) OCPD requirements.
5) Manufacturer's model number.
6) System voltage.
7) Modes of protection.

B. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For manufacturer's special warranty.

1.5 WARRANTY

A. Special Manufacturer Extended Warranty: Manufacturer warrants that SPDs perform in accordance with specified requirements and agrees to provide repair or replacement of SPDs that fail to perform as specified within extended warranty period.

1. Initial Extended Warranty Period: [Five]<Insert number> year(s) from date of Substantial Completion, for labor, materials, and equipment.
2. Follow-On Extended Warranty Period: [10]<Insert number> year(s) from date of Substantial Completion, for materials only, f.o.b. the nearest shipping point to Project site.

PART 2 - PRODUCTS

2.1 TYPE 3, TYPE 4, AND TYPE 5 SURGE PROTECTIVE DEVICES (SPDs)

A. Type 3, Type 4, and Type 5 SPDs are not approved for field installation.[See "Related Requirements" Paragraph in "Summary" Article for products with manufacturer-installed Type 3, Type 4, and Type 5 SPDs.]

2.2 ENCLOSURES

A. Indoor Enclosures: Type 1.

B. Outdoor Enclosures: [Type 3R][Type 4X].

2.3 CONDUCTORS AND CABLES

A. Power Wiring: Same size as SPD leads, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide OCPD and disconnect for installation of SPD in accordance with UL 1449 and manufacturer's instructions.

B. Install leads between disconnects and SPDs short, straight, twisted, and in accordance with manufacturer's instructions. Comply with wiring methods in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

1. Do not splice and extend SPD leads unless specifically permitted by manufacturer.
2. Do not exceed manufacturer's recommended lead length.
3. Do not bond neutral and ground.

C. Use crimped connectors and splices only. Wire nuts are unacceptable.

3.2 FIELD QUALITY CONTROL

A. Field tests and inspections must be witnessed by [Architect][Tenant][authorities having jurisdiction]<Insert names or titles of witnesses>.

B. Tests and Inspections:

1. Compare equipment nameplate data for compliance with Drawings and the Specifications.
2. Inspect anchorage, alignment, grounding, and clearances.

3. Verify that electrical wiring installation complies with manufacturer's installation requirements.

C. Nonconforming Work:

1. SPDs that do not pass tests and inspections will be considered defective.
2. Remove and replace defective units and retest.

D. Prepare test and inspection reports.

E. Manufacturer Services:

1. Engage factory-authorized service representative to [support][supervise] field tests and inspections.

3.3 STARTUP SERVICE

A. Complete startup checks in accordance with manufacturer's instructions.

B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests; reconnect them immediately after the testing is over.

C. Energize SPDs after power system has been energized, stabilized, and tested.

END OF SECTION 26 43 13

SECTION 26 56 00

EXTERIOR SOLID STATE 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.

B. Related Sections:
1. Section 26 51 00 "Interior Solid State Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.

1.2 DESCRIPTION OF WORK

A. Section Includes:

1. Exterior luminaires with lamps, ballasts and drivers.
2. Luminaire-mounted photoelectric relays.
3. Poles and accessories.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color-rendering index.

C. HID: High-intensity discharge.

D. LED: Light Emitting Diode.

E. LER: Luminaire efficacy rating.

F. Luminaire: Complete lighting fixture, including ballast housing if provided.

G. Pole: Luminaire support structure, including tower used for large area illumination.

H. Standard: Same definition as "Pole" above.

1.4 REFERENCES

A. ANSI/NFPA 70, National Electrical Code

B. IEEE C62.41, Guide on the Surge Environment in Low-Voltage (1000 V and Less) AC Power Circuits

C. FCC 47 CFR Part 15, Federal Code Of Regulation (CFR) testing standard for electronic equipment

D. IESNA LM-79, Electrical and Photometric Measurements of Solid-State Lighting Products

E. IESNA LM-80, Approved Method for Measuring Lumen Maintenance of LED Light Sources

F. IESNA TM-15, Luminaire Classification System for Outdoor Luminaires

G. IESNA TM-21-11, Projecting Long Term Lumen Maintenance of LED Light Sources

H. UL1598, Standard for Safety of Luminaires

I. NEMA SSL 3-2010, High-Power White LED Binning for General Illumination

1.5 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.

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 90 mph.
    a. Wind Importance Factor: 1.0
    b. Minimum Design Life: 25 years
    c. Velocity Conversion Factors: 1.0

1.6 ACTION SUBMITTALS

A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:

1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
2. Details of attaching luminaires and accessories.
3. Details of installation and construction.
4. Luminaire materials.
5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.
    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.

