



DENTON REGIONAL PUBLIC SAFETY TRAINING FACILITY

PROJECT MANUAL FOR PHASE 1 BID DOCUMENTS

DENTON, TEXAS

Project No.: 518.07016.00

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SECTION 01 10 00

SUMMARY

PART 1 GENERAL

1.01 PROJECT

- A. Project Name: Denton Regional Public Safety Training Facility
Denton, Texas
- B. Owner's Name: City of Denton Texas
604 E. Hickory
Denton, TX 76205
- C. Architect's Name: Pierce Goodwin Alexander & Linville
3030 LBJ Freeway, Suite 1220
Dallas, Texas 75234
- D. Phase 1 consists of: Outdoor Training Classroom, four story Burn Tower, Apparatus Staging Area, Propane Tank Concrete Pad, Concrete Pads for existing relocated Props, Trench Rescue and Drive Aisles.

1.02 OWNER OCCUPANCY

- A. Owner intends to occupy the Project by the date stated in the Agreement as the contract completion date.
- B. Cooperate with Owner to minimize conflict and to facilitate Owner's operations.
- C. Schedule the Work to accommodate Owner occupancy.

1.03 CONTRACTOR USE OF SITE AND PREMISES

- A. Construction Operations: Limited to areas noted on Drawings.
- B. Arrange use of site and premises to allow:
 - 1. Owner occupancy.
 - 2. Work by Others.
 - 3. Work by Owner.
- C. Provide access to and from site as required by law and by Owner:
 - 1. Emergency Building Exits During Construction: Keep all exits required by code open during construction period; provide temporary exit signs if exit routes are temporarily altered.
 - 2. Do not obstruct roadways, sidewalks, or other public ways without permit.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 01 20 00
PRICE AND PAYMENT PROCEDURES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Procedures for preparation and submittal of applications for progress payments.
- B. Documentation of changes in Contract Sum and Contract Time.
- C. Change procedures.
- D. Correlation of Contractor submittals based on changes.
- E. Procedures for preparation and submittal of application for final payment.

1.02 RELATED SECTIONS

- A. Construction Contracts and Supplements to Contracts: Additional requirements for progress payments, final payment, changes in the Work.

1.03 SCHEDULE OF VALUES

- A. Submit a printed schedule on AIA Form G703 - Application and Certificate for Payment Continuation Sheet.
- B. Submit Schedule of Values in duplicate within 20 calendar days after date of Owner-Contractor Agreement.
- C. Format: Utilize the Table of Contents of this Project Manual. Identify each line item with number and title of the specification Section. Identify bonds and insurance.
- D. Include separately from each line item, a direct proportional amount of Contractor's overhead and profit.
- E. Revise schedule to list approved Change Orders, with each Application For Payment.

1.04 APPLICATIONS FOR PROGRESS PAYMENTS

- A. Payment Period: Submit at intervals stipulated in the Agreement.
- B. Present required information on electronic media printout.
- C. Form: AIA G702 Application and Certificate for Payment and AIA G703 - Continuation Sheet including continuation sheets when required.
- D. For each item, provide a column for listing each of the following:
 - 1. Item Number.
 - 2. Description of work.
 - 3. Scheduled Values.
 - 4. Previous Applications.
 - 5. Work in Place and Stored Materials under this Application.
 - 6. Authorized Change Orders.
 - 7. Total Completed and Stored to Date of Application.
 - 8. Percentage of Completion.
 - 9. Balance to Finish.
 - 10. Retainage.
- E. Execute certification by signature of authorized officer.

- F. Use data from approved Schedule of Values. Provide dollar value in each column for each line item for portion of work performed and for stored Products.
- G. List each authorized Change Order as a separate line item, listing Change Order number and dollar amount as for an original item of Work.
- H. Submit three copies of each Application for Payment.
- I. Include the following with the application:
 - 1. Transmittal letter as specified for Submittals in Section 01 30 00.
 - 2. Construction progress schedule, revised and current as specified in Section 01 32 16.
 - 3. Current construction photographs specified in Section 01 30 00.
 - 4. Partial release of liens from major Subcontractors and vendors.
 - 5. Project record documents as specified in Section 01 78 00, for review by Owner which will be returned to the Contractor.
 - 6. Affidavits attesting to off-site stored products.
- J. When Architect requires substantiating information, submit data justifying dollar amounts in question. Provide one copy of data with cover letter for each copy of submittal. Show application number and date, and line item by number and description.

1.05 MODIFICATION PROCEDURES

- A. Architect will advise of minor changes in the Work not involving an adjustment to Contract Sum or Contract Time as authorized by the Conditions of the Contract by issuing supplemental instructions on AIA Form G710.
- B. Construction Change Directive: Architect may issue a document, signed by Owner, instructing Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.
 - 1. The document will describe changes in the Work, and will designate method of determining any change in Contract Sum or Contract Time.
 - 2. Promptly execute the change in Work.
- C. Proposal Request: Architect may issue a document which includes a detailed description of a proposed change with supplementary or revised Drawings and specifications, a change in Contract Time for executing the change with a stipulation of any overtime work required and the period of time during which the requested price will be considered valid. Contractor shall prepare and submit a fixed price quotation within 10 calendar days.
- D. Contractor may propose a change by submitting a request for change to Architect, describing the proposed change and its full effect on the Work, with a statement describing the reason for the change, and the effect on the Contract Sum and Contract Time with full documentation and a statement describing the effect on Work by separate or other contractors. Document any requested substitutions in accordance with Section 01 60 00.
- E. Computation of Change in Contract Amount:
 - 1. For change requested by Architect for work falling under a fixed price contract, the amount will be based on Contractor's price quotation.
 - 2. For change requested by Contractor, the amount will be based on the Contractor's request for a Change Order as approved by Architect.
 - 3. For pre-determined unit prices and quantities, the amount will be based on the fixed unit prices.
 - 4. For change ordered by Architect without a quotation from Contractor, the amount will be determined by Architect based on the Contractor's substantiation of costs as specified for Time and Material work.

- F. Substantiation of Costs: Provide full information required for evaluation.
 - 1. On request, provide following data:
 - a. Quantities of products, labor, and equipment.
 - b. Taxes, insurance, and bonds.
 - c. Overhead and profit.
 - d. Justification for any change in Contract Time.
 - e. Credit for deletions from Contract, similarly documented.
 - 2. Support each claim for additional costs with additional information:
 - a. Origin and date of claim.
 - b. Dates and times work was performed, and by whom.
 - c. Time records and wage rates paid.
 - d. Invoices and receipts for products, equipment, and subcontracts.
 - 3. For Time and Material work, submit itemized account and supporting data after completion of change, within time limits indicated in the Conditions of the Contract.
- G. Execution of Change Orders: Contractor will issue Change Orders for signatures of parties as provided in the Conditions of the Contract on AIA G701.
- H. After execution of Change Order, promptly revise Schedule of Values and Application for Payment forms to record each authorized Change Order as a separate line item and adjust the Contract Sum.
- I. Promptly revise progress schedules to reflect any change in Contract Time, revise sub-schedules to adjust times for other items of work affected by the change, and resubmit.
- J. Promptly enter changes in Project Record Documents.

1.06 APPLICATION FOR FINAL PAYMENT

- A. Prepare Application for Final Payment as specified for progress payments, identifying total adjusted Contract Sum, previous payments, and sum remaining due.
- B. Application for Final Payment will not be considered until the following have been accomplished:
 - 1. All closeout procedures specified in Section 01 78 00.
 - 2. Release of liens from major Subcontractors and vendors effective as of the date of the application.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 01 22 00

UNIT PRICES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. List of unit prices, for use in preparing Bids.
- B. Measurement and payment criteria applicable to Work performed under a unit price payment method.
- C. Defect assessment and non-payment for rejected work.

1.02 COSTS INCLUDED

- A. Unit Prices shall include full compensation for all required labor, products, tools, equipment, plant, transportation, services and incidentals; erection, application or installation of an item of the Work including overhead and profit.

1.03 UNIT QUANTITIES SPECIFIED

- A. Quantities indicated in the drawings or specifications are for bidding and contract purposes only. Quantities and measurements of actual Work will determine the payment amount.

1.04 MEASUREMENT OF QUANTITIES

- A. Take all measurements and compute quantities. Measurements and quantities will be verified by Owner.
- B. Assist by providing necessary equipment, workers, and survey personnel as required.
- C. Measurement Devices:
 - 1. Weigh Scales: Inspected, tested and certified by the applicable state regulatory department within the past year.
 - 2. Platform Scales: Of sufficient size and capacity to accommodate the conveying vehicle.
 - 3. Metering Devices: Inspected, tested and certified by the applicable State regulatory department within the past year.
- D. Measurement by Weight: Concrete reinforcing steel, rolled or formed steel or other metal shapes will be measured by handbook weights. Welded assemblies will be measured by handbook or scale weight.
- E. Measurement by Volume: Measured by cubic dimension using mean length, width and height or thickness.
- F. Measurement by Area: Measured by square dimension using mean length and width or radius.
- G. Linear Measurement: Measured by linear dimension, at the item centerline or mean chord.
- H. Stipulated Sum/Price Measurement: Items measured by weight, volume, area, or linear means or combination, as appropriate, as a completed item or unit of the Work.
- I. Perform surveys required to determine quantities, including control surveys to establish measurement reference lines. Notify Architect prior to starting work.
- J. Contractor's Engineer Responsibilities: Sign surveyor's field notes or keep duplicate field notes, calculate and certify quantities for payment purposes.

1.05 PAYMENT

- A. Payment for Work governed by unit prices will be made on the basis of the actual measurements and quantities of Work which is incorporated in or made necessary by the Work and accepted by the Architect, multiplied by the unit sum/price.
- B. Payment will not be made for any of the following:
 - 1. Products wasted or disposed of in a manner that is not acceptable.
 - 2. Products determined as unacceptable before or after placement.
 - 3. Products not completely unloaded from the transporting vehicle.
 - 4. Products placed beyond the lines and levels of the required Work.
 - 5. Products remaining on hand after completion of the Work.
 - 6. Loading, hauling, and disposing of rejected Products.

1.06 DEFECT ASSESSMENT

- A. Replace Work, or portions of the Work, not conforming to specified requirements.
- B. If, in the opinion of Architect, it is not practical to remove and replace the Work, Architect will direct one of the following remedies:
 - 1. The defective Work may remain, but the unit sum/price will be adjusted to a new sum/price at the discretion of Architect.
 - 2. The defective Work will be partially repaired to the instructions of the Architect, and the unit sum/price will be adjusted to a new sum/price at the discretion of Architect.
- C. The authority of the Architect to assess the defect and identify payment adjustment is final.

1.07 SCHEDULE OF UNIT PRICES

- A. Unit Price Number One: Drilled Concrete Piers.
 - 1. For actual depth versus anticipated depth indicated on Drawings.
 - 2. Include cost of providing and placing casings in Base Contract.
 - 3. Reconciliation: Per pier diameter category for net add or deduct, not per individual pier.
 - 4. For each diameter category pier required, provide:
 - a. Unit price per additional / deleted lineal foot of installed pier.
 - b. Unit price per lineal foot for deleting steel casings.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 01 30 00
ADMINISTRATIVE REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Progress meetings.
- B. Progress photographs.
- C. Coordination drawings.
- D. Submittals for review, information, and project closeout.
- E. Number of copies of submittals.
- F. Submittal procedures.

1.02 RELATED SECTIONS

- A. Section 01 32 16 - Construction Progress Schedule: Form, content, and administration of schedules.
- B. Section 01 70 00 - Execution Requirements: Additional coordination requirements.
- C. Section 01 78 00 - Closeout Submittals: Project record documents.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 PROGRESS MEETINGS

- A. Schedule and administer meetings throughout progress of the Work at maximum monthly intervals.
- B. Make arrangements for meetings, prepare agenda with copies for participants, and preside at meetings.
- C. Attendance Required: Job superintendent, major Subcontractors and suppliers. Owner and/or Architect may attend when appropriate to agenda topics for each meeting.
- D. Agenda:
 - 1. Review minutes of previous meetings.
 - 2. Review of Work progress.
 - 3. Field observations, problems, and decisions.
 - 4. Identification of problems which impede planned progress.
 - 5. Review of submittals schedule and status of submittals.
 - 6. Review of off-site fabrication and delivery schedules.
 - 7. Maintenance of progress schedule.
 - 8. Corrective measures to regain projected schedules.
 - 9. Planned progress during succeeding work period.
 - 10. Maintenance of quality and work standards.
 - 11. Effect of proposed changes on progress schedule and coordination.
 - 12. Other business relating to Work.
- E. Record minutes and distribute copies within two days after meeting. Provide two copies to participants, Architect, Owner and those affected by decisions made.

3.02 PROGRESS PHOTOGRAPHS

- A. Provide photographs of site and construction throughout progress of Work produced by an experienced photographer, acceptable to Architect.
- B. Take photographs on date for each application for a payment and as follows:
 - 1. Structural framing.
 - 2. Enclosure of building.
 - 3. Final completion.
- C. Views:
 - 1. Provide non-aerial photographs from four principal views at each specified time, until Date of Substantial Completion. Select view points suitable to best illustrate construction progress.
 - 2. Provide factual presentation.
 - 3. Provide correct exposure and focus, high resolution and sharpness, maximum depth of field, and minimum distortion.
- D. Digital Photographs: 24 bit color, minimum resolution of 1024 by 768, in JPG format; provide files unaltered by photo editing software.
 - 1. Delivery Medium: Electronic transmission.
 - 2. File Naming: Include project identification, date and time of view, and view identification.
 - 3. PDF File: Assemble all photos into printable pages in PDF format, with 2 to 3 photos per page, each photo labeled with file name; one PDF file per submittal.
- E. Deliver prints with each Application for Payment with transmittal letter specified in this Section.
- F. Deliver digital photography files to Owner with project record documents. Name and index digital files in chronological sequence; provide typed table of contents.

3.04 COORDINATION DRAWINGS

- A. Review drawings prior to submission to Architect.

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.
 - 5. Substitution Request Forms.
- B. Submit to Architect for review for the limited purpose of checking for conformance with information given and the design concept expressed in the contract documents.
- C. Samples will be reviewed only 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 01 7800 - CLOSEOUT SUBMITTALS.

3.06 SUBMITTALS FOR INFORMATION

- A. When the following are specified in individual sections, submit them for information:
 - 1. Design data.
 - 2. Certificates.
 - 3. Test reports.
 - 4. Inspection reports.
 - 5. Manufacturer's instructions.
 - 6. Manufacturer's field reports.

- 7. Substitution Request Forms.
- 8. Other types indicated.
- B. Submit for Architect's knowledge as contract administrator or for Owner.

3.07 SUBMITTALS FOR PROJECT CLOSEOUT

- A. When the following are specified in individual sections, submit them at project closeout:
 - 1. Project record documents.
 - 2. Operation and maintenance data.
 - 3. Warranties.
 - 4. Bonds.
 - 5. Substitution Request Forms.
 - 6. Other types as indicated.
- B. Submit for Owner's benefit during and after project completion.

3.08 NUMBER OF COPIES OF SUBMITTALS

- A. Documents for Review:
 - 1. Small Size Sheets, Not Larger Than 8-1/2 x 11 inches: Submit the number of copies which the Contractor requires, plus one copy which will be retained by the Architect.
 - 2. Larger Sheets, Not Larger Than 36 x 48 inches: Submit one reproducible transparency and two opaque reproductions.
- B. Documents for Information: Submit two copies.
- C. Documents for Project Closeout: Make one reproduction of submittal originally reviewed. Submit one extra of submittals for information.
- D. 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 stated.

3.09 SUBMITTAL PROCEDURES

- A. Transmit each submittal with AIA Form G810.
- B. Sequentially number the transmittal form. Revise submittals with original number and a sequential alphabetic suffix.
- C. Identify Project, Contractor, Subcontractor or supplier; pertinent drawing and detail number, and specification section number, as appropriate on each copy.
- D. 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.
- E. Deliver submittals to Architect at the Architect's business address.
- F. Schedule submittals to expedite the Project, and coordinate submission of related items.
- G. For each submittal for review, allow 14 calendar days excluding delivery time to and from the Contractor.
- H. Identify variations from Contract Documents and Product or system limitations which may be detrimental to successful performance of the completed Work.
- I. Provide space for Contractor and Architect review stamps.
- J. When revised for resubmission, identify all changes made since previous submission.

- K. Distribute copies of reviewed submittals as appropriate. Instruct parties to promptly report any inability to comply with requirements.
- L. Submittals not requested will not be recognized or processed.

END OF SECTION

SECTION 01 31 00
REQUESTS FOR INTERPRETATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Definitions.
- B. Procedure for submittals requesting interpretation.
- C. Number of copies of submittals.
- D. Submittal procedures.

1.02 RELATED SECTIONS

- A. Section 01 30 00 - Administrative Requirements: Additional administrative requirements.
- B. Section 01 78 00 - Closeout Submittals: Project record documents.

1.03 PROJECT COORDINATION

- A. When required, make the following types of submittals to the Architect.
 - 1. Requests for Interpretation.

1.04 DEFINITIONS

- A. The term Owner throughout this section refers to the Owner or the Owner's designated representative.
- B. Requests for Interpretation: A request from the Contractor or one of its subcontractors, to the owner, seeking an interpretation or a clarification of some requirement of the contract documents. The Contractor shall clearly and concisely set forth the issue for which it seeks clarification or interpretation and why a response is needed from the owner. The Contractor shall, in the written request, set forth its interpretation or understanding of the contracts requirements along with reasons why it has reached such an understanding. Responses from the Owner will not change any requirements of the contract documents. Responses to Contractor inquiries shall be as outlined in the Article "Requests for Interpretation" shown in this section and as additionally described in the General Conditions.
- C. Drawing/Plan Clarification: An answer from the owner, in response to an inquiry from the Contractor, intended to make some requirement(s) of the drawings or plans clearly understood. Drawing/plan clarifications may be sketches, drawings, or in narrative form and will not change any requirements of the drawings or plans. Responses to Contractor inquiries shall be as outlined in the Article "Requests for Interpretation" shown in this section and as additionally described in the General Conditions.
- D. Project Communications: Routine written communications between the owner and the Contractor shall be in letter, field memo, fax format or email where the appropriate form is attached to the email. Such communications shall not be identified as Requests for Interpretation nor shall they substitute for any other written requirement pursuant to the provisions of these contract documents.

1.05 REQUESTS FOR INTERPRETATION

- A. In the event that the Contractor or subcontractor, at any tier, determines that some portion of the drawings, specifications, or other contract documents requires clarification or interpretation by the owner, the Contractor shall submit a Request for Interpretation in writing to the Owner. Requests for Information may only be submitted by the Contractor and shall only be submitted

on the Request for Interpretation Forms provided by the Owner, or Contractor provided forms approved by the Owner. The Contractor shall clearly and concisely set forth the issue for which clarification or interpretation is sought and why a response is needed from the Owner. In the Request for Interpretation, the Contractor shall set forth an interpretation or understanding of the requirement along with reasons why such an understanding was reached.

- B. The Owner will review all Requests for Interpretation to determine whether they are Requests for Interpretation within the meaning of this term. If the Owner determines that the document is not a Request for Interpretation, it will be returned to the Contractor, unreviewed, for resubmittal on the proper form and in the proper manner.
- C. Responses to Requests for Interpretation shall be issued within fifteen (15) working days of receipt of the request from the Contractor unless the Owner determines that a longer time is necessary to provide an adequate response. If a longer time is determined necessary by the Owner, the Owner will, within five (5) working days of receipt of the request, notify the Contractor of the anticipated response time. If the Contractor submits a Request for Interpretation on an activity with ten (10) working days or less of float on the current project schedule, the Contractor shall not be entitled to any time extension due to the time it takes the owner to respond to the request provided that the owner responds within the 15 (Fifteen) working days set forth above.
- D. Responses from the Owner will not change any requirement of the contract documents. In the event the Contractor believes that a response to a Request for Interpretation will cause a change to the requirements of the contract documents, the Contractor shall give written notice to the owner stating that the Contractor considers the response to be a Change Order. Failure to give such written notice within (5) working days shall waive the Contractor's right to seek additional time or cost under the Changes article of the General Conditions.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 REQUESTS FOR INTERPRETATION

- A. Where interpretation of Contract Documents is required, submit to Architect for review for the limited purpose of providing clarification of the information given and the design concept expressed in the contract documents.

3.02 SUBMITTALS OF REQUEST FOR INTERPRETATION

- A. Submit on form provided by the Owner or Owner approved Contractor form. Incomplete forms will not be considered.

3.03 NUMBER OF COPIES OF SUBMITTALS

- A. Submit two copies of each Request For interpretation to Owner's designated representative

3.04 SUBMITTAL PROCEDURES

- A. Sequentially number the Requests for Interpretation.
- B. Distribute copies of reviewed forms as appropriate. Instruct parties to promptly report any inability to comply with requirements.
- C. Submittals deemed to be a submittal that does not qualify as a Request for Interpretation will be returned. Re-submittal will be processed under the appropriate category.

END OF SECTION

SECTION 01 40 00
QUALITY REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. References and standards.
- B. Quality assurance submittals.
- C. Mock-ups.
- D. Control of installation.
- E. Tolerances.
- F. Testing and inspection services.
- G. Manufacturers' field services.

1.02 RELATED SECTIONS

- A. General Conditions: Submittal dates for applications for payment.
- B. Section 01 30 00 - Administrative Requirements: Submittal procedures.
- C. Section 01 60 00 - Product Requirements: Requirements for material and product quality.

1.03 SUBMITTALS

- A. Testing Agency Qualifications:
 - 1. Prior to start of Work, submit agency name, address, and telephone number, and names of full time registered Engineer and responsible officer.
 - 2. Submit copy of report of laboratory facilities inspection made by NIST Construction Materials Reference Laboratory during most recent inspection, with memorandum of remedies of any deficiencies reported by the inspection.
- B. Design Data: Submit for Architect's knowledge as contract administrator or for the Owner, for information for the limited purpose of assessing conformance with information given and the design concept expressed in the contract documents.
- C. Test Reports: After each test/inspection, promptly submit two copies of report to Architect and to Contractor.
 - 1. Include:
 - a. Date issued.
 - b. Project title and number.
 - c. Name of inspector.
 - d. Date and time of sampling or inspection.
 - e. Identification of product and specifications section.
 - f. Location in the Project.
 - g. Type of test/inspection.
 - h. Date of test/inspection.
 - i. Results of test/inspection.
 - j. Conformance with Contract Documents.
 - k. When requested by Architect, provide interpretation of results.
 - 2. Test reports are submitted for Architect's knowledge as contract administrator or for the Owner, for information for the limited purpose of assessing conformance with information given and the design concept expressed in the contract documents.

- D. Certificates: When specified in individual specification sections, submit certification by the manufacturer and Contractor or installation/application subcontractor to Architect, in quantities specified for Product Data.
 - 1. Indicate material or product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.
 - 2. Certificates may be recent or previous test results on material or product, but must be acceptable to Architect.
- E. Manufacturer's Instructions: When specified in individual specification sections, submit printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, for the Owner's information. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.
- F. Manufacturer's Field Reports: Submit reports for Architect's benefit as contract administrator or for Owner.
 - 1. Submit report in duplicate within 30 days of observation to Architect for information.
 - 2. Submit for information for the limited purpose of assessing conformance with information given and the design concept expressed in the contract documents.
- G. Erection Drawings: Submit drawings for Architect's benefit as contract administrator or for Owner.
 - 1. Submit for information for the limited purpose of assessing conformance with information given and the design concept expressed in the contract documents.
 - 2. Data indicating inappropriate or unacceptable Work may be subject to action by Architect or Owner.

1.04 REFERENCES AND STANDARDS

- A. For products and workmanship specified by reference to a document or documents not included in the Project Manual, also referred to as reference standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.
- B. Conform to reference standard of date of issue current on date of Contract Documents, except where a specific date is established by applicable code.
- C. Obtain copies of standards where required by product specification sections.
- D. Maintain copy at project site during submittals, planning, and progress of the specific work, until Substantial Completion.
- E. Should specified reference standards conflict with Contract Documents, request clarification from Architect before proceeding.
- F. Neither the contractual relationships, duties, or responsibilities of the parties in Contract nor those of Architect shall be altered from the Contract Documents by mention or inference otherwise in any reference document.

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. Tests will be performed under provisions identified in this section and identified in the respective product specification sections.
- B. Assemble and erect specified items with specified attachment and anchorage devices, flashings, seals, and finishes.
- C. Accepted mock-ups shall be a comparison standard for the remaining Work.
- D. Where mock-up has been accepted by Architect and is specified in product specification sections to be removed, remove mock-up and clear area when directed to do so.

3.03 TOLERANCES

- A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.
- B. Comply with manufacturers' tolerances. Should manufacturers' tolerances conflict with Contract Documents, request clarification from Architect before proceeding.
- C. Adjust products to appropriate dimensions; position before securing products in place.

3.04 TESTING AND INSPECTION

- A. See individual specification sections for testing required.
- B. Testing Agency Duties:
 - 1. Test samples of mixes submitted by Contractor.
 - 2. Provide qualified personnel at site. Cooperate with Architect and Contractor in performance of services.
 - 3. Perform specified sampling and testing of products in accordance with specified standards.
 - 4. Ascertain compliance of materials and mixes with requirements of Contract Documents.
 - 5. Promptly notify Architect and Contractor of observed irregularities or non-conformance of Work or products.
 - 6. Perform additional tests and inspections required by Architect.
 - 7. Attend preconstruction meetings and progress meetings when the meeting agenda is relevant to information provided by the testing agency.
 - 8. Submit reports of all tests/inspections specified.
- C. 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.

- D. Contractor Responsibilities:
 - 1. Deliver to agency at designated location, adequate samples of materials proposed to be used which 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.
- E. Re-testing required because of non-conformance to specified requirements shall be performed by the same agency on instructions by Architect. Payment for re testing will be charged to the Contractor by deducting testing charges from the Contract Sum.

3.05 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 of equipment as applicable, and to initiate instructions when necessary.
- B. Submit qualifications of observer to Architect 30 days in advance of required observations.
 - 1. Observer subject to approval of Architect.
- C. Report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.

3.06 DEFECT ASSESSMENT

- A. Replace Work or portions of the Work not conforming to specified requirements.
- B. If, in the opinion of Architect, it is not practical to remove and replace the Work, Architect will direct an appropriate remedy or adjust payment.

END OF SECTION

SECTION 01 45 29
TESTING LABORATORY SERVICES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and other Division-1 Specification Sections apply to work specified in this Section.

1.02 STANDARDS

- A. The following Standards are listed in this specification:

ASTM A6	Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
ASTM A325	Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A416	Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete
ASTM A490	Standard Specification for Heat-Treated Structural Bolts, 150 ksi Minimum Tensile Strength
ASTM A568	Standard Specification for Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled
ASTM A615	Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM C25	Standard Test Methods for Chemical Analysis of Limestone, Quicklime, and Hydrated Lime
ASTM C31	Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33	Standard Specification for Concrete Aggregates
ASTM C40	Standard Test Method for Organic Impurities in Fine Aggregates for Concrete
ASTM C42	Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C88	Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C94	Standard Specification for Ready-Mixed Concrete
ASTM C109	Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. Cube Specimens)
ASTM C117	Standard Test Method for Materials Finer than 75- μ m (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C127	Standard Test Method for Specific Gravity and Absorption of Coarse Aggregate
ASTM C128	Standard Test Method for Specific Gravity and Absorption of Fine Aggregate
ASTM C131	Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C138	Standard Test Method for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete
ASTM C140	Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units
ASTM C143	Standard Test Method for Slump of Hydraulic Cement Concrete
ASTM C150	Standard Specification for Portland Cement
ASTM C157	Standard Test Method for Length Change of Hardened Hydraulic-Cement, Mortar and Concrete
ASTM C172	Standard Practice for Sampling Freshly Mixed Concrete

ASTM C173	Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C231	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C330	Standard Specification for Lightweight Aggregates for Structural Concrete
ASTM C332	Standard Specification for Lightweight Aggregates for Insulating Concrete
ASTM C495	Standard Test Method for Compressive Strength of Lightweight Insulating Concrete
ASTM C1064	Standard Test Method for Temperature of Freshly Mixed Portland Cement Concrete
ASTM C1314	Standard Test Method for Compressive Strength of Masonry Prisms
ASTM D75	Standard Practice for Sampling Aggregate
ASTM D422	Standard Test Method for Particle Size Analysis of Soils
ASTM D698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort
ASTM D1143	Standard Test Method for Piles Under Static Axial Compressive Load
ASTM D1556	Standard Test Method for Density and Unit Weight of Soil by the Sand Cone Method
ASTM D1557	Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort
ASTM D2922	Standard Test Methods for Density of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D2937	Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method
ASTM D4253	Standard Test Method for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
ASTM D4254	Standard Test Method for Maximum Index Density and Unit Weight of Soils and Calculation of Relative Density
ASTM D4318	Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM E329	Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction
ASTM E605	Standard Test Methods for Thickness and Density of Sprayed Fire-Resistive Material (SFRM) Applied to Structural Members
ASTM F710	Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring
ASTM E736	Standard Test Method for Cohesion/Adhesion of Sprayed Fire-Resistive Materials Applied to Structural Members
ASTM F1869	Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride

1.03 SCOPE OF WORK

- A. Services Provided for the Contractor: An independent testing laboratory will sample and test materials that are components of the final work product of the Contractor and provide certification that the materials meet the required specifications. The laboratory shall oversee the certification process of construction personnel to ensure their qualifications to perform the specified duties. The presence of a testing laboratory shall in no way relieve the Contractor of his obligation to perform the work in accordance with the Contract Documents. The contractor shall be responsible for paying the testing laboratory for these services.
- B. Services Provided for the Owner: An independent testing laboratory will sample and test materials as they are being installed for compliance with specified requirements and report and interpret the results. The laboratory shall monitor the installation of all constructed work and shall perform tests on the completed construction as required to indicate compliance with the various material specifications governing this work. The owner shall be responsible for paying the testing laboratory for these services.

1.04 SPECIAL INSPECTIONS

- A. The Testing Laboratory providing services for the Owner shall provide Special Inspection services for the items listed below. The scope of such services for each item shall be as defined in The International Building Code – 2006 or as defined in the local building code of the jurisdiction wherein the project is located. These inspections are mandatory for conformance to the legal requirements of the building code and shall be in addition to the inspections and tests otherwise defined in this specification.
1. Reinforcing Steel Placement
 2. Bolts Installed in Concrete
 3. Concrete Work
 4. Formwork
 5. Precast Concrete Erection
 6. Inspection of Structural Steel, Bolting, and Welding Material
 7. Welding of Structural Steel
 8. Welding of Reinforcing Steel
 9. High-Strength Bolting
 10. Spray-Applied Fire-Resistive Materials
 11. Prepared Earth Fill
 12. Pier Foundations
 13. Masonry Work
- B. Qualifications of Special Inspector: The special inspector shall be a qualified person who shall demonstrate competence, to the satisfaction of the Building Official, for inspection of the particular type of construction or operation being inspected. The Special Inspector shall meet all legal qualifications of the building code having jurisdiction.
- C. Duties and Responsibilities of the Special Inspector:
1. The special inspector shall observe the work assigned for conformance to the approved design drawings and specifications.
 2. The special inspector shall furnish inspection reports to the Building Official, the Architect/Engineer, and the Owner. All discrepancies shall be brought to the immediate attention of the Architect/Engineer, Contractor, and Owner. A report that the corrected work has been inspected shall be sent to the Building Official, the Architect/Engineer, and the Owner.
 3. The special inspector shall submit a final signed report stating whether the work requiring special inspection was, to the best of the inspector's knowledge, in conformance to the approved plans and specifications and the applicable workmanship provisions of the building code.

1.05 QUALIFICATIONS OF TESTING LABORATORY

- A. The Testing Laboratory selected for either or both scopes of work noted above shall meet the basic requirements of ASTM E329, and shall submit to the Owner, Architect, and Engineer evidence of current accreditation from the American Association for Laboratory Accreditation, the AASHTO Accreditation Program or the National Voluntary Laboratory Accreditation Program.
- B. The Testing Laboratory shall be approved by the Building Official of the city wherein the project is located to perform Special Inspections as outlined in the applicable building code.
- C. Tests and inspections shall be conducted in accordance with specified requirements, and if not specified, in accordance with the applicable standards of the American Society for Testing and Materials or other recognized and accepted authorities in the field.

1.06 AUTHORITIES AND DUTIES OF THE LABORATORY

- A. Attending Preconstruction Conferences: The Testing Laboratory providing services for the Contractor and the Testing Laboratory providing services for the Owner shall obtain and review the project plans and specifications with the Architect and Engineer as soon as possible prior to the start of construction. All Laboratories shall attend preconstruction conferences with the Architect, Engineer, Project Manager, General Contractor, and Material Suppliers as required to coordinate materials inspection and testing requirements with the planned construction schedule. The Laboratory providing services for the Owner shall participate in such conferences throughout the course of the project.
- B. Outline Testing Program: The Testing Laboratory providing services for the Owner shall be responsible for outlining a written detailed testing and inspection program conforming to the requirements as specified in the Contract Documents and in consultation with the Owner, Architect, and Engineer. The testing and inspection program shall contain an outline of inspections and tests to be performed with reference to applicable sections of the specifications or drawings and a list of personnel assigned to each portion of the work. Such testing program shall be submitted to the Owner, Architect, and Engineer two weeks in advance of the start of construction so as not to delay the start of construction. It shall be the Testing Laboratory's responsibility that such program conforms to the requirements of the Specifications and falls within the Owner's budget for testing laboratory services. If the allocated budget is not sufficient to cover the services as outlined in the Specifications, it shall be the responsibility of the Laboratory to notify the Architect, Engineer, and Owner so that the Laboratory services can be modified accordingly prior to the start of construction. Furthermore, the Testing Laboratory shall monitor its expenditures throughout the course of the job and notify immediately the Owner, Architect, and Engineer, of any significant deviation from the planned testing program and budget.
- C. Cost Proposal: The Testing Laboratory's proposal to the Owner shall contain the outlined testing and inspection program based on a unit price basis for tests and inspections and on an hourly basis for personnel. A total estimated price shall also be submitted.
- D. Cooperation with Design Team: The Laboratory shall cooperate with the Architect, Engineer, and Contractor and provide qualified personnel promptly on notice.
- E. The Laboratory shall perform the required inspections, sampling, and testing of materials as specified under each section and observe methods of construction for compliance with the requirements of the Contract Documents.
- F. Inspections Required by Government Agencies: The Testing Laboratory shall perform all inspections and submit all reports and certifications as required by all government agencies.
- G. Notification of Deficiencies in the Work: The Laboratory shall notify the Architect, Engineer, and Contractor within 24 hours of discovery by telephone or e-mail, and then in writing of observed irregularities and deficiencies of the work and other conditions not in compliance with the requirements of the Contract Documents.
- H. Reports:
1. Information on Reports: The Laboratory shall submit copies of all reports of inspections and tests promptly and directly to the parties named below within five days of the test/inspection. All reports shall contain at least the following information:
 - a. Project Name
 - b. Date report issued
 - c. Testing Laboratory name and address
 - d. Name and signature of inspector
 - e. Date of inspection and sampling

- f. Date of test
 - g. Identification of product and Specification section
 - h. Location in the project
 - i. Identification of inspection or test
 - j. Record of weather conditions and temperature (if applicable)
 - k. Results of test regarding compliance with Contract Documents
- 2. Copies: The Laboratory shall send certified copies of test and inspection reports to the following parties:
 - a. 2 copies to the Owner or his representative
 - b. 2 copies to the General Contractor
 - c. 1 copy to the Architect
 - d. 1 copy to the Engineer of responsibility
 - e. 1 copy to the Supplier of the material tested
- 3. Certification: Upon completion of the job, the Testing Laboratory providing services to the Owner shall furnish to the Owner, Architect, and Engineer of Record, a statement signed by a licensed professional engineer that, to the best of their knowledge, all required tests and inspections were made in accordance with the requirements of the Contract Documents.
- I. Accounting: The Testing Laboratory shall be responsible for separating and billing costs attributed to the Owner and costs attributed to the Contractor.
- J. Obtaining Product and Material Certifications: The Testing Laboratory shall be responsible for obtaining all product and material certifications from manufacturers and suppliers as specified in the Specifications.
- K. Limitations of Authority: The Testing Laboratory is not authorized to revoke, alter, relax, enlarge upon, or release any requirements of the Specifications or to approve or accept any portion of the work or to perform any duties of the General Contractor and his Subcontractors.