6. Photoelectric relays.
7. Lamps, including life, output, CCT, CRI, lumens, and energy-efficiency data.
8. Materials, dimensions, and finishes of poles.
9. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
10. Anchor bolts for poles.
11. 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.
4. Wiring Diagrams: For power, signal, and control wiring.

1.7 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.

1.8 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and poles, operation, and maintenance manuals.

1.9 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. Optical cartridge system assembly: One for every 20 of each type of [pole mounted] light fixture. Furnish at least one of each [pole mounted] fixture type. Assembly shall include all electrical parts necessary for operation (driver, LED

engine, LED lamps, SPD, wiring, etc). If the assembly, as described is not available for the provided fixture type(s), then a complete fixture replacement shall be provided to fulfill this requirement.

2. Surge protective Device Module: One for every 20 of each type of pole mounted light fixture. Furnish at least one of each type.

1.10 QUALITY ASSURANCE

A. 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.

B. 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.

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

D. Comply with IEEE C2, "National Electrical Safety Code."

E. Comply with NFPA 70.

1.11 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.

1.12 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.

1. Warranty Period for Luminaires: Five years from date of Substantial Completion.

2. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.

3. Warranty Period for Color Retention: Five years from date of Substantial Completion.

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

B. Contractor Support Warranty: Contractor shall provide field replacement of failed fixtures. This includes all costs for labor, equipment, and miscellaneous items necessary to restore operation of the equipment. This warranty requirement shall be provided within the terms of this Contract regardless of the mode or cause of fixture failure.

1. The Contractor is responsible to provide support and coordination for determining cause of failure and report findings to the Owner, [Architect], and Engineer of Record.

2. If fixture failure or nonoperation is caused by mis-installation, the Contractor shall provide remedial work to bring the installation into compliance with manufacturer's installation and Contractual requirements.

3. If fixtures have failed and subsequently warranted by the manufacturer, then the Contractor shall install replacement equipment provided by the manufacturer.

4. If fixtures have failed and are not warranted by the manufacturer for any reason other than mis-installation, then maintenance materials specified hereinabove shall be used as replacement equipment as necessary.

5. Warranty Period for Contractor Support: One year from date of Substantial Completion or through duration of the manufacturer's warranty, whichever is longer.

6. Timeliness: Contractor shall provide warranty support in a timely manner and provide the Owner with scheduled dates for remedial action necessary to restore operation.

PART 2 PRODUCTS

2.1 LED LUMINAIRES

A. General: Except as otherwise indicated, provide LED luminaires, of types and sizes indicated on fixture schedules.

B. Material and specifications for each luminaire are as follows:

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 listed with Underwriters Laboratory, Inc. under UL1598 (wet location) for luminaires, or an approved equivalent standard from a nationally recognized testing laboratory.

3. NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.
4. L70 lamp life of 50,000 hours.
5. The rated operating temperature range shall be -40°C (-40ºF) to +40°C (104ºF).
6. Each luminaire is capable of operating above 104°F (40°C), but not expected to comply with photometric requirements at elevated temperatures.
7. Photometry must be compliant with IESNA LM-79 and shall be conducted at 25°C ambient temperature.
8. Each luminaire shall meet all parameters of this specification throughout the minimum operational life when operated at the average nighttime temperature.
9. The individual LEDs shall be constructed such that a catastrophic loss or the failure of one LED will not result in the loss of the entire luminaire.
10. Luminare shall be constructed such that LED modules may be replaced or repaired without replacement of whole luminaire.
11. Source Limitations: For luminaires, obtain each luminaire type designation from single source with resources to provide products of consistent quality in appearance and physical properties.

C. Technical Requirements
   1. Electrical
      a. Luminaire shall have a minimum efficacy of the scheduled fixture (basis of design). The luminaire shall not consume power in the off state.
      b. Operation Voltage: The luminaire shall operate from a 60 HZ ±3 HZ AC line over a voltage ranging from 108 VAC to 305 VAC. The fluctuations of line voltage shall have no visible effect on the luminous output.
      c. Power Factor: The luminaire shall have a power factor of 0.90 or greater.
      d. THD: Total harmonic distortion (current and voltage) induced into an AC power line by a luminaire shall not exceed 20 percent.
      e. Surge Suppression: The luminaire on-board circuitry shall include surge protection device (SPD) to withstand high repetition noise transients as a result of utility line switching, nearby lightning strikes, and other interference. The SPD protects the luminaire from damage and failure for common and differential mode transient peak currents up to [20kA] [10 kA] (minimum). SPD conforms to UL 1449. SPD performance has been tested per procedures in ANSI/IEEE C62.41-2:2002 category C high exposure and ANSI C136.2 10kV BIL. The SPD shall fail in such a way as the Luminaire will no longer operate. The SPD shall be field replaceable.
      f. Operational Performance: The LED circuitry shall prevent visible flicker to the unaided eye over the voltage range specified above.

g. RF Interference: LED Drivers must meet Class A emission limits referred in Federal Communications Commission (FCC) Title 47, Subpart B, Section 15 regulations concerning the emission of electronic noise.

h. Drivers shall be an IP66 rated UL class 2 power unit as per UL 1310 with a Class A sound rating and comply with FCC rules and regulations as per Title 47 CFR part 15.