1.07 CONTRACTOR'S RESPONSIBILITY

- A. Cooperation with Design Team: The Contractor shall cooperate with laboratory personnel, provide access to the work, and to manufacturer's operations.
- B. Furnishing Samples: The Contractor shall provide to the laboratory representative, samples of materials proposed for use in the work in quantities sufficient for accurate testing as specified.
- C. Furnishing Casual Labor, Equipment and Facilities: The Contractor shall furnish casual labor, equipment, and facilities as required for sampling and testing by the laboratory and otherwise facilitate all required inspections and tests.
- D. Advance Notice: The Contractor shall be responsible for notifying the Testing Laboratory sufficiently in advance of operations to allow for assignment of personnel and scheduling of tests.
- E. Payment for Substitution Testing: The Contractor shall arrange with the Testing Laboratory providing services for the Contractor and pay for any additional samples and tests above those required by the Contract Documents as requested by the Contractor for his convenience in performing the work.
- F. Payment for Retesting: The Contractor shall be liable to the Owner for the cost for any additional inspections, sampling, testing, and retesting done by the Testing Laboratory providing services for the Owner as required when initial tests indicate work does not comply with the requirements of the Contract Documents.

G. Payment by Contractor: The Contractor shall furnish and pay for the following items:

1. Soil survey of the location of borrowed soil materials, samples of existing soil materials, and delivery to the Testing Laboratory providing services for the Contractor.
2. Samples of concrete aggregates and delivery to the Testing Laboratory providing services for the Contractor.
3. Concrete mix designs as prepared by his concrete supplier or by the Testing Laboratory providing services for the Contractor.
4. Concrete coring, tests of below strength concrete, and load tests, if ordered by the Owner, Architect, or Engineer.
5. Certification of reinforcing steel and prestressing steel mill order.
6. Certification of structural steel mill order.
7. Certification of portland cement, lime, fly ash.
8. Certification of welders and preparation of Welding Procedure Specifications.
9. Tests, samples, and mock-ups of substitute material where the substitution is requested by the Contractor and the tests are necessary in the opinion of the Owner, Architect or Engineer to establish equality with specified items.
10. Concrete cylinders for the purpose of evaluating strength at time of form stripping or for post-tensioning.
11. Any other tests when such costs are required by the Contract Documents to be paid by the Contractor.

H. Notification of Source Change: The Contractor shall be responsible for notifying the Owner, Architect, Engineer, and Testing Laboratory providing services for the Owner when the source of any material is changed after the original tests or inspections have been made.

I. Tests for Suspected Deficient Work: If in the opinion of the Owner, Architect, or Engineer any of the work of the Contractor is not satisfactory, the Contractor shall make all tests that the Owner, Architect, or Engineer deem advisable to determine its proper construction. The Owner shall pay all costs if the tests prove the questioned work to be satisfactory.

1.08 PAYMENT OF TESTING LABORATORY

A. The Owner will pay for the initial Laboratory services for testing of materials for compliance with the requirements of the Contract Documents. The Contractor will be liable to the Owner for the cost for testing and retesting of materials that do not comply with the requirements of the Contract Documents and shall furnish and pay for the testing and inspection of all other items as specified in these Specifications.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.01 SCOPE OF WORK

A. The work to be performed by the Testing Laboratory shall be as specified in this Section of the Specification and as determined in meetings with the Owner, Architect, and Engineer.

3.02 EARTHWORK

A. Tests of Proposed Fill Material: The Testing Laboratory providing services for the Contractor shall conduct a survey of the Contractor's proposed location of borrow soil materials and shall establish the suitability of any proposed fill material by determining the required engineering properties. Soil tests shall include soil classification by the Atterberg Limit Tests ASTM D4318, and grain size determination by ASTM D422.

B. Moisture - Density Relationship for Natural and Fill Materials: The Testing Laboratory providing services for the Contractor shall provide one moisture - density curve for each type of soil, natural, imported fill, or on-site fill, encountered in subgrade and fills under building slabs and paved areas. Curves shall be generated in accordance with ASTM D698 for cohesive soils and ASTM 4253 plus ASTM 4254 for cohesionless soils.

C. Quality Control Testing Required During Construction:

1. Inspection of Subgrade and Fill: The Testing Laboratory providing services for the Owner shall inspect and approve the following subgrades and fill layers before further construction work is performed thereon:
 - a. Paved Areas and Building Slab Subgrade: Make at least one field density test of the natural subgrade for every 2500 square feet of paved area or building slab but in no case less than three tests. In each compacted fill layer or lift, make one field density test for every 2500 square feet of building slab or paved area but in no case less than three tests.
 - b. Foundation Wall Backfill: Make at least one field density test for each 200 lineal feet of wall with a minimum of 4 tests for the basement walls around the perimeter of each building and a minimum of one test for every other type of foundation wall on the site. Tests shall be at random locations and elevations for each wall.
2. Field Density Tests: Field Density Tests shall be run according to ASTM D1556, ASTM D2937, or ASTM D2922 as applicable.
3. Acceptance Criteria: The results of field density tests by the Testing Laboratory providing services for the Owner will be considered satisfactory if the average of any three consecutive tests has a value not less than the required density with no single test falling more than 2 percent below the required density.
4. Report Copies: All moisture-density curves and results of field density tests shall be submitted to the parties specified earlier in this section.
5. Additional Testing: If reports by the Testing Laboratory providing services for the Owner indicate field densities lower than specified, additional tests will be run by the Testing Laboratory providing services for the Owner with at least the frequencies scheduled above on recompacted fill and/or natural subgrade. The Testing Laboratory shall notify the Contractor on a timely basis for any required retesting so as not to delay the work. The costs of such tests shall be borne by the Contractor.

D. Foundation Inspection by the Testing Laboratory:

1. Material Testing: The Testing Laboratory providing services for the Owner shall provide testing and inspection of materials used in foundation elements as described below.
2. Drilled Piers
 - a. Concrete Cylinders: Make and test concrete cylinders as specified for Cast-in-Place Concrete.
 - b. Reinforcing Steel: Inspect reinforcing steel for proper number and size of bars and confirm dowel or anchor bolt placement into top of pier.

E. Foundation Inspection by the Geotechnical Engineer: The Geotechnical Engineer of Record shall provide inspection service for the following items before and during foundation installation as appropriate for the foundation type. The Geotechnical Engineer shall submit written field inspection reports promptly after inspection to all parties listed above and report his findings after each inspection by telephone or e-mail to the Engineer.

1. Drilled Piers:
 - a. Bearing Elevation: Observe that piers are founded in proper bearing strata as defined in the Geotechnical Report and that bottom of hole is clean and properly formed. Recommend appropriate action if specified bearing elevation does not provide proper strength.

- b. Shaft Sizes: Verify that the shaft diameters are within specified tolerances.
- c. Shaft Stability: Observe the shaft sides as drilling proceeds and recommend appropriate action if sloughing becomes excessive.
- d. Concrete Quantities: Record quantity of concrete placed in each pier and compare against theoretical quantity required. Report discrepancies to Engineer.
- e. Placement Method: Observe that piers are placed by approved methods as defined in the Geotechnical Report and in the specifications. Confirm that casings are being used as recommended in the Geotechnical Report. Confirm that concrete is not being contaminated by soil encroachment into pier.
- f. Report: For each drilled shaft installed, prepare and submit a report indicating the following information: pier number and location, pier shaft diameter, bottom elevation, top elevation, pier length, theoretical volume of concrete in pier, estimate of actual volume of concrete placed, reinforcing steel size and depth actually placed, drilling start and finish time, concreting start and finish time, variation from specified tolerances including surveyed location and plumbness, construction method (dry method, casing method, or slurry displacement method), groundwater conditions (rate of water infiltration and depth of water in hole prior to concreting for dry piers; water elevation in hole for wet piers), elevation of top and bottom of any casing left in place, description of temporary or permanent casing (including purpose, diameter, wall thickness and length), description and elevation of any obstructions encountered and whether removal was obtained, description of pier bottom including amount and extent of loose material, method of concrete placement, any difficulties encountered in drilling or concreting operations, and any deviations from specifications. The report shall include the name of the project, the name of the drilling contractor and the name of the field superintendent. The report shall be signed by a licensed engineer in the state where the project is located.

3.03 REINFORCING STEEL

- A. Visual Inspection: When the Contractor or reinforcing steel Fabricator notifies the Testing Laboratory providing services for the Contractor that a shipment of reinforcing steel is in the final stages of fabrication and ready for shipment, the Testing Laboratory providing services for the Contractor shall inspect the shipment to determine the following:
 1. The bars should be free from injurious defects and shall have a workman-like finish.
 2. Deformations shall be of the proper sizes, shapes, and spacing as detailed in ASTM A615.
 3. The bars shall not have excessive rust and/or pelting.
 4. The bars shall not have any unusual twists or bends.
- B. Identified Stock: Where job material is taken from bundles as delivered from the mill, is properly identified as to heat number and is accompanied by mill and analysis test reports, such material shall be used without further local tests provided an affidavit is given from the Supplier to the Testing Laboratory providing services for the Contractor that the materials conform with the requirements of the ASTM specification as listed on the structural drawings. In case of controversy, the procedure as stipulated below for unidentified stock shall be followed.
- C. Unidentified Stock: For all unidentified stock, the Testing Laboratory providing services for the Contractor shall secure samples of the reinforcing steel bars at the time of inspection. The samples shall conform to the following:
 1. The sample shall include 2 bars for each ten tons or fraction thereof, of each bar size, heat number, and manufacturer being shipped.
 2. The sample bars shall be a minimum of 24 inches in length and should be identical to the material being shipped.

The Testing Laboratory providing services for the Contractor shall tag each of the steel bundles with the Laboratory identification tag and appropriately mark the samples

corresponding to the steel being inspected and shipped. The fabricator will supply shipping lists showing the weight of each bar size in the shipment. The sample reinforcing bars shall be returned to the Testing Laboratory providing services for the Contractor for tensile strength tests and bend tests according to ASTM A615. Bend tests will not be required for #14 and #18 bars.

D. Reinforcing Steel Field Inspection: The Testing Laboratory providing services for the Owner shall inspect all reinforcement before each concrete pour to verify the information noted below. All inspection reports shall be prepared and distributed in accordance with the local building code and as specified in this specification.

1. Primary and secondary, longitudinal reinforcement has correct size and number in proper layers.
2. Longitudinal reinforcement has correct length and lap.
3. Ties and stirrups are of correct size, spacing, and number and have the proper termination-hook geometry.
4. Unscheduled face reinforcement in beams are provided and are of correct size, number and spacing and have the proper end terminations.
5. Proper hooks are provided at bar ends as detailed.
6. Reinforcement is properly supported and braced to formwork to prevent movement during concreting operation.
7. Reinforcement has proper cover.
8. Sufficient spacing between reinforcement for concrete placement.
9. Dowel reinforcement is of proper size, at proper spacing, and has proper lap length and embedment length.
10. Welded wire reinforcement is composed of flat sheets, has proper wire gage and spacing, is properly supported, and is properly lapped with a length of one square plus two inches.
11. Proper Construction/Control/Expansion joint spacing and reinforcement.
12. Reinforcement around embedded items is erected according to details.
13. Welded reinforcement has been done according to AWS requirements.

3.04 CONCRETE MATERIALS AND POURED IN PLACE CONCRETE

A. Tests of Portland Cement: Portland Cement shall be tested by the Testing Laboratory providing services for the Contractor for compliance with the requirements of ASTM C150.

1. Mill Certificates: Mill certificates certifying that the cement has been tested and meets the requirements of the Specifications will be acceptable as test results, provided the cement proposed for use can be identified with test lots. Mill certificates shall be submitted by the Contractor prior to use of any such material.
2. Retesting: Retesting of cement will be required if:
 - a. In the opinion of the Owner, Architect, or Engineer, the cement has been damaged in storage or transit or is in any way defective.
 - b. The cement has been in storage at the mixing site for over 30 days.
3. Cube Tests: Compressive strength cube specimens shall be made by the Testing Laboratory providing services for the Contractor at the start of the job and at a frequency of one set per 250 tons of cement or whenever the source or brand of cement changes so that the quality of cement can be observed throughout the project. Each set of 2 inch cubes shall consist of three cubes for each test age as specified in ASTM C150 for the type of cement being tested. The cubes shall be tested according to ASTM C109.

B. Tests of Aggregates:

1. The Testing Laboratory providing services for the Contractor shall verify that concrete aggregates proposed for use conform to one of the following specifications:

- a. ASTM C33
 - b. ASTM C330
2. Tests of aggregates by the Testing Laboratory providing services for the Contractor shall be made before the concrete mix is established and thereafter as the character of the aggregate changes and whenever the source of materials is changed. The following tests will be required:
 - a. Sampling: The Testing Laboratory providing services for the Contractor shall secure samples of aggregate in accordance with ASTM D75 from the concrete Supplier. The proposed aggregate shall not be used until the Laboratory has approved the pit source and the plant capacity and ability to produce uniform products has been verified.
 - b. Sieve analysis: ASTM C136
 - c. Organic impurities: ASTM C40
 - d. Soundness: ASTM C88
 - e. Abrasion of Concrete Aggregate: ASTM C131
 - f. Specific gravity: ASTM C127 (coarse aggregate), ASTM C128 (fine aggregate)
 - g. Deleterious materials: ASTM C33
 - h. Materials Passing No. 200 Sieve: ASTM C117

Suppliers record of such tests run on the proposed material will be adequate provided a written affidavit is furnished as a shop drawing submittal.

C. Concrete Mix Designs:

1. The Testing Laboratory providing services for the Contractor, acting in conjunction with the Contractor and his Concrete Supplier shall provide testing services as required to assist the Contractor in submitting mix designs in accordance with the Specifications for each class of concrete indicated on the structural drawings. Refer to the Cast-in-Place Concrete Specifications for mix design requirements.
2. The Testing Laboratory providing services for the Owner shall review the submitted mix designs for conformance to the specifications and for suitability for use in the project. The Testing Laboratory shall attend the Mix Design Conference and the Pre-Concrete Conference as noted in the Cast-in-Place Concrete Specification.

D. Concrete Test Cylinders by the Testing Laboratory providing services for the Owner:

1. Molding and Testing: Cylinders for strength tests shall be molded and Laboratory cured in accordance with ASTM C31 and tested in accordance with ASTM C39.
2. Field Samples: Field samples for strength tests shall be taken in accordance with ASTM C172.
3. Frequency of Testing: Each set of test cylinders shall consist of a minimum of four standard test cylinders. A set of test cylinders shall be made according to the following minimum frequency guidelines:
 - a. One set for each class of concrete taken not less than once a day.
 - b. Piers: One set for each 50 cubic yards or fraction thereof.
 - c. Basement Walls: One set for each 150 cubic yards.
 - d. Floors: One set for each 150 cubic yards or fraction thereof but not less than one set for each 5000 square foot of floor area.
 - e. Columns: One set for each 50 cubic yards or fraction thereof with a minimum of 2 sets per floor.
 - f. All Other Concrete: A minimum of one set for each 150 cubic yards or fraction thereof.
 - g. No more than one set of cylinders at a time shall be made from any single truck.
 - h. If the total volume of concrete is such that the frequency of testing as specified above would provide less than five strength tests for a given class of concrete, tests shall be made from at least five randomly selected batches or from each batch if fewer than five batches are used.

- i. The above frequencies assume that one batch plant will be used for each pour. If more than one batch plant is used, the frequencies cited above shall apply for each plant used.

The cylinders shall be numbered, dated, and the point of concrete placement in the building recorded.

For concrete specified on the drawings to reach the required strength at 28 days, break one of the four cylinders of the set at seven days, two at 28 days, and one at 56 days.

- 4. Additional Cylinder for Floor Form Stripping: One additional cylinder per set will be required for formed slab and pan joist floors for the purpose of evaluating the concrete strength at the time of form stripping. This cylinder shall be stored on the floor where form removal is to occur under the same exposure conditions as the floor concrete. The cylinder shall be cured under field conditions in accordance with ASTM C31. Field cured test cylinders shall be molded at the same time and from the same samples as Laboratory cured test specimens. The cylinder shall be broken at the time of form removal as directed by the Contractor.
 - 5. Additional Cylinder for Post-Tensioned Concrete: One additional cylinder per set will be required for post-tensioned concrete floors or walls for the purpose of evaluating concrete strength at the time of stressing. This cylinder shall be subject to the same requirements for curing as stated for the stripping cylinder above. The cylinder shall be tested at the time of stressing as directed by the Contractor.
 - 6. Cylinder Storage Box: The Contractor shall be responsible for providing a protected concrete cylinder storage box at a point on the job site mutually agreeable with the Testing Laboratory for the purpose of storing concrete cylinders until they are transported to the Laboratory. The box shall be equipped to maintain the internal temperature of the box to between 60°F and 80°F while storing the cylinders.
 - 7. Transporting Cylinders: The Testing Laboratory providing services for the Owner shall be responsible for transporting the cylinders to the Laboratory in a protected environment such that no damage or ill effect will occur to the concrete cylinders including loss of moisture, freezing temperatures or jarring.
 - 8. Information on Concrete Test Reports: The Testing Laboratory providing services for the Owner shall make and distribute concrete test reports after each job cylinder is broken. Such reports shall contain the following information:
 - a. Truck number and ticket number
 - b. Concrete Batch Plant
 - c. Mix design number
 - d. Accurate location of pour in the structure
 - e. Strength requirement
 - f. Date cylinders made and broken
 - g. Technician making cylinders
 - h. Concrete temperature at placing
 - i. Air temperature at point of placement in the structure
 - j. Amount of water added to the truck at the batch plant and at the site and whether it exceeds the amount allowed by the mix design
 - k. Slump
 - l. Unit weight
 - m. Air content
 - n. Cylinder compressive strengths with type of failure if concrete does not meet Specification requirements. Seven day breaks are to be flagged if they are less than 60% of the required 28 day strength. 28 day breaks are to be flagged if either cylinder fails to meet Specification requirements.
- E. Other Required Tests of Concrete by the Testing Laboratory providing services for the Owner (unless noted otherwise):

1. Slump Tests: Slump Tests (ASTM C143) shall be made at the beginning of concrete placement for each batch plant and for each set of test cylinders made. The slump test shall be made from concrete taken from the end of the concrete truck chute. The concrete shall be considered acceptable if the slump is within plus or minus 1 inch of the slump noted on the mix design submittal form for that class of concrete.
2. Air Entrainment: Air entrainment tests (ASTM C231 or C173, C173 only for lightweight concrete) shall be made at the same time slump tests are made as cited above.
3. Concrete Temperature: Concrete temperature at placement shall be measured (ASTM C1064) at the same time slump tests are made as cited above.
4. Chloride Ions: The Contractor shall have the Testing Laboratory providing services for the Contractor verify in a written submittal with the mix designs that the chloride ion concentration will not exceed the limits specified.

Tests shall be run for each class of concrete according to AASHTO Designation T 260-82 Sampling and Testing for Total Chloride Ion in Concrete and Concrete Raw Materials to determine that the maximum chloride ion content does not exceed the limits stated in the concrete section of the specifications. One test shall be run for each mix design for each class of concrete at the start of the project and each time a change is made to the mix design (such as a change in aggregate type or source).

F. Evaluation and Acceptance of Concrete:

1. Strength Test: A strength test shall be defined as the average strength of two cylinder breaks from each set of cylinders tested at the time indicated above.
2. Quality Control Charts and Logs: The Testing Laboratory providing services for the Owner shall keep the following quality control logs and charts for each class of concrete containing more than 2,000 cubic yards. The records shall be kept for each batch plant and submitted on a weekly basis with cylinder test reports:
 - a. Number of strength tests made to date.
 - b. Strength test results containing the average of all strength tests to date, the high test result, the low test result, the standard deviation, and the coefficient of variation.
 - c. Number of tests under specified strength.
 - d. A histogram plotting the number of strength test cylinders versus compressive strength.
 - e. Quality control chart plotting compressive strength test results for each test.
 - f. Quality control chart plotting moving average for strength where each point plotted is the average strength of three previous test results.
 - g. Quality control chart plotting moving average for range where each point plotted is the average of 10 previous ranges.
3. Acceptance Criteria: The strength level of an individual class of concrete shall be considered satisfactory if both of the following requirements are met:
 - a. The average of all sets of three consecutive strength tests equal or exceed the required f'_c .
 - b. No individual strength test falls below the required f'_c by more than 500 PSI.

If either of the above requirements is not met, the Testing Laboratory shall immediately notify the Engineer by telephone. Steps shall immediately be taken to increase the average of subsequent strength tests.

G. Investigation of Low Strength Concrete Test Results:

1. Cost of Investigations for Low Strength Concrete: The costs of all investigations of low strength concrete, as defined by any individual strength test falling more the 500 psi below the required f'_c , shall be borne by the Contractor.

2. Scope of Investigations: See Specification Section 03 30 00, Cast-In-Place Concrete, for the investigations that may be required by the Engineer. The Testing Laboratory providing services for the Owner will conduct these investigations.

H. Concrete Batch Plant Inspection: The following types of concrete inspection shall be provided by the Testing Laboratory providing services for the Owner for the classes of concrete described in each type of inspection below:

1. Initial Concrete Inspection at the Batch Plant: Initial concrete inspection at the batch plant for each pour and travel to the jobsite with the first truckloadings to inspect concrete placement at the point of discharge shall be followed for all structural concrete not specified above.

The Testing Laboratory providing services for the Owner will assign a technician with the necessary equipment to each scheduled concrete placement. The technician will initiate concrete mix inspection at the batch plant, then will proceed to the project site with the first truckloadings to continue to inspect the mix at the point of discharge. He will remain at the jobsite to inspect the mix for the required consistency for the duration of the concrete placement.

I. Scope of Batch Plant Inspection: The scope of batch plant inspection by the Testing Laboratory providing services for the Owner shall include the following:

1. Inspection of Batch Plant Facilities: Prior to the start of concrete work, the Testing Laboratory providing services for the Owner shall inspect batch plant facilities proposed for use in the work and report in writing inspection results to the Architect, Engineer, and Owner for approval before the start of the work. The inspection shall follow that outline in ASTM C94 and as recommended by the National Concrete Ready Mix Association. Inspection shall include:

- a. Batch Plant operations and equipment
- b. Truck mixers
- c. Scales
- d. Stockpile placement
- e. Material storage
- f. Admixture dispensers

2. Duties of Inspector: The duties of the batch plant inspector shall include the following:

- a. Perform initial inspection of batch plant facilities as specified above.
- b. Secure samples of aggregates for testing.
- c. Perform visual inspection of aggregates stockpiles to determine uniformity, cleanliness, and moisture variation to be performed each visit to the plant facility.
- d. Adjust design weights for moisture in aggregates to be performed each visit if required.
- e. Inspect aggregate conveying system for possible segregation to be performed at each visit.
- f. Observe batching procedure at each visit. Verify that concrete mix design number is being batched and randomly monitor weighing operation for correct weights of each mix ingredient, including admixture dosages.
- g. Prior to loading the truck at the batch plant verify that the drum is free of water, fresh concrete, or aggregates. Check conditions and cleanliness of drum, fins, and blades.
- h. During loading, observe loading procedures.
- i. After loading, hold the truck for proper mix time and inspect concrete for thorough mix and consistency prior to leaving the batch plant.
- j. Check size of batch for rated truck capacity.

J. Job Site Inspection: The scope of the work to be performed by the inspector on the jobsite shall be as follows:

1. Prior to Concrete Placing

- a. Grade Beams
 - (1) Verify width, depth and elevation of grade beams.
 - (2) Verify that forms are plumb and straight, braced against movement, and lubricated for removal.
 - (3) Verify that carton forms below grade beam are dry.
 - (4) Verify that carton forms are neatly formed around piers.
 - (5) Inspect reinforcement per REINFORCING STEEL section.
 - b. Slab-on-Grade
 - (1) Verify that moisture retarder is provided, is lapped properly, and is not torn or punctured.
 - (2) Verify formwork at turndowns and slab edges is plumb and straight, braced against movement and lubricated for removal.
 - (3) Inspect reinforcement per REINFORCING STEEL section.
 - (4) Verify there is no standing water or debris in pour area.
 2. On-Site Concrete Material Testing and Inspection
 - a. Verify that the Contractor is following appropriate concreting practices consistent with any extreme environmental conditions at the point of placement in the structure as defined below.
 - b. Inspect concrete upon arrival to verify that the proper concrete mix number, type of concrete, and concrete strength is being placed at the proper location.
 - c. Inspect plastic concrete upon arrival at the jobsite to verify proper batching. Observe mix consistency and adding of water as required to achieve target slumps in mix designs. Record the amount of water added and note if it exceeds that allowed in the mix design. The responsibility for adding water to trucks at the job site shall rest only with the Contractor's designated representative. The Contractor is responsible that all concrete placed in the field is in conformance to the Contract Documents.
 - d. Obtain concrete test cylinders.
 - e. Perform tests to determine slump, concrete temperature, and air entrainment. The slump tests shall be made on concrete taken from the same location from which the concrete for the test cylinders is obtained.
 - f. Record information for concrete test reports.
 - g. Verify that all concrete being placed meets job Specifications. Report concrete not meeting the specified requirements and immediately notify the Contractor, Batch Plant Inspector, Architect, Engineer, and Owner.
 - h. Pick up and transport to Laboratory, cylinders cast the previous day.
 3. During Concrete Placing
 - a. Verify that the concrete is not over 90 minutes old at the time of placement.
 - b. Verify that Hot-Weather or Cold-Weather techniques are being applied as required.
 - c. Verify that concrete deposited is uniform and that vertical drop does not exceed six feet and is not permitted to drop freely over reinforcement causing segregation.
 - d. Verify that there are no cold joints.
 - e. Verify that the concrete is properly vibrated.
 - f. Verify that the finishing of the concrete surface is done according to specifications.
 - g. Verify that the curing process is according to specifications and that any curing compound used is applied in accordance with manufacturer's recommendations.
 - h. Verify that sawcut control joints on slab-on-grades are cut within 12 hours of placement.
 - i. Verify that the formwork has remained stable during the concreting operation.
 4. The job site inspector shall report any irregularities that occur in the concrete at the job site or test results to the Contractor, Architect, Owner, and Engineer.
- K. Causes for Rejection of Concrete: The Contractor shall reject all concrete delivered to the site for any of the following reasons:

1. Wrong class of concrete (incorrect mix design number).
2. Environmental Conditions: Environmental condition limits shall be as follows unless appropriate provisions in concreting practices have been made for cold or hot weather:
 - a. Cold Weather: Air temperature must be 40°F and rising or the average daily temperature cannot have been lower than 40°F for 3 consecutive days unless the temperature rose above 50°F for at least one-half of any of those 24 hour periods.
 - b. Hot Weather: Environmental conditions must be such that cause an evaporation rate from the concrete surface of 0.2 lb./sq. ft./hr. or less as determined by Figure 2.1.5 in ACI 305R-91.

Concrete may be placed at other environmental condition ranges only with approval of the job inspector for the Testing Laboratory providing services for the Owner or other duly appointed representative.

3. Concrete with temperatures exceeding 95°F shall not be placed in the structure.
4. Air contents outside the limits specified in the mix designs.
5. Slumps outside the limits specified.
6. Excessive Age: Concrete shall be discharged within 90 minutes of plant departure or before it begins to set if sooner than 90 minutes unless approved by the Laboratory job inspector or other duly appointed representative.

The Contractor is responsible that all concrete placed in the field is in conformance to the Contract Documents.

L. Testing of Concrete Floor Slabs for Acceptability to Receive an Adhesive-Applied, Low-Permeable Floor Covering

1. The following tests shall be made prior to installing adhesive-applied, low-permeability floor coverings such as vinyl composition tile (VCT), linoleum, sheet vinyl, vinyl-backed carpet, rubber, athletic flooring, synthetic turf, wood, acrylic terrazzo, thin-set tile, epoxy overlays and adhesives, et.al.
2. Moisture Vapor Emission Rate: Perform testing according to ASTM F 1869 to determine if the moisture emission rate from the floor is below the flooring manufacturer's maximum recommended value but not greater than 5lbs/1000sq.ft./24h.
3. Alkalinity Testing: Perform testing in accordance with ASTM F 710-98, paragraph 5.3, to determine if the pH level of the concrete slab surface is below the flooring manufacturer's maximum recommended value but not greater than 10. Perform three tests per 1000 sq. ft.

M. Concrete Batch Trip Tickets: All concrete batch trip tickets shall be collected and retained by the Contractor. Compressive strength, slump, air, and temperature tests shall be identified by reference to a particular trip ticket. All tickets shall contain the information specified in ASTM C94. Each ticket shall also show the amount of water that may be added in the field for the entire batch that will not exceed the specified water cement ratio for the design mix. The Contractor and Testing Laboratory providing services for the Owner shall immediately notify the Architect/Engineer and each other of tickets not meeting the criteria specified.

3.05 STRUCTURAL STEEL

A. Contract Obligations:

1. Owner Responsibility: The Owner shall pay for all initial shop and field inspections and tests as required during the fabrication and erection of the structural steel.
2. Contractor Responsibility: The Contractor shall pay for and arrange with the Testing Laboratory providing services for the Contractor for the certification of all shop and field welders. The Testing Laboratory providing services for the Contractor shall provide the qualification testing required by AWS D1.1 Chapter 4, Part B to qualify any non-qualified

Welding Procedure Specification (WPS) needed for the project. The Testing Laboratory shall prepare Procedure Qualification Records (PQR) documenting the successful qualification of each WPS. Each bolting crew and welder shall be assigned an identifying symbol or mark and all shop and field connections shall be so identified so that the inspector can refer back to the person or crew performing the work. The costs of all retesting of material or workmanship not in conformance with the Contract Documents shall be borne by the Contractor. The Fabricator and Erector shall provide the Laboratory inspector with access to all places where work is being done. A minimum of 24 hours notification shall be given prior to commencement of work. The Contractor shall provide the Testing Laboratory providing services for the Owner with the following:

- a. A complete set of Architect/Engineer reviewed shop and erection drawings including all revisions and addenda.
 - b. Cutting lists, order sheets, material bills, shipping bills and mill test reports.
 - c. Information as to time and place of all rollings and shipment of material to shops.
 - d. Representative sample pieces requested for testing.
 - e. Full and ample means and assistance for testing all material.
 - f. Proper facilities, including scaffolding, temporary work platforms, hoisting facilities, etc., for inspection of the work in the mills, shop and field.
3. Testing Laboratory Responsibility: The inspection by the Testing Laboratory providing services for the Owner of the Fabricator's work done in the shop shall be performed in the Fabricator's shop to the fullest extent possible. Such inspections shall be in sequence, timely, and performed in such a manner as to minimize disruptions in operations and to permit the repair of all nonconforming work while the material is in process in the fabricating shop. Inspection of field work shall be completed promptly so that corrections can be made without delaying the progress of the work. Inspections shall be performed by qualified technicians with a minimum of two years experience in structural steel testing and inspection. All inspection personnel shall be certified in accordance with AWS QC-1. The Testing Laboratory shall provide test reports of all shop and field inspections. Shop test reports shall include shop welders certifications. All test reports shall indicate types and locations of all defects found during inspection, the measures required and performed to correct such defects, statements of final approval of all welding and bolting of shop and field connections, and other fabrication and erection data pertinent to the safe and proper welding and bolting of shop and field connections. In addition to the parties listed in this Specification the Fabricator and Erector shall receive copies of all test reports.
4. Rejection of Material or Workmanship: The Owner, Architect, Engineer, and Testing Laboratory reserve the right to reject any material or workmanship not in conformance with the Contract Documents at any time during the progress of the work. However, this provision does not allow waiving the obligation for timely, in sequence inspections.

B. Mill Tests of Structural Steel:

1. Mill Order Steel: The Fabricator shall furnish certified mill test reports and an affidavit stating that the structural steel furnished meets the requirements of the grade specified on the structural drawings for all mill order steel. In case of controversy, tests of the material according to ASTM A6 or A568 as applicable made by the Testing Laboratory providing services for the Contractor with certified test reports paid for by the Contractor shall be made to verify conformity with ASTM standards. Tests shall be made for each 10 tons of material used unless approved otherwise by the Engineer.
2. Local Stock Steel: Materials taken from stock by a Fabricator for use for structural purposes must be of a quality at least equal to that required by the ASTM specifications applicable to the classification covering the intended use. Certified mill test reports shall be accepted as sufficient record of the quality of materials carried in stock by the fabricator provided the stock steel can be identified by heat or melt numbers. In case of controversy, tests by the Testing Laboratory providing services for the Contractor with certified reports as specified for mill order steel shall be required.

3. If tests are required, test specimens shall be taken by the Contractor under the direction of the Testing Laboratory providing services for the Contractor and shall be machined by the Testing Laboratory to dimensions as required by the applicable ASTM standards.

C. Shop Inspections and Tests: The Testing Laboratory providing services for the Owner shall provide inspection at the designated fabrication shops for the designated periods of time to perform shop inspection and tests. The designated fabrication shops and time periods of inspection shall be determined in consultation with the Architect, Owner, and Engineer prior to the start of fabrication in a timely manner so as to not delay the fabrication process. The following tests and inspections shall be performed:

1. Review shop drawings and shop procedures with Fabricator's supervisory personnel.
2. Request and obtain necessary mill certifications of steel and verify proper material throughout the duration of the job.
3. Approve Welding Procedure Specifications submitted by the Contractor. Approve any changes submitted by the Contractor to any WPS that has already been approved. Obtain the Welding Procedure Qualification Record (WPQR) for each successful WPS qualification.
4. Verify welder qualifications either by certification and/or by retesting. Obtain welder certificates.
5. Check layout and dimensions of jigs and fixtures for multiple fabrication, joint preparation, and fit up of members.
6. Verify welding electrodes to be used and other welding consumables as the job progresses.
7. Check preheating procedures for uniformity and thoroughness through the full thickness of the material. Inspect preheating and interpass temperatures for conformance to AWS D1.1, Table 4.2. Verify procedure for control of distortion and shrinkage stresses.
8. Verify procedures for welding in accordance with applicable portions of Section 4, "Technique", AWS D1.1.
9. Inspect welding equipment for capacity, maintenance, and working condition.
10. Perform random dimensional checks of completed members.
11. Provide inspection of surface preparation for coating and coating operations.
12. Check shipping preparation schedules and obtain copies of shipping lists.
13. Inspect bolting operations according to inspection procedures outlined in the "Specification for Structural Joints using ASTM A325 or A490 Bolts".
14. Perform Arbitration Testing and Inspection according to procedures outlined in the "Specification for Structural Joints using ASTM A325 or A490 Bolts" when a disagreement exists between the Testing Laboratory and the Fabricator as to the minimum tension of installed bolts that have been inspected according to paragraph above.
15. Make visual inspection of welding in progress for size, length, and quality.
16. Perform non-destructive examination services for various weldments of shop fabrication determined in consultation with the Structural Engineer prior to the start of fabrication. The testing agency shall submit recommendations to the Structural Engineer for approval as to the type of nondestructive inspection methods best suited to the member being tested. Specifically, the Laboratory shall provide a qualified technician with the necessary equipment to perform the following:
 - a. Nondestructive examination conducted in accordance with the specific requirements for the item being examined including radiographic, ultrasonic, magnetic particle, or dye penetrant inspection. All nondestructive inspection procedures shall conform to AWS D1.1.
 - b. Interpret, record, and report all results of the nondestructive tests.
 - c. Mark for repair, any area not meeting Specification requirements. Correction of rejected welds shall be made in accordance with AWS D1.1.
 - d. Re-examine all repair areas and interpret, record, and report the results of examinations of repair welds.
 - e. Verify that quality of welds meet the requirements of AWS D1.1.

17. Unless otherwise specified, test all partial and complete penetration welds in connections of beams, girders, columns, trusses, and braces. Test a minimum of 10% of connections with fillet welds. Increase the testing rate for welders having a high rejection rate as required to ensure acceptable welds. Visual inspection is required for all welds. The costs of repairing all defective welds and the costs of retesting by the Testing Laboratory providing services for the Owner shall be borne by the Contractor. If removal of a backing strip is required by the Testing Laboratory to investigate a suspected weld defect, such cost shall be borne by the Contractor.