2. Photometric Requirements

a. Optical Assemblies: Illumination shall be provided through a single injection molded acrylic lens with microscopic inclusions that form a repeatable and redundant pattern to direct light in a precisely prescribed type 5 distribution patterns. Individual LEDs shall not be visible. Optical assemblies shall have a minimum efficiency of 85% regardless of distribution type. The optical assembly shall be designed such that catastrophic failures of individual LEDs will not constitute a loss in the distribution pattern.

b. Light Color/Quality: The luminaire shall have a correlated color temperature (CCT) of 4,000K +/-275K. The color rendition index (CRI) shall be 70 minimum.

c. The optical assembly of the luminaire shall be protected against dust and moisture intrusion per the requirements of IP-66 (minimum) to protect all optical components.

3. Thermal Management

a. 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.

b. The LED manufacturer’s maximum thermal pad temperature for the expected life shall not be exceeded.

c. Thermal management shall be passive by design. The use of fans or other mechanical devices shall not be allowed.

d. 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.

e. The heat sink material shall be aluminum.

4. Physical and Mechanical Requirements

a. The luminaire shall be a single, self-contained device, not requiring on-site assembly for installation. The power supply for the luminaire shall be integral to the unit.

b. The maximum weight of the luminaire shall be 16 lbs.

c. The housing shall meet the requirements for NEMA/UL wet location, be UL listed, IP66 rated.

d. Each housing shall be provided with a universal, galvanized steel quick mount plate with click-and-lock tab releases that will mate with standard one-gang, two-gang or 4” round wet location junction box. Mounting mechanism shall provide a provision for retaining fixture during wiring. Mounting shall allow wire inspection without disassembling luminaire or entering electrical chamber.

Luminaire options shall include 0-10V dimming driver, occupancy sensor, integral cold weather battery pack, and 50°C high ambient operation.

e. The assembly and manufacturing process for the LED luminaire shall be designed to assure all internal components are adequately supported to withstand mechanical shock and vibration. Luminaire vibration rating shall be 3G minimum.

f. The electronics/power supply enclosure shall meet the requirements for NEMA/UL wet location.

5. Materials

a. Housing and door frame shall be aluminum with a nominal 2.5 mil thick paint finish able to withstand a 3000-hour salt spray test as specified in ASTM Designation: B117.

b. Each refractor or lens shall be made from UV inhibited high impact optical grade acrylic and be resistant to scratching.

2.2 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 cover secured by stainless-steel captive screws. Provide on all, except wood poles.

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. Breakaway Supports: Frangible breakaway supports, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-4-M.

2.3 ALUMINUM POLES

A. Poles: Seamless, extruded structural tube complying with ASTM B 429/B 429M, Alloy 6063-T6 with access handhole in pole wall.

B. Poles: ASTM B 209, 5052-H34 marine sheet alloy with access handhole in pole wall.

1. Shape: Refer to Light Fixture Schedule
2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

C. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

D. 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.

E. Brackets for Luminaires: Detachable, with pole and adapter fittings of cast aluminum. Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.

1. Tapered oval cross section, with straight tubular end section to accommodate luminaire.
2. Finish: Same as luminaire.

F. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.

G. Aluminum Finish: 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.
5. Color: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 LUMINAIRE INSTALLATION

A. Install lamps in each luminaire.

B. Fasten luminaire to indicated structural supports.

1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.

3.2 POLE INSTALLATION

A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on Drawings:

1. Fire Hydrants and Storm Drainage Piping: 60 inches.
2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet.
3. Trees: 15 feet from tree trunk.

C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Section 033000 "Cast-in-Place Concrete."

D. 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 non-shrink 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. Make holes 6 inches in diameter larger than pole diameter.
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).

3.3 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."

3.4 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."

3.5 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch-thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.6 GROUNDING

A. Ground metal poles and support structures according to Section 260526 "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole unless otherwise indicated.
2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

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.

3.7 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:

1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IESNA testing guide(s):
    a. IESNA LM-5, "Photometric Measurements of Area and Sports Lighting Installations."
    b. IESNA LM-50, "Photometric Measurements of Roadway Lighting Installations."
    c. IESNA LM-52, "Photometric Measurements of Roadway Sign Installations."
    d. IESNA LM-64, "Photometric Measurements of Parking Areas."
    e. 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.

END OF SECTION 26 56 00