D. Field Inspections and Tests: The Testing Laboratory providing services for the Owner shall provide inspection in the field for a period of time as determined in consultation with the Architect, Owner, and Engineer prior to the start of erection in a timely manner so as to not delay the start of erection. The following tests and inspections shall be made:

1. Obtain the planned erection procedure, and review with the Erectors supervisory personnel.
2. Check the installation of base plates for proper leveling, grout type, and grout application.
3. Verify field welding procedures and obtain welder certificates.
4. Check steel as received in the field for possible shipping damage, workmanship, and piece marking.
5. Check plumbness and frame alignment as erection progresses.
6. Check joint preparation and fit up, backing strips, and runout plates for welded moment connections and column splices.
7. Check preheating to assure proper temperature, uniformity, and thoroughness through the full material thickness.
8. Review welding sequence.
9. Visually inspect all field welding for size, length, and quality.
10. Perform nondestructive examination services for various weldments of field erection determined in consultation with the Structural Engineer prior to the start of erection. The Laboratory shall furnish a qualified technician with the necessary equipment to perform radiographic, ultrasonic, magnetic particle, or dye penetrant inspection as required for the item being tested and other duties as outlined for shop inspection in the previous Section. Unless specified otherwise, check all partial and complete penetration welds in connections of beams, girders, columns, trusses, and braces. Check 10% of connections with fillet welds. Visual inspection is required for all welds.
11. Perform preinstallation verification testing of the pretensioning method to be used in the field in accordance with the requirements of the "Specification for Structural Joints Using ASTM A325 and A490 Bolts". Daily check calibration of impact wrenches used in field bolted connections.
12. Inspect bolting operations for all high strengthfield bolted connections according to inspection procedures outlined in the "Specification for Structural Joints Using ASTM A325 or A490 Bolts".
13. Perform Arbitration Testing and Inspection according to procedures outlined in the "Specification for Structural Joints using ASTM A325 or A490 Bolts" when a disagreement exists between the Testing Laboratory and the Fabricator as to the minimum tension of installed bolts that have been inspected according to paragraph above.
14. Visually inspect the welding or other attachment method of metal deck to the structure.

The costs of repairing all defective welds and the costs of retesting by the Testing Laboratory providing services for the Owner shall be borne by the Contractor. If removal of a backing strip is required by the Testing Laboratory providing services for the Owner to investigate a suspected weld defect, such cost shall be borne by the Contractor.

E. Tests and Inspection of Sprayed-On Fireproofing:

1. The Testing Laboratory providing services for the Owner shall confirm that sprayed-on fireproofing conforms to all performance criteria as specified in the project specifications by obtaining and reviewing manufacturer's certification or test reports.
2. The Testing Laboratory providing services for the Owner shall sample sprayed-on fireproofing at each floor for each day's operation and verify oven-dry density (ASTM E605) and adhesion/cohesion (ASTM E736) as specified on the drawings.
3. The Testing Laboratory providing services for the Owner shall verify proper installation method, proper material, and proper material thickness (ASTM E605) for each day's operation. The thickness of fireproofing shall be as specified in the UL designation numbers on the Architectural Drawings.

3.06 NON-SHRINK GROUT FOR BASE PLATES AND BEARING PLATES

- A. Compressive Strength Tests (by the Testing Laboratory providing services for the Owner): Compressive strength of grout shall be determined by testing grout cubes according to the requirements of ASTM C109 - Modified. Test one set of three cubes at 1 day, and one set of three cubes at 28 days.
- B. Frequency of Testing: One set of cubes (6 cubes) shall be made for every ten base plates and bearing plates or fraction thereof but not less than one set for each day's operation. One set of cubes shall be made for each day's operation of grouting wall panels.

3.07 MASONRY

A. Mortar:

1. The Testing Laboratory providing services for the Contractor, acting in conjunction with the Contractor and his Masonry Subcontractor, shall provide testing services as required to assist the Contractor in submitting mix designs in accordance with the Specifications for each class of mortar indicated on the structural drawings. Refer to the Unit Masonry Specifications for mix design requirements.
2. The Testing Laboratory providing services for the Owner shall review the submitted mix designs for conformance to the specifications and for suitability for use in the project.
3. Field Inspection and Testing: The Testing Laboratory providing services for the Owner shall verify that the proportions of the mortar comply with the submitted mix design and the specifications. This verification shall be done at the beginning of each day of masonry construction.

B. Grout:

1. The Testing Laboratory providing services for the Contractor, acting in conjunction with the Contractor and his Masonry Subcontractor, shall provide testing services as required to assist the Contractor in submitting mix designs in accordance with the Specifications for each class of grout indicated on the structural drawings. Refer to the Unit Masonry Specifications for mix design requirements.
2. The Testing Laboratory providing services for the Owner shall review the submitted mix designs for conformance to the specifications and for suitability for use in the project.
3. Field Inspection and Testing The Testing Laboratory providing services for the Owner shall verify that the proportions of the grout comply with the submitted mix design and the specifications. This verification shall be done for each batch of grout from the beginning and continuously during masonry construction.

- C. Experience Requirement: Field inspection of masonry construction by the Testing Laboratory providing services for the Owner as herein described shall be performed by qualified technicians with a minimum of five years experience in masonry testing and inspection.

D. Field Inspection Requirements: The duties and responsibilities of the Testing Laboratory Inspector in the field shall be as follows:

1. All Masonry Work
 - a. Review and become familiar with project drawings and specifications.
 - b. Review methods of storing and handling of masonry materials and accessories for conformance to project specifications.
 - c. Review the foundation to verify proper foundation construction tolerances, location, size and spacing of reinforcing dowels, and that foundation surfaces are properly prepared to accept the masonry.
 - d. Review all masonry materials used in the field for conformance to project specifications. This shall include masonry units, mortar, grout, portland cement, masonry cement, sand, lime, horizontal joint reinforcement, vertical reinforcement, ties, masonry anchoring devices to the structure, flashing, and control and expansion joint strips.
2. Periodic Inspection: For Masonry work not specified on the drawings or in the local building code as requiring continuous inspection, the field inspection shall additionally include the following:
 - a. At the beginning of construction, verify that the workmanship of masonry construction including the mortar joints is in accordance with specifications.
 - b. At the beginning of construction, review proper horizontal joint reinforcement, bond-beam and lintel reinforcement, and vertical reinforcement size and spacing and size and spacing of wall ties.
 - c. At the beginning of each day of construction, verify proper mortar batching proportions and procedures as prescribed above.
 - d. Prior to each grouting operation, verify that the following are in compliance with specifications:
 - (1) grout space and clean-outs
 - (2) construction of mortar joints, lintels, and bond-beams.
 - (3) placement and size of reinforcement and connectors
 - (4) proportions of site-prepared grout mix
 - (5) installed flashing, weep holes, construction joints, control joints and wall vents
 - e. During grouting operation, provide continuous inspection to verify that grouting is proceeding according to specifications.
 - f. Gather specimens and perform tests on prisms and masonry units as specified above.

END OF SECTION

SECTION 01 50 00
TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Temporary utilities.
- B. Temporary telephone and facsimile service.
- C. Temporary sanitary facilities.
- D. Temporary Controls: Barriers, enclosures, and fencing.
- E. Security requirements.
- F. Vehicular access and parking.
- G. Waste removal facilities and services.
- H. Project identification sign.
- I. Field offices.

1.02 TEMPORARY UTILITIES

- A. Provide and pay for all electrical power, lighting, water, heating and cooling, and ventilation required for construction purposes.
- B. Existing facilities may not be used.
- C. New permanent facilities may not be used.
- D. Use trigger operated nozzles for water hoses, to avoid waste of water.

1.03 TELEPHONE SERVICE

- A. Provide, maintain, and pay for telephone service to field office at time of project mobilization.
- B. Architect will provide it's own telephone service.
- C. Provide, maintain and pay for facsimile service and a dedicated telephone line to field office at time of project mobilization.
- D. Architect will utilize Contractor's facsimile service when required.

1.04 TEMPORARY SANITARY FACILITIES

- A. Provide and maintain required sanitary facilities and enclosures. Provide at time of project mobilization.
- B. Use of newly constructed facilities is not permitted.
- C. Maintain daily in clean and sanitary condition.

1.05 BARRIERS

- A. Provide barriers to prevent unauthorized entry to construction areas and to protect existing facilities and adjacent properties from damage from construction operations.
- B. Provide barricades and covered walkways required by governing authorities for public rights-of-way.

- C. Protect non-owned vehicular traffic, stored materials, site, and structures from damage.

1.06 EXTERIOR ENCLOSURES

- A. Provide temporary insulated weather tight closure of exterior openings to accommodate acceptable working conditions and protection for Products, to allow for temporary heating and maintenance of required ambient temperatures identified in individual specification sections, and to prevent entry of unauthorized persons. Provide access doors with self-closing hardware and locks.

1.07 SECURITY

- A. Provide security and facilities to protect Work, existing facilities, and Owner's operations from unauthorized entry, vandalism, or theft.

1.08 VEHICULAR ACCESS AND PARKING

- A. Coordinate access and haul routes with governing authorities and Owner.
- B. Provide and maintain access to fire hydrants, free of obstructions.
- C. Provide means of removing mud from vehicle wheels before entering streets.
- D. Provide temporary parking areas to accommodate construction personnel. When site space is not adequate, provide additional off-site parking.
- E. Do not allow vehicle parking on existing city streets and pavement, unless authorized by the city.
- F. Designate one parking space for Owner and Architect use.

1.09 WASTE REMOVAL

- A. Provide waste removal facilities and services as required to maintain the site in clean and orderly condition.
- B. Provide containers with lids. Remove trash from site on a regular schedule that prevents container overflow.
- C. If materials to be recycled or re-used on the project must be stored on-site, provide suitable non-combustible containers; locate containers holding flammable material outside the structure unless otherwise approved by the authorities having jurisdiction.
- D. Open free-fall chutes are not permitted. Terminate closed chutes into appropriate containers with lids.

1.10 PROJECT IDENTIFICATION

- A. Provide project identification sign of design and construction indicated on Drawings.
- B. Erect on site at location established by Architect.
- C. No other signs are allowed without Owner permission except those required by law.

1.11 FIELD OFFICES

- A. Office: Weather tight, with lighting, electrical outlets, heating, cooling equipment, and equipped with sturdy furniture, drawing rack and drawing display table.
- B. Provide space for Project meetings, with table and chairs to accommodate 6 persons.
- C. Locate offices a minimum distance of 30 feet from existing and new structures.

1.12 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

- A. Remove temporary utilities, equipment, facilities, materials, prior to Final Application for Payment inspection.
- B. Remove underground installations to a minimum depth of 2 feet.
- C. Clean and repair damage caused by installation or use of temporary work.
- D. Restore new permanent facilities used during construction to specified condition.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 01 57 13

TEMPORARY EROSION AND SEDIMENT CONTROL

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Prevention of erosion due to construction activities.
- B. Prevention of sedimentation of waterways, open drainage ways, and storm and sanitary sewers due to construction activities.
- C. Restoration of areas eroded due to insufficient preventive measures.
- D. Compensation of Owner for fines levied by authorities having jurisdiction due to non-compliance by Contractor.

1.02 RELATED REQUIREMENTS

- A. Section 01 35 15 - LEED Certification Procedures: LEED credits relating to erosion and sedimentation control.

1.03 PERFORMANCE REQUIREMENTS

- A. Comply with all requirements of U.S. Environmental Protection Agency for erosion and sedimentation control, as specified for the National Pollutant Discharge Elimination System (NPDES), Phases I and II, under requirements for the 2003 Construction General Permit (CGP), whether the project is required by law to comply or not.
- B. Develop and follow an Erosion and Sedimentation Prevention Plan and submit periodic inspection reports.
- C. Do not begin clearing, grading, or other work involving disturbance of ground surface cover until applicable permits have been obtained; furnish all documentation required to obtain applicable permits.
- D. Timing: Put preventive measures in place as soon as possible after disturbance of surface cover and before precipitation occurs.
- E. Storm Water Runoff: Control increased storm water runoff due to disturbance of surface cover due to construction activities for this project.
 - 1. Prevent runoff into storm and sanitary sewer systems, including open drainage channels, in excess of actual capacity or amount allowed by authorities having jurisdiction, whichever is less.
 - 2. Anticipate runoff volume due to the most extreme short term and 24-hour rainfall events that might occur in 25 years.
- F. Erosion On Site: Minimize wind, water, and vehicular erosion of soil on project site due to construction activities for this project.
 - 1. Control movement of sediment and soil from temporary stockpiles of soil.
 - 2. Prevent development of ruts due to equipment and vehicular traffic.
 - 3. If erosion occurs due to non-compliance with these requirements, restore eroded areas at no cost to Owner.
- G. Erosion Off Site: Prevent erosion of soil and deposition of sediment on other properties caused by water leaving the project site due to construction activities for this project.
 - 1. Prevent windblown soil from leaving the project site.
 - 2. Prevent tracking of mud onto public roads outside site.
 - 3. Prevent mud and sediment from flowing onto sidewalks and pavements.
 - 4. If erosion occurs due to non-compliance with these requirements, restore eroded areas at no cost to Owner.

- H. Sedimentation of Waterways On Site: Prevent sedimentation of waterways on the project site, including rivers, streams, lakes, ponds, open drainage ways, storm sewers, and sanitary sewers.
 - 1. If sedimentation occurs, install or correct preventive measures immediately at no cost to Owner; remove deposited sediments; comply with requirements of authorities having jurisdiction.
 - 2. If sediment basins are used as temporary preventive measures, pump dry and remove deposited sediment after each storm.
- I. Sedimentation of Waterways Off Site: Prevent sedimentation of waterways off the project site, including rivers, streams, lakes, ponds, open drainage ways, storm sewers, and sanitary sewers.
 - 1. If sedimentation occurs, install or correct preventive measures immediately at no cost to Owner; remove deposited sediments; comply with requirements of authorities having jurisdiction.
- J. Open Water: Prevent standing water that could become stagnant.
- K. Maintenance: Maintain temporary preventive measures until permanent measures have been established.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. LEED Submittals: Submit all submittals required in this section in accordance with procedures specified in Section 01 35 15.
- C. Erosion and Sedimentation Control Plan:
 - 1. Include:
 - a. Site plan identifying soils and vegetation, existing erosion problems, and areas vulnerable to erosion due to topography, soils, vegetation, or drainage.
 - b. Site plan showing grading; new improvements; temporary roads, traffic accesses, and other temporary construction; and proposed preventive measures.
 - c. Where extensive areas of soil will be disturbed, include storm water flow and volume calculations, soil loss predictions, and proposed preventive measures.
 - d. Schedule of temporary preventive measures, in relation to ground disturbing activities.
 - e. Other information required by law.
 - f. Format required by law is acceptable, provided any additional information specified is also included.
 - 2. Obtain the approval of the Plan by authorities having jurisdiction.
 - 3. Obtain the approval of the Plan by Owner.
- D. Inspection Reports: Submit report of each inspection; identify each preventive measure, indicate condition, and specify maintenance or repair required and accomplished.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Use materials indicated on the drawings.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine site and identify existing features that contribute to erosion resistance; maintain such existing features to greatest extent possible.

3.02 PREPARATION

- A. Schedule work so that soil surfaces are left exposed for the minimum amount of time.

3.03 SCOPE OF PREVENTIVE MEASURES

- A. In all cases, if permanent erosion resistant measures have been installed temporary preventive measures are not required.
- B. Construction Entrances: Traffic-bearing aggregate surface.
1. Width: As required; 20 feet, minimum.
 2. Length: 50 feet, minimum.
 3. Provide at each construction entrance from public right-of-way.
 4. Where necessary to prevent tracking of mud onto right-of-way, provide wheel washing area out of direct traffic lane, with drain into sediment trap or basin.
- C. Linear Sediment Barriers: Made of silt fences.
1. Provide linear sediment barriers:
 - a. Along downhill perimeter edge of disturbed areas, including soil stockpiles.
 2. Space sediment barriers with the following maximum slope length upslope from barrier:
 - a. Slope of Less Than 2 Percent: 100 feet..
 - b. Slope Between 2 and 5 Percent: 75 feet.
 - c. Slope Between 5 and 10 Percent: 50 feet.
 - d. Slope Between 10 and 20 Percent: 25 feet.
 - e. Slope Over 20 Percent: 15 feet.
- D. Storm Drain Curb Inlet Sediment Trap: As detailed on drawings.
- E. Storm Drain Drop Inlet Sediment Traps: As detailed on drawings.
- F. Temporary Splash Pads: Stone aggregate over filter fabric; size to suit application; provide at downspout outlets and storm water outlets.
- G. Soil Stockpiles: Protect using one of the following measures:
1. Cover with polyethylene film, secured by placing soil on outer edges.
 2. Cover with mulch at least 4 inches thickness of pine needles, sawdust, bark, wood chips, or shredded leaves, or 6 inches of straw or hay.
- H. Mulching: Use only for areas that may be subjected to erosion for less than 6 months.
- I. Temporary Seeding: Use where temporary vegetated cover is required.

3.04 INSTALLATION

- A. Traffic-Bearing Aggregate Surface:
1. Excavate minimum of 6 inches.
 2. Place geotextile fabric full width and length, with minimum 12 inch overlap at joints.
 3. Place and compact at least 6 inches of 1.5 to 3.5 inch diameter stone.
- B. Silt Fences:
1. Store and handle fabric in accordance with ASTM D 4873.
 2. Where slope gradient is less than 3:1 or barriers will be in place less than 6 months, use nominal 16 inch high barriers with minimum 36 inch long posts spaced at 6 feet maximum, with fabric embedded at least 4 inches in ground.
 3. Where slope gradient is steeper than 3:1 or barriers will be in place over 6 months, use nominal 28 inch high barriers, minimum 48 inch long posts spaced at 6 feet maximum, with fabric embedded at least 6 inches in ground.
 4. Where slope gradient is steeper than 3:1 and vertical height of slope between barriers is more than 20 feet, use nominal 32 inch high barriers with woven wire reinforcement and steel posts spaced at 4 feet maximum, with fabric embedded at least 6 inches in ground.
 5. Install with top of fabric at nominal height and embedment as specified.
 6. Do not splice fabric width; minimize splices in fabric length; splice at post only, overlapping at least 18 inches, with extra post.

7. Wherever runoff will flow around end of barrier or over the top, provide temporary splash pad or other outlet protection; at such outlets in the run of the barrier, make barrier not more than 12 inches high with post spacing not more than 4 feet.
- C. Temporary Seeding:
1. When hydraulic seeder is used, seedbed preparation is not required.
 2. When surface soil has been sealed by rainfall or consists of smooth undisturbed cut slopes, and conventional or manual seeding is to be used, prepare seedbed by scarifying sufficiently to allow seed to lodge and germinate.
 3. If temporary mulching was used on planting area but not removed, apply nitrogen fertilizer at 1 pound per 1000 sq ft.
 4. On soils of very low fertility, apply 10-10-10 fertilizer at rate of 12 to 16 pounds per 1000 sq ft.
 5. Incorporate fertilizer into soil before seeding.
 6. Apply seed uniformly; if using drill or cultipacker seeders place seed 1/2 to 1 inch deep.
 7. Irrigate as required to thoroughly wet soil to depth that will ensure germination, without causing runoff or erosion.
 8. Repeat irrigation as required until grass is established.

3.05 MAINTENANCE

- A. Inspect preventive measures weekly, within 24 hours after the end of any storm that produces 0.5 inches or more rainfall at the project site, and daily during prolonged rainfall.
- B. Repair deficiencies immediately.
- C. Silt Fences:
 1. Promptly replace fabric that deteriorates unless need for fence has passed.
 2. Remove silt deposits that exceed one-third of the height of the fence.
 3. Repair fences that are undercut by runoff or otherwise damaged, whether by runoff or other causes.
- D. Clean out temporary sediment control structures weekly and relocate soil on site.
- E. Place sediment in appropriate locations on site; do not remove from site.

3.06 CLEAN UP

- A. Remove temporary measures after permanent measures have been installed, unless permitted to remain by Architect.
- B. Clean out temporary sediment control structures that are to remain as permanent measures.
- C. Where removal of temporary measures would leave exposed soil, shape surface to an acceptable grade and finish to match adjacent ground surfaces.

END OF SECTION

SECTION 01 60 00
PRODUCT REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. General product requirements.
- B. Transportation, handling, storage and protection.
- C. Product option requirements.
- D. Substitution limitations and procedures.
- E. Procedures for Owner-supplied products.
- F. Spare parts and maintenance materials.

1.02 RELATED SECTIONS

- A. Section 01 40 00 - Quality Requirements: Product quality monitoring.

1.03 SUBMITTALS

- A. Product Data Submittals: Submit manufacturer's standard published data. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.
- B. Shop Drawing Submittals: Prepared specifically for this Project; indicate utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.
- C. Sample Submittals: Illustrate functional and aesthetic characteristics of the product, with integral parts and attachment devices. Coordinate sample submittals for interfacing work.
 - 1. For selection from standard finishes, submit samples of the full range of the manufacturer's standard colors, textures, and patterns.

PART 2 PRODUCTS

2.01 NEW PRODUCTS

- A. Provide new products unless specifically required or permitted by the Contract Documents.
- B. Do not use products having any of the following characteristics:
- C. Where all other criteria are met, Contractor shall give preference to products that:
 - 1. Are extracted, harvested, and/or manufactured closer to the location of the project.
 - 2. Have longer documented life span under normal use.
 - 3. Result in less construction waste.

2.02 PRODUCT OPTIONS

- A. Products Specified by Reference Standards or by Description Only: Use any product meeting those standards or description.
- B. Products Specified by Naming One or More Manufacturers: Use a product of one of the manufacturers named and meeting specifications, no options or substitutions allowed.
- C. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit a request for substitution for any manufacturer not named.

2.03 SPARE PARTS AND MAINTENANCE PRODUCTS

- A. Provide spare parts, maintenance, and extra products of types and in quantities specified in individual specification sections.
- B. Deliver to Project site; obtain receipt prior to final payment.

PART 3 EXECUTION

3.01 SUBSTITUTION PROCEDURES

- A. Architect will consider requests for substitutions only within 15 days after date of Agreement.
- B. Substitutions may be considered when a product becomes unavailable through no fault of the Contractor.
- C. Document each request with complete data substantiating compliance of proposed substitution with Contract Documents.
- D. A request for substitution 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.
 - 2. Will provide the same warranty for the substitution as for the specified product.
 - 3. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to Owner.
 - 4. Waives claims for additional costs or time extension which may subsequently become apparent.
- E. Substitutions will not be considered when they are indicated or implied on shop drawing or product data submittals, without separate written request, or when acceptance will require revision to the Contract Documents.
- F. Substitution Submittal Procedure:
 - 1. Use Architect provided Substitution Request Form.
 - 2. Submit three copies of request for substitution for consideration. Limit each request to one proposed substitution.
 - 3. Submit shop drawings, product data, and certified test results attesting to the proposed product equivalence. Burden of proof is on the party requesting a substitution.
 - 4. The Architect will notify Contractor in writing of decision to accept or reject request.

3.02 OWNER-SUPPLIED PRODUCTS

- A. Owner's Responsibilities:
 - 1. Arrange for and deliver Owner reviewed shop drawings, product data, and samples, to Contractor.
 - 2. Arrange and pay for product delivery to site.
 - 3. On delivery, inspect products jointly with Contractor.
 - 4. Submit claims for transportation damage and replace damaged, defective, or deficient items.
 - 5. Arrange for manufacturers' warranties, inspections, and service.
- B. Contractor's Responsibilities:
 - 1. Review Owner reviewed shop drawings, product data, and samples.
 - 2. Receive and unload products at site; inspect for completeness or damage jointly with Owner.
 - 3. Handle, store, install and finish products.
 - 4. Repair or replace items damaged after receipt.

3.03 TRANSPORTATION AND HANDLING

- A. Coordinate schedule of product delivery to designated prepared areas in order to minimize site storage time and potential damage to stored materials.
- B. Transport and handle products in accordance with manufacturer's instructions.
- C. Transport materials in covered trucks to prevent contamination of product and littering of surrounding areas.
- D. Promptly inspect shipments to ensure that products comply with requirements, quantities are correct, and products are undamaged.
- E. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage.
- F. Arrange for the return of packing materials, such as wood pallets, where economically feasible.

3.04 STORAGE AND PROTECTION

- A. Designate receiving/storage areas for incoming products so that they are delivered according to installation schedule and placed convenient to work area in order to minimize waste due to excessive materials handling and misapplication.
- B. Store and protect products in accordance with manufacturers' instructions.
- C. Store with seals and labels intact and legible.
- D. Store sensitive products in weather tight, climate controlled, enclosures in an environment favorable to product.
- E. For exterior storage of fabricated products, place on sloped supports above ground.
- F. Provide bonded off-site storage and protection when site does not permit on-site storage or protection.
- G. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.
- H. Store loose granular materials on solid flat surfaces in a well-drained area. Prevent mixing with foreign matter.
- I. Prevent contact with material that may cause corrosion, discoloration, or staining.
- J. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.
- K. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.

END OF SECTION

**PRODUCT SUBSTITUTION
REQUEST FORM**

(During the Bidding Phase – Must be submitted a minimum of 5 days before the bid date)

Project: _____ _____	Substitution Request No: _____
	From: _____
To: _____ _____	Date: _____
	A/E Project No: _____
Reference: _____	Contract For: _____

Specification Title: _____

Section: _____ Page: _____ Article / Paragraph: _____

Proposed Substitution: _____

Manufacturer: _____ Address: _____

Telephone: _____ Proposed Model No.: _____

Attached data includes product description, specifications, drawings, photographs, and performance and test data adequate for evaluation of the request; applicable portions of the data are clearly identified.

Attached data also includes a description of changes to the Contract Documents that the proposed substitution will require for its installation.

The undersigned certifies:

- Proposed substitution has been fully investigated and determined to be equal or superior in all respects to specified product.
- Same warranty will be furnished for proposed substitution as for specified product.
- Same maintenance service and source of replacement parts, as applicable, is available.
- Proposed substitution will have no adverse effect on other trades and will not affect or delay progress schedule.
- Proposed substitution does not affect dimensions and functional clearances.
- Payment will be made for changes to building design, including A/E design, detailing, and construction costs caused by substitution.

Submitted By: _____	Signed : _____
Firm: _____	Address: _____
Phone: _____	_____

A/E's REVIEW & ACTION

- ☐ Substitution approved – Make submittals in accordance with Project Manual requirements.
- ☐ Substitution approved as noted – Make submittals in accordance with Project Manual requirements.
- ☐ Substitution rejected – Use specified materials.
- ☐ Substitution Request received too late – Use specified materials.

A/E Signature: _____ Date: _____

Supporting Data Attached: ☐ Drawings ☐ Product Data ☐ Samples ☐ Tests ☐ Reports ☐ _____

END OF REQUEST FORM

**PRODUCT SUBSTITUTION
REQUEST FORM**
(After the Bidding Phase)

Project: _____ _____	Substitution Request No: _____
	From: _____
To: _____ _____	Date: _____
	A/E Project No: _____
Reference: _____	Contract For: _____

Specification Title: _____

Section: _____ Page: _____ Article / Paragraph: _____

Proposed Substitution: _____

Manufacturer: _____ Address: _____

Telephone: _____ Proposed Model No.: _____

Installer: _____ Address: _____ Phone: _____

History: ☐ New product ☐ 2-5 years old ☐ 5-10 years old ☐ More than 10 years old

Differences between proposed substitution and specified product: _____

☐ Point-by-point comparative data attached – REQUIRED BY A/E

Reason for not providing specified item: _____

Similar installation:

Project: _____	Architect: _____
Address: _____ _____	Owner: _____
	Date Installed: _____

Proposed substitution affects other parts of Work: ☐ No ☐ Yes; Explain _____

Savings to Owner for accepting substitution: _____ (\$ _____)

Proposed substitution changes Contract Time: ☐ No ☐ Yes (Add) (Deduct) _____ days

Supporting Data Attached: ☐ Drawings ☐ Product Data ☐ Samples ☐ Tests ☐ Reports ☐ _____

PRODUCT SUBSTITUTION
REQUEST FORM
(Continued)

The undersigned certifies:

- Proposed substitution has been fully investigated and determined to be equal or superior in all respects to specified product.
- Same warranty will be furnished for proposed substitution as for specified product.
- Same maintenance service and source of replacement parts, as applicable, is available.
- Proposed substitution will have no adverse effect on other trades and will not affect or delay progress schedule.
- Cost data as stated above is complete. Claims for additional costs related to accepted substitution which may subsequently become apparent are to be waived.
- Proposed substitution does not affect dimensions and functional clearances.
- Payment will be made for changes to building design, including A/E design, detailing, and construction costs caused by substitution.
- Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

Submitted By: _____ Signed : _____

Firm: _____ Address: _____

Phone: _____

Attachments: _____

A/E's REVIEW & ACTION

- ☐ Substitution approved – Make submittals in accordance with Project Manual requirements.
- ☐ Substitution approved as noted – Make submittals in accordance with Project Manual requirements.
- ☐ Substitution rejected – Use specified materials.
- ☐ Substitution Request received too late – Use specified materials.

A/E Signature: _____ Date: _____

Additional Comments: ☐ Contractor ☐ Subcontractor ☐ Supplier ☐ Manufacturer ☐ A/E ☐ _____

END OF REQUEST FORM

SECTION 01 70 00
EXECUTION REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Examination, preparation, and general installation procedures.
- B. Pre-installation meetings.
- C. Cutting and patching.
- D. Surveying for laying out the work.
- E. Cleaning and protection.
- F. Starting of systems and equipment.
- G. Demonstration and instruction of Owner personnel.
- H. Closeout procedures, except payment procedures.

1.02 RELATED SECTIONS

- A. Section 01 30 00 - Administrative Requirements: Submittals procedures.
- B. Section 01 40 00 - Quality Requirements: Testing and inspection procedures.
- C. Section 01 50 00 - Temporary Facilities and Controls: Temporary exterior enclosures.
- D. Section 01 78 00 - Closeout Submittals: Project record documents, operation and maintenance data, warranties and bonds.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Survey work: Submit name, address, and telephone number of Surveyor before starting survey work.
 - 1. On request, submit documentation verifying accuracy of survey work.
 - 2. Submit a copy of site drawing signed by the Land Surveyor, that the elevations and locations of the work are in conformance with Contract Documents.
 - 3. Submit surveys and survey logs for the project record.
- C. Cutting and Patching: Submit written request in advance of cutting or alteration which affects:
 - 1. Structural integrity of any element of Project.
 - 2. Integrity of weather exposed or moisture resistant element.
 - 3. Efficiency, maintenance, or safety of any operational element.
 - 4. Visual qualities of sight exposed elements.
 - 5. Work of Owner or separate Contractor.
 - 6. Include in request:
 - a. Identification of Project.
 - b. Location and description of affected work.
 - c. Necessity for cutting or alteration.
 - d. Description of proposed work and products to be used.
 - e. Alternatives to cutting and patching.
 - f. Effect on work of Owner or separate Contractor.
 - g. Written permission of affected separate Contractor.
 - h. Date and time work will be executed.

- D. Project Record Documents: Accurately record actual locations of capped and active utilities.

1.04 QUALIFICATIONS

- A. For survey work, employ a land surveyor registered in the State in which the Project is located and acceptable to Architect. Submit evidence of Surveyor's Errors and Omissions insurance coverage in the form of an Insurance Certificate.
- B. For field engineering, employ a professional engineer of the discipline required for specific service on Project, licensed in the State in which the Project is located.

1.05 PROJECT CONDITIONS

- A. Grade site to drain. Maintain excavations free of water. Provide, operate, and maintain pumping equipment.
- B. Protect site from puddling or running water. Provide water barriers as required to protect site from soil erosion.
- C. Ventilate enclosed areas to assist cure of materials, to dissipate humidity, and to prevent accumulation of dust, fumes, vapors, or gases.
- D. Dust Control: Execute work by methods to minimize raising dust from construction operations. Provide positive means to prevent air-borne dust from dispersing into atmosphere.
- E. Erosion and Sediment Control: Plan and execute work by methods to control surface drainage from cuts and fills, from borrow and waste disposal areas. Prevent erosion and sedimentation.
 - 1. Minimize amount of bare soil exposed at one time.
 - 2. Provide temporary measures such as berms, dikes, and drains, to prevent water flow.
 - 3. Construct fill and waste areas by selective placement to avoid erosive surface silts or clays.
 - 4. Periodically inspect earthwork to detect evidence of erosion and sedimentation; promptly apply corrective measures.
- F. Noise Control: Provide methods, means, and facilities to minimize noise produced by construction operations.
- G. Pest Control: Provide methods, means, and facilities to prevent pests and insects from damaging the work.
- H. Rodent Control: Provide methods, means, and facilities to prevent rodents from accessing or invading premises.
- I. Pollution Control: Provide methods, means, and facilities to prevent contamination of soil, water, and atmosphere from discharge of noxious, toxic substances, and pollutants produced by construction operations.

1.06 COORDINATION

- A. Coordinate scheduling, submittals, and work of the various sections of the Project Manual to ensure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.
- B. Notify affected utility companies and comply with their requirements.
- C. Verify that utility requirements and characteristics of new operating equipment are compatible with building utilities. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.

- D. Coordinate space requirements, supports, and installation of mechanical and electrical work which are indicated diagrammatically on Drawings. Follow routing shown for pipes, ducts, and conduit, as closely as practicable; place runs parallel with lines of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
- E. In finished areas except as otherwise indicated, conceal pipes, ducts, and wiring within the construction. Coordinate locations of fixtures and outlets with finish elements.
- F. Coordinate completion and clean-up of work of separate sections.
- G. After Owner occupancy of premises, coordinate access to site for correction of defective work and work not in accordance with Contract Documents, to minimize disruption of Owner's activities.

PART 2 PRODUCTS

2.01 PATCHING MATERIALS

- A. New Materials: As specified in product sections; match existing products and work for patching and extending work.
- B. Type and Quality of Existing Products: Determine by inspecting and testing products where necessary, referring to existing work as a standard.
- C. Product Substitution: For any proposed change in materials, submit request for substitution described in Section 01 60 00.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that existing site conditions and substrate surfaces are acceptable for subsequent work. Start of work means acceptance of existing conditions.
- B. Verify that existing substrate is capable of structural support or attachment of new work being applied or attached.
- C. Examine and verify specific conditions described in individual specification sections.
- D. Take field measurements before confirming product orders or beginning fabrication, to minimize waste due to over-ordering or misfabrication.
- E. Verify that utility services are available, of the correct characteristics, and in the correct locations.
- F. Prior to Cutting: Examine existing conditions prior to commencing work, including elements subject to damage or movement during cutting and patching. After uncovering existing work, assess conditions affecting performance of work. Beginning of cutting or patching means acceptance of existing conditions.

3.02 PREPARATION

- A. Clean substrate surfaces prior to applying next material or substance.
- B. Seal cracks or openings of substrate prior to applying next material or substance.
- C. Apply manufacturer required or recommended substrate primer, sealer, or conditioner prior to applying any new material or substance in contact or bond.

3.03 PREINSTALLATION MEETINGS

- A. When required in individual specification sections, convene a preinstallation meeting at the site prior to commencing work of the section.
- B. Require attendance of parties directly affecting, or affected by, work of the specific section.
- C. Notify Architect four days in advance of meeting date.
- D. Prepare agenda and preside at meeting:
 - 1. Review conditions of examination, preparation and installation procedures.
 - 2. Review coordination with related 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.

3.04 LAYING OUT THE WORK

- A. Verify locations of survey control points prior to starting work.
- B. Promptly notify Architect of any discrepancies discovered.
- C. Contractor shall locate and protect survey control and reference points.
- D. Control datum for survey is that indicated on Drawings.
- E. Protect survey control points prior to starting site work; preserve permanent reference points during construction.
- F. Promptly report to Architect the loss or destruction of any reference point or relocation required because of changes in grades or other reasons.
- G. Replace dislocated survey control points based on original survey control. Make no changes without prior written notice to Architect.
- H. Utilize recognized engineering survey practices.
- I. Establish a minimum of two permanent bench marks on site, referenced to established control points. Record locations, with horizontal and vertical data, on project record documents.
- J. Establish elevations, lines and levels. Locate and lay out by instrumentation and similar appropriate means:
 - 1. Site improvements including pavements; stakes for grading, fill and topsoil placement; utility locations, slopes, and invert elevations.
 - 2. Grid or axis for structures.
 - 3. Building foundation, column locations, ground floor elevations.
- K. Periodically verify layouts by same means.
- L. Maintain a complete and accurate log of control and survey work as it progresses.
- M. On completion of foundation walls and major site improvements, prepare a certified survey illustrating dimensions, locations, angles, and elevations of construction and site work.

3.05 GENERAL INSTALLATION REQUIREMENTS

- A. Install products as specified in individual sections, in accordance with manufacturer's instructions and recommendations, and so as to avoid waste due to necessity for replacement.
- B. Make vertical elements plumb and horizontal elements level, unless otherwise indicated.
- C. Install equipment and fittings plumb and level, neatly aligned with adjacent vertical and horizontal lines, unless otherwise indicated.
- D. Make consistent texture on surfaces, with seamless transitions, unless otherwise indicated.

- E. Make neat transitions between different surfaces, maintaining texture and appearance.

3.06 CUTTING AND PATCHING

- A. Execute cutting and patching including excavation and fill to complete the work, to uncover work in order to install improperly sequenced work, to remove and replace defective or non-conforming work, to remove samples of installed work for testing when requested, to provide openings in the work for penetration of mechanical and electrical work, to execute patching to complement adjacent work, and to fit products together to integrate with other work.
- B. Execute work by methods to avoid damage to other work, and which will provide appropriate surfaces to receive patching and finishing. In existing work, minimize damage and restore to original condition.
- C. Employ original installer to perform cutting for weather exposed and moisture resistant elements, and sight exposed surfaces.
- D. Cut rigid materials using masonry saw or core drill. Pneumatic tools not allowed without prior approval.
- E. Restore work with new products in accordance with requirements of Contract Documents.
- F. Fit work air tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
- G. At penetrations of fire rated walls, partitions, ceiling, or floor construction, completely seal voids with fire rated material in accordance with Section 07 84 00, to full thickness of the penetrated element.
- H. Refinish surfaces to match adjacent finish. For continuous surfaces, refinish to nearest intersection or natural break. For an assembly, refinish entire unit.
- I. Make neat transitions. Patch work to match adjacent work in texture and appearance. Where new work abuts or aligns with existing, perform a smooth and even transition.
- J. Patch or replace surfaces that are damaged, lifted, discolored, or showing other imperfections due to patching work. Repair substrate prior to patching finish. Finish patches to produce uniform finish and texture over entire area. When finish cannot be matched, refinish entire surface to nearest intersections.

3.07 PROGRESS CLEANING

- A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition.
- B. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces, and other closed or remote spaces, prior to enclosing the space.
- C. Broom and vacuum clean interior areas prior to start of surface finishing, and continue cleaning to eliminate dust.
- D. Collect and remove waste materials, debris, and trash/rubbish from site periodically and dispose off-site; do not burn or bury.

3.08 PROTECTION OF INSTALLED WORK

- A. Protect installed work from damage by construction operations.
- B. Provide special protection where specified in individual specification sections.
- C. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.
- D. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.

- E. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.
- F. Prohibit traffic or storage upon waterproofed or roofed surfaces. If traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.
- G. Prohibit traffic from landscaped areas.
- H. Remove protective coverings when no longer needed; reuse or recycle plastic coverings if possible.

3.09 STARTING SYSTEMS

- A. Coordinate schedule for start-up of various equipment and systems.
- B. Notify Architect and owner seven days prior to start-up of each item.
- C. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions which may cause damage.
- D. Verify tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.
- E. Verify that wiring and support components for equipment are complete and tested.
- F. Execute start-up under supervision of applicable Contractor personnel and manufacturer's representative in accordance with manufacturers' instructions.
- G. When specified in individual specification Sections, require manufacturer to provide authorized representative to be present at site to inspect, check, and approve equipment or system installation prior to start-up, and to supervise placing equipment or system in operation.
- H. Submit a written report that equipment or system has been properly installed and is functioning correctly.

3.10 DEMONSTRATION AND INSTRUCTION

- A. Demonstrate operation and maintenance of products to Owner's personnel two weeks prior to date of Substantial Completion.
- B. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at scheduled time, at equipment location.
- C. For equipment or systems requiring seasonal operation, perform demonstration for other season within six months.
- D. Provide a qualified person who is knowledgeable about the Project to perform demonstration and instruction of owner personnel.
- E. Utilize operation and maintenance manuals as basis for instruction. Review contents of manual with Owner's personnel in detail to explain all aspects of operation and maintenance.
- F. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.

3.11 ADJUSTING

- A. Adjust operating products and equipment to ensure smooth and unhindered operation.
- B. Testing, adjusting, and balancing HVAC systems: See applicable Division 23 sections.

3.12 FINAL CLEANING

- A. Execute final cleaning prior to Substantial Completion.
 - 1. Clean areas to be occupied by Owner prior to final completion before Owner occupancy.
- B. Use cleaning materials that are nonhazardous.
- C. Clean interior and exterior glass, surfaces exposed to view; remove temporary labels, stains and foreign substances, polish transparent and glossy surfaces, vacuum carpeted and soft surfaces.
- D. Clean equipment and fixtures to a sanitary condition with cleaning materials appropriate to the surface and material being cleaned.
- E. Clean filters of operating equipment.
- F. Clean debris from roofs, gutters, downspouts, and drainage systems.
- G. Clean site; sweep paved areas, rake clean landscaped surfaces.
- H. Remove waste, surplus materials, trash/rubbish, and construction facilities from the site; dispose of in legal manner; do not burn or bury.

3.13 CLOSEOUT PROCEDURES

- A. Make submittals that are required by governing or other authorities.
 - 1. Provide copies to Architect and Owner.
- B. Accompany Architect and Owner on preliminary inspection to determine items to be listed for completion or correction in Contractor's Notice of Substantial Completion.
- C. Notify Architect when work is considered ready for Substantial Completion.
- D. Submit written certification that Contract Documents have been reviewed, work has been inspected, and that work is complete in accordance with Contract Documents and ready for Architect's review.
- E. Owner will occupy all of the building as specified in Section 01 10 00.
- F. Correct items of work listed in executed Certificates of Substantial Completion and comply with requirements for access to Owner-occupied areas.
- G. Accompany Architect and Owner on preliminary final inspection.
- H. Notify Architect when work is considered finally complete.
- I. Complete items of work determined by Architect's final inspection.

3.14 MAINTENANCE SERVICE

- A. Furnish service and maintenance of components indicated in specification sections.
- B. Examine system components at a frequency consistent with reliable operation. Clean, adjust, and lubricate as required.
- C. Include systematic examination, adjustment, and lubrication of components. Repair or replace parts whenever required. Use parts produced by the manufacturer of the original component.
- D. Maintenance service shall not be assigned or transferred to any agent or Subcontractor without prior written consent of the Owner.

END OF SECTION

SECTION 01 74 19

CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 GENERAL

1.01 WASTE MANAGEMENT REQUIREMENTS

- A. Owner requires that this project generate the least amount of trash and waste possible.
- B. Employ processes that ensure the generation of as little waste as possible due to error, poor planning, breakage, mishandling, contamination, or other factors.
- C. Minimize trash/waste disposal in landfills; reuse, salvage, or recycle as much waste as economically feasible.
- D. Owner may decide to pay for additional recycling, salvage, and/or reuse based on Landfill Alternatives Proposal specified below.
- E. Contractor shall submit periodic Waste Disposal Reports; all landfill disposal, incineration, recycling, salvage, and reuse must be reported regardless of to whom the cost or savings accrues; use the same units of measure on all reports.
- F. Contractor shall develop and follow a Waste Management Plan designed to implement these requirements.
- G. Methods of trash/waste disposal that are not acceptable are:
 - 1. Burning on the project site.
 - 2. Burying on the project site.
 - 3. Dumping or burying on other property, public or private.
 - 4. Other illegal dumping or burying.
- H. Regulatory Requirements: Contractor is responsible for knowing and complying with regulatory requirements, including but not limited to Federal, State and local requirements, pertaining to legal disposal of all construction and demolition waste materials.

1.02 DEFINITIONS

- A. Clean: Untreated and unpainted; not contaminated with oils, solvents, caulk, or the like.
- B. Construction and Demolition Waste: Solid wastes typically including building materials, packaging, trash, debris, and rubble resulting from construction, remodeling, repair and demolition operations.
- C. Hazardous: Exhibiting the characteristics of hazardous substances, i.e., ignitibility, corrosivity, toxicity or reactivity.
- D. Nonhazardous: Exhibiting none of the characteristics of hazardous substances, i.e., ignitibility, corrosivity, toxicity, or reactivity.
- E. Nontoxic: Neither immediately poisonous to humans nor poisonous after a long period of exposure.
- F. Recyclable: The ability of a product or material to be recovered at the end of its life cycle and remanufactured into a new product for reuse by others.
- G. Recycle: To remove a waste material from the project site to another site for remanufacture into a new product for reuse by others.

- H. Recycling: The process of sorting, cleansing, treating and reconstituting solid waste and other discarded materials for the purpose of using the altered form. Recycling does not include burning, incinerating, or thermally destroying waste.
- I. Return: To give back reusable items or unused products to vendors for credit.
- J. Reuse: To reuse a construction waste material in some manner on the project site.
- K. Salvage: To remove a waste material from the project site to another site for resale or reuse by others.
- L. Sediment: Soil and other debris that has been eroded and transported by storm or well production run-off water.
- M. Source Separation: The act of keeping different types of waste materials separate beginning from the first time they become waste.
- N. Toxic: Poisonous to humans either immediately or after a long period of exposure.
- O. Trash: Any product or material unable to be reused, returned, recycled, or salvaged.
- P. Waste: Extra material or material that has reached the end of its useful life in its intended use. Waste includes salvageable, returnable, recyclable, and reusable material.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Landfill Alternatives Proposal: Within 10 calendar days after receipt of Notice of Award of Bid, or prior to any trash or waste removal, whichever occurs sooner, submit a projection of trash/waste that will require disposal and alternatives to landfilling, with net costs.
 - 1. Submit to Architect for Owner's review and approval.
 - 2. If Owner wishes to implement any cost alternatives, the Contract Sum will be adjusted as specified elsewhere.
 - 3. Include an analysis of trash/waste to be generated and landfill options as specified for Waste Management Plan described below.
 - 4. Describe as many alternatives to landfilling as possible:
 - a. List each material proposed to be salvaged, reused, or recycled.
 - b. List the proposed local market for each material.
 - c. State the estimated net cost resulting from each alternative, after subtracting revenue from sale of recycled or salvaged materials and landfill tipping fees saved due to diversion of materials from the landfill.
 - 5. Provide alternatives to landfilling for at least the following materials:
 - a. Aluminum and plastic beverage containers.
 - b. Corrugated cardboard.
 - c. Wood pallets.
 - d. Clean dimensional wood.
 - e. Land clearing debris, including brush, branches, logs, and stumps.
 - f. Concrete.
 - g. Bricks.
 - h. Concrete masonry units.
 - i. Asphalt paving.
 - j. Metals, including packaging banding, metal studs, sheet metal, structural steel, piping, reinforcing bars, door frames, and other items made of steel, iron, galvanized steel, stainless steel, aluminum, copper, zinc, lead, brass, and bronze.
 - k. Glass.
 - l. Plastic buckets.
 - m. Carpet, carpet cushion, carpet tile, and carpet remnants, both new and removed:

- DuPont (<http://flooring.dupont.com>) and Interface (www.interfaceinc.com) conduct reclamation programs.
- n. Paint.
 - o. Plastic sheeting.
 - p. Rigid foam insulation.
 - q. Acoustical ceiling tile and panels.
- C. Once Owner has determined which of the landfill alternatives addressed in the Proposal above are acceptable, prepare and submit Waste Management Plan; submit within 10 calendar days after notification by Architect.
- D. Waste Management Plan: Include the following information:
- 1. Analysis of the trash and waste projected to be generated during the entire project construction cycle, including types and quantities.
 - 2. Landfill Options: The name, address, and telephone number of the landfill(s) where trash/waste will be disposed of, the applicable landfill tipping fee(s), and the projected cost of disposing of all project trash/waste in the landfill(s).
 - 3. Landfill Alternatives: List all waste materials that will be diverted from landfills by reuse, salvage, or recycling.
 - 4. Meetings: Describe regular meetings to be held to address waste prevention, reduction, recycling, salvage, reuse, and disposal.
 - 5. Materials Handling Procedures: Describe the means by which materials to be diverted from landfills will be protected from contamination and prepared for acceptance by designated facilities; include separation procedures for recyclables, storage, and packaging.
 - 6. Transportation: Identify the destination and means of transportation of materials to be recycled; i.e. whether materials will be site-separated and self-hauled to designated centers, or whether mixed materials will be collected by a waste hauler.
- E. Waste Disposal Reports: Submit at specified intervals, with details of quantities of trash and waste, means of disposal or reuse, and costs; show both totals to date and since last report.
- 1. Submit updated Report with each Application for Progress Payment; failure to submit Report will delay payment.
 - 2. Submit Report on a form acceptable to Owner.
 - 3. Landfill Disposal: Include the following information:
 - a. Identification of material.
 - b. Amount, in tons or cubic yards, of trash/waste material from the project disposed of in landfills.
 - c. State the identity of landfills, total amount of tipping fees paid to landfill, and total disposal cost.
 - d. Include manifests, weight tickets, receipts, and invoices as evidence of quantity and cost.
 - 4. Incinerator Disposal: Include the following information:
 - a. Identification of material.
 - b. Amount, in tons or cubic yards, of trash/waste material from the project delivered to incinerators.
 - c. State the identity of incinerators, total amount of fees paid to incinerator, and total disposal cost.
 - d. Include manifests, weight tickets, receipts, and invoices as evidence of quantity and cost.
 - 5. Recycled and Salvaged Materials: Include the following information for each:
 - a. Identification of material, including those retrieved by installer for use on other projects.
 - b. Amount, in tons or cubic yards, date removed from the project site, and receiving party.
 - c. Transportation cost, amount paid or received for the material, and the net total cost or savings of salvage or recycling each material.

- d. Include manifests, weight tickets, receipts, and invoices as evidence of quantity and cost.
 - e. Certification by receiving party that materials will not be disposed of in landfills or by incineration.
- 6. Material Reused on Project: Include the following information for each:
 - a. Identification of material and how it was used in the project.
 - b. Amount, in tons or cubic yards.
 - c. Include weight tickets as evidence of quantity.
- 7. Other Disposal Methods: Include information similar to that described above, as appropriate to disposal method.

PART 2 PRODUCTS

2.01 PRODUCT SUBSTITUTIONS

- A. See Section 01 60 00 - Product Requirements for substitution submission procedures.
- B. For each proposed product substitution, submit the following information in addition to requirements specified in Section 01 60 00:
 - 1. Relative amount of waste produced, compared to specified product.
 - 2. Cost savings on waste disposal, compared to specified product, to be deducted from the Contract Sum.
 - 3. Proposed disposal method for waste product.
 - 4. Markets for recycled waste product.

PART 3 EXECUTION

3.01 WASTE MANAGEMENT PROCEDURES

- A. See Section 01 30 00 for additional requirements for project meetings, reports, submittal procedures, and project documentation.
- B. See Section 01 50 00 for additional requirements related to trash/waste collection and removal facilities and services.
- C. See Section 01 60 00 for waste prevention requirements related to delivery, storage, and handling.
- D. See Section 01 70 00 for trash/waste prevention procedures related to demolition, cutting and patching, installation, protection, and cleaning.

3.02 WASTE MANAGEMENT PLAN IMPLEMENTATION

- A. Manager: Designate an on-site person or persons responsible for instructing workers and overseeing and documenting results of the Waste Management Plan.
- B. Communication: Distribute copies of the Waste Management Plan to job site foreman, each subcontractor, Owner, and Architect.
- C. Instruction: Provide on-site instruction of appropriate separation, handling, and recycling, salvage, reuse, and return methods to be used by all parties at the appropriate stages of the project.
- D. Meetings: Discuss trash/waste management goals and issues at project meetings.
 - 1. Pre-bid meeting.
 - 2. Pre-construction meeting.
 - 3. Regular job-site meetings.

- E. Facilities: Provide specific facilities for separation and storage of materials for recycling, salvage, reuse, return, and trash disposal, for use by all contractors and installers.
 - 1. Provide containers as required.
 - 2. Provide adequate space for pick-up and delivery and convenience to subcontractors.
 - 3. Keep recycling and trash/waste bin areas neat and clean and clearly marked in order to avoid contamination of materials.
- F. Hazardous Wastes: Separate, store, and dispose of hazardous wastes according to applicable regulations.
- G. Recycling: Separate, store, protect, and handle at the site identified recyclable waste products in order to prevent contamination of materials and to maximize recyclability of identified materials. Arrange for timely pickups from the site or deliveries to recycling facility in order to prevent contamination of recyclable materials.
- H. Reuse of Materials On-Site: Set aside, sort, and protect separated products in preparation for reuse.
- I. Salvage: Set aside, sort, and protect products to be salvaged for reuse off-site.

END OF SECTION

SECTION 01 78 00

CLOSEOUT SUBMITTALS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Project Record Documents.
- B. Operation and Maintenance Data.
- C. Warranties and bonds.

1.02 RELATED SECTIONS

- A. Section 01 30 00 - Administrative Requirements: Submittals procedures, shop drawings, product data, and samples.
- B. Section 01 70 00 - Execution Requirements: Contract closeout procedures.
- C. Individual Product Sections: Specific requirements for operation and maintenance data.
- D. Individual Product Sections: Warranties required for specific products or Work.

1.03 SUBMITTALS

- A. Project Record Documents: Submit documents to Architect with claim for final Application for Payment.
- B. Operation and Maintenance Data:
 - 1. Submit two copies of preliminary draft or proposed formats and outlines of contents before start of Work. Architect will review draft and return one copy with comments.
 - 2. For equipment, or component parts of equipment put into service during construction and to be operated by Owner, submit completed documents within ten days after acceptance.
 - 3. Submit 1 copy of completed documents 15 days prior to final inspection. This copy will be reviewed and returned after final inspection, with Architect comments. Revise content of all document sets as required prior to final submission.
 - 4. Submit two sets of revised final documents in final form within 10 days after final inspection.
- C. Warranties and Bonds:
 - 1. For equipment or component parts of equipment put into service during construction with Owner's permission, submit documents within ten days after acceptance.
 - 2. Make other submittals within ten days after Date of Substantial Completion, prior to final Application for Payment.
 - 3. For items of Work for which acceptance is delayed beyond Date of Substantial Completion, submit within ten days after acceptance, listing the date of acceptance as the beginning of the warranty period.

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. Specifications.

3. Addenda.
 4. Change Orders and other modifications to the Contract.
 5. Reviewed shop drawings, product data, and samples.
 6. Manufacturer's instruction for assembly, installation, and adjusting.
- 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. Specifications: Legibly mark and record at each product section description of actual products installed, including the following:
1. Manufacturer's name and product model and number.
 2. Product substitutions or alternates utilized.
 3. Changes made by Addenda and modifications.
- F. Record Drawings: Legibly mark each item to record actual construction including:
1. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
 2. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
 3. Field changes of dimension and detail.
 4. Details not on original Contract drawings.

3.02 OPERATION AND MAINTENANCE DATA

- A. For Each Product or System: List names, addresses and telephone numbers of Subcontractors and suppliers, including local source of supplies and replacement parts.
- B. Product Data: Mark each sheet to clearly identify specific products and component parts, and data applicable to installation. Delete inapplicable information.
- C. Drawings: Supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams. Do not use Project Record Documents as maintenance drawings.
- D. Typed Text: As required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions.

3.03 OPERATION AND MAINTENANCE DATA FOR MATERIALS AND FINISHES

- A. For Each Product, Applied Material, and Finish:
1. Product data, with catalog number, size, composition, and color and texture designations.
 2. Information for re-ordering custom manufactured products.
- B. Instructions for Care and Maintenance: Manufacturer's recommendations for cleaning agents and methods, precautions against detrimental cleaning agents and methods, and recommended schedule for cleaning and maintenance.
- C. Additional information as specified in individual product specification sections.
- D. Provide a listing in Table of Contents for design data, with tabbed fly sheet and space for insertion of data.

3.04 OPERATION AND MAINTENANCE DATA FOR EQUIPMENT AND SYSTEMS

- A. For Each Item of Equipment and Each System:
1. Description of unit or system, and component parts.
 2. Identify function, normal operating characteristics, and limiting conditions.
 3. Include performance curves, with engineering data and tests.
 4. Complete nomenclature and model number of replaceable parts.

- B. Panelboard Circuit Directories: Provide electrical service characteristics, controls, and communications; typed.
- C. Operating Procedures: Include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and any special operating instructions.
- D. Maintenance Requirements: Include routine procedures and guide for preventative maintenance and trouble shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
- E. Provide servicing and lubrication schedule, and list of lubricants required.
- F. Include manufacturer's printed operation and maintenance instructions.
- G. Include sequence of operation by controls manufacturer.
- H. Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
- I. Include test and balancing reports.
- J. Additional Requirements: As specified in individual product specification sections.

3.05 OPERATION AND MAINTENANCE MANUALS

- A. Prepare instructions and data by personnel experienced in maintenance and operation of described products.
- B. Prepare data in the form of an instructional manual.
- C. Binders: Commercial quality, 8-1/2 x 11 inch three D side ring binders with durable plastic covers; 2 inch maximum ring size. When multiple binders are used, correlate data into related consistent groupings.
- D. Cover: Identify each binder with typed or printed title OPERATION AND MAINTENANCE INSTRUCTIONS; identify title of Project; identify subject matter of contents.
- E. Provide tabbed dividers for each separate product and system, with typed description of product and major component parts of equipment.
- F. Text: Manufacturer's printed data, or typewritten data on 24 pound paper.
- G. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.
- H. Arrange content by systems under section numbers and sequence of Table of Contents of this Project Manual.
- I. Contents: Prepare a Table of Contents for each volume, with each product or system description identified, in three parts as follows:
 - 1. Part 1: Directory, listing names, addresses, and telephone numbers of Architect, Contractor, Subcontractors, and major equipment suppliers.
 - 2. Part 2: Operation and maintenance instructions, arranged by system and subdivided by specification section number. For each category, identify names, addresses, and telephone numbers of Subcontractors and suppliers. Identify the following:
 - a. Significant design criteria.
 - b. List of equipment.
 - c. Parts list for each component.
 - d. Operating instructions.
 - e. Maintenance instructions for equipment and systems.
 - f. Maintenance instructions for special finishes, including recommended cleaning methods and materials, and special precautions identifying detrimental agents.

3. Part 3: Project documents and certificates, including the following:
 - a. Shop drawings and product data.
 - b. Air and water balance reports.
 - c. Certificates.
 - d. Photocopies of warranties and bonds.
- J. Provide a listing in Table of Contents for design data, with tabbed dividers and space for insertion of data.
- K. Table of Contents: Provide title of Project; names, addresses, and telephone numbers of Architect, Consultants, and Contractor with name of responsible parties; schedule of products and systems, indexed to content of the volume.

3.06 WARRANTIES AND BONDS

- A. Obtain warranties and bonds, executed in duplicate by responsible Subcontractors, suppliers, and manufacturers, within ten 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 the 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.
- E. Manual: Bind in commercial quality 8-1/2 x 11 inch three D side ring binders with durable plastic covers.
- F. Cover: Identify each binder with typed or printed title WARRANTIES AND BONDS, with title of Project; name, address and telephone number of Contractor and equipment supplier; and name of responsible company principal.
- G. Table of Contents: Neatly typed, in the sequence of the Table of Contents of the Project Manual, with each item identified with the number and title of the specification section in which specified, and the name of product or work item.
- H. Separate each warranty or bond with index tab sheets keyed to the Table of Contents listing. Provide full information, using separate typed sheets as necessary. List Subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.

END OF SECTION

SECTION 01 79 00
DEMONSTRATION AND TRAINING

PART 1 GENERAL

1.01 SUMMARY

- A. Demonstration of products and systems where indicated in specific specification sections.
- B. Training of Owner personnel in operation and maintenance is required for:
 - 1. All software-operated systems.
 - 2. HVAC systems and equipment.
 - 3. Plumbing equipment.
 - 4. Electrical systems and equipment.
 - 5. Conveying systems.
 - 6. Items specified in individual product Sections.

1.02 RELATED SECTIONS

- A. Section 01 78 00 - Closeout Submittals: Operation and maintenance manuals.
- B. Other Specification Sections: Additional requirements for demonstration and training.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Training Plan: Owner will designate personnel to be trained; tailor training to needs and skill-level of attendees.
 - 1. Submit to Architect for transmittal to Owner.
 - 2. Submit not less than four weeks prior to start of training.
 - 3. Revise and resubmit until acceptable.
 - 4. Provide an overall schedule showing all training sessions.
 - 5. Include at least the following for each training session:
 - a. Identification, date, time, and duration.
 - b. Description of products and/or systems to be covered.
 - c. Name of firm and person conducting training; include qualifications.
 - d. Intended audience, such as job description.
 - e. Objectives of training and suggested methods of ensuring adequate training.
 - f. Methods to be used, such as classroom lecture, live demonstrations, hands-on, etc.
 - g. Media to be used, such as slides, hand-outs, etc.
 - h. Training equipment required, such as projector, projection screen, etc., to be provided by Contractor.
- C. Training Manuals: Provide training manual for each attendee; allow for minimum of two attendees per training session.
 - 1. Include applicable portion of O&M manuals.
 - 2. Include copies of all hand-outs, slides, overheads, video presentations, etc., that are not included in O&M manuals.
 - 3. Provide one extra copy of each training manual to be included with operation and maintenance data.
- D. Video Recordings: Submit digital video recording of each demonstration and training session for Owner's subsequent use.
 - 1. Format: DVD Disc.
 - 2. Label each disc and container with session identification and date.

1.04 QUALITY ASSURANCE

- A. Instructor Qualifications: Familiar with design, operation, maintenance and troubleshooting of the relevant products and systems.
 - 1. Provide as instructors the most qualified trainer of those contractors and/or installers who actually supplied and installed the systems and equipment.
 - 2. Where a single person is not familiar with all aspects, provide specialists with necessary qualifications.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 DEMONSTRATION - GENERAL

- A. Demonstrations conducted during system start-up do not qualify as demonstrations for the purposes of this section, unless approved in advance by Owner.
- B. Demonstration may be combined with Owner personnel training if applicable.
- C. Operating Equipment and Systems: Demonstrate operation in all modes, including start-up, shut-down, seasonal changeover, emergency conditions, and troubleshooting, and maintenance procedures, including scheduled and preventive maintenance.
 - 1. Perform demonstrations not less than two weeks prior to Substantial Completion.
 - 2. For equipment or systems requiring seasonal operation, perform demonstration for other season within six months.
- D. Non-Operating Products: Demonstrate cleaning, scheduled and preventive maintenance, and repair procedures.
 - 1. Perform demonstrations not less than two weeks prior to Substantial Completion.

3.02 TRAINING - GENERAL

- A. Conduct training on-site unless otherwise indicated.
- B. Owner will provide classroom and seating at no cost to Contractor.
- C. Training schedule will be subject to availability of Owner's personnel to be trained; re-schedule training sessions as required by Owner; once schedule has been approved by Owner failure to conduct sessions according to schedule will be cause for Owner to charge Contractor for personnel "show-up" time.
- D. Review of Facility Policy on Operation and Maintenance Data: During training discuss:
 - 1. The location of the O&M manuals and procedures for use and preservation; backup copies.
 - 2. Typical contents and organization of all manuals, including explanatory information, system narratives, and product specific information.
 - 3. Typical uses of the O&M manuals.
- E. Product- and System-Specific Training:
 - 1. Review the applicable O&M manuals.
 - 2. For systems, provide an overview of system operation, design parameters and constraints, and operational strategies.
 - 3. Review instructions for proper operation in all modes, including start-up, shut-down, seasonal changeover and emergency procedures, and for maintenance, including preventative maintenance.
 - 4. Provide hands-on training on all operational modes possible and preventive maintenance.

5. Emphasize safe and proper operating requirements; discuss relevant health and safety issues and emergency procedures.
 6. Discuss common troubleshooting problems and solutions.
 7. Discuss any peculiarities of equipment installation or operation.
 8. Discuss warranties and guarantees, including procedures necessary to avoid voiding coverage.
 9. Review recommended tools and spare parts inventory suggestions of manufacturers.
 10. Review spare parts and tools required to be furnished by Contractor.
 11. Review spare parts suppliers and sources and procurement procedures.
- F. Be prepared to answer questions raised by training attendees; if unable to answer during training session, provide written response within three days.

END OF SECTION

SECTION 03 10 00
CONCRETE FORMWORK

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.02 DESCRIPTION OF WORK

- A. The work of this section includes all labor, materials and equipment required to form all cast-in-place concrete shown on the drawings including but not limited to all slabs, joists, beams, columns, walls, stairs, and equipment pads.

1.03 CODES AND STANDARDS

- A. Comply with the provision of the following codes, specifications and standards except where more stringent requirements are shown or specified:

1. ACI 301 "Specifications for Structural Concrete for Buildings"
2. ACI 318 "Building Code Requirements for Reinforced Concrete"
3. ACI 117 "Specifications for Tolerances for Concrete Construction and Materials".
4. Concrete Reinforcing Steel Institute "Manual of Standard Practice"

1.04 RESPONSIBILITY

- A. The design, construction and safety of all formwork shall be the responsibility of the General Contractor. All forms, shores, backshores, falsework, bracing, and other temporary supports shall be engineered to support all loads imposed including the wet weight of concrete, construction equipment, live loads, lateral loads due to wind and wet concrete imbalance. The Contractor shall also be responsible for determining when temporary supports, shores, backshores, and other bracing may be safely removed.

1.05 DESIGN RESPONSIBILITY

- A. The design of all concrete formwork, formwork removal, shoring, and backshoring requirements shall be performed by a registered professional engineer in the state where the project is located and experienced in the design of concrete formwork. The Contractor shall employ the formwork engineer. Calculations, sealed by the registered professional engineer, shall be issued for Owner's record but will not be reviewed or returned.

1.06 SUBMITTALS

- A. Design Calculations: Submit for record calculations of all concrete formwork and the shoring plan sealed by a registered engineer in the state where the project is located.
- B. Formwork Drawings: Formwork Drawings, prepared under the supervision and sealed by a registered professional engineer in the state where the project is located, shall be submitted for Owners record and shall be reviewed by the Engineer for conformance to structural layout only. Such shop drawings shall indicate types of materials, sizes, lengths, connection details, design allowance for construction loads, anchors, form ties, shores, braces, construction joints, reveals, camber, openings, formwork coatings and all other pertinent information.

- C. Pan Form Shop Drawings: The Contractor shall submit pan shop drawings for Engineer's review and approval. Approval will be for conformance to structural layout only.
- D. Shoring Plan: Submit drawings to indicate the number of levels of shoring, proposed time and sequence of formwork and shore removal, minimum concrete strength for stripping of forms and shore removal, assumed construction loads, amount and layout of shores (specify whether backshores or reshores), and length of time shores are to be left in place. This plan shall be strictly followed by the Contractor. Shoring plans are to be submitted for Owner's record only and will not be reviewed or returned.

PART 2 PRODUCTS

2.01 PAN FORMS

- A. Specification: Unless specified otherwise, concrete joist construction shall conform to:

- 1. Manual of Standard Practice, Chapter 10, as published by CRSI.

- B. Material and Pan Type:

- 1. Material: Pans shall be fabricated either of steel that is free of dents, irregularities, sag and rust or of glass-fiber reinforced plastic that is molded under pressure with matched dies.
 - 2. New or Reconditioned Pans. Subject to pan tolerance and surface finish requirements below, pan joist forms may be either new pans or reconditioned pans at Contractor's option. Forms may be "long forms", "flange forms", "long flange forms", or "adjustable forms" at Contractor's option. Pan splices may be lapped, reinforced butt jointed, or semi-butt jointed (using end caps welded back-to-back with 2" maximum distance between pan ends). The maximum number of joints in any bay shall be four located at approximately the one-fifth points in each bay.

- C. Pan Tolerance and Surface Finish:

- 1. Pans shall be free of dents, surface irregularities, sag, rust, or stains. Pan forms allowing warped surfaces, leakage of concrete at joints, and uneven surfaces will not be acceptable.
 - 2. Discontinuities in the concrete surface at lapped splice or semi-butt joint splices (end caps welded back-to-back) shall not exceed 1/2" or the thickness of the form material, whichever is greater.
 - 3. The flatness of the formed concrete surface formed with pans shall not have a gradual or abrupt surface irregularity greater than a Class C surface (1/2"), as defined in ACI 347-94, Table 3.4.

2.02 FORMS FOR EXPOSED FINISH CONCRETE

Unless otherwise specified, formwork for exposed concrete surfaces shall consist of plywood, metal, metal framed plywood, or other acceptable surface. Formwork shall provide a continuous straight and smooth surface conforming to the joint system as specified on the Architect's drawings. Form material shall have sufficient thickness to withstand pressure of concrete without bow or deflection. Plywood shall be exterior grade overlaid plywood complying with U.S. Product Standard PS-1 and as follows:

- A. "B-B (Concrete Form) Plywood", Class 1, or better, mill-oiled and edge sealed.

Each piece shall bear a legible inspection trademark.

2.03 FORMS FOR UNEXPOSED FINISH CONCRETE

- A. Unless otherwise specified, formwork for unexposed concrete surfaces shall be constructed with plywood, lumber, metal or other acceptable material. Lumber shall be dressed on at least two edges and one side for tight fit.

2.04 FORMWORK COATINGS

- A. Formwork coatings shall be a commercial formulation that will not bond with, stain, nor adversely affect concrete surfaces or impair subsequent treatment of concrete surfaces requiring bond or adhesion, nor impede curing with water or curing compounds. Provide a product that has a maximum VOC (Volatile Organic Compounds) of 450 g/l but not greater than that permitted by the local government agency having jurisdiction in the area where the project is located.

Products: Subject to compliance with requirements, provide one of the following:

"Eucoslip VOX", Euclid Chemical Co.
"Enviroform", Conspec Marketing and Manufacturing Co., Inc.
"Cast-Off WB", Sonneborn Building Products

2.05 NAILS AND FASTENERS

- A. Use only galvanized nails and fasteners for securing formwork in structures exposed to weather or unconditioned spaces such as garages, canopies and porte-cocheres.

2.06 FORM TIES

Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

- A. Exposed Surfaces: Furnish units that will leave no corrodible metal closer than 1 inch to the plane of the exposed concrete surface. Furnish ties that, when removed, will leave holes not larger than 1 inch in diameter in concrete surface.
- B. Dampproofed Surfaces: Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.
- C. Exposed to Weather or Unconditioned Space: Provide galvanized form ties in surfaces that will be exposed to weather or in an unconditioned space in the final structure.

2.07 CHAMFER STRIPS

- A. Provide wood, metal, PVC, or rubber strips, $\frac{3}{4}$ by $\frac{3}{4}$ inch, minimum.

PART 3 EXECUTION

3.01 FABRICATION AND CONSTRUCTION

- A. Design, erect, support, brace and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic construction loads that might be applied until the concrete structure can support such loads.
- B. Construct formwork so concrete members and structures are of correct size, shape, alignment, elevation and position. Maintain formwork construction tolerances complying with ACI 117.

- C. Construct forms to sizes, shapes, lines and dimensions shown, and to obtain accurate alignment, location, grades, level and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts and other features required in work. Use selected materials to obtain required finishes. Solidly butt joints and provide back-up at joints to prevent leakage of cement paste.
- D. Construct forms so as to limit the offset between adjacent pieces of formwork facing material in accordance with the following classifications as defined in ACI 117. The offset limits shall apply to both abrupt and gradual variations in the surface.
1. Class A, 1/8 inch, for surfaces prominently exposed to public view in the completed structure.
 2. Class B, 1/4 inch, for surfaces scheduled to receive plaster, stucco, or wainscoting.
 3. Class C, 1/2 inch, for all other surfaces.
- E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical. Kerf wood inserts for forming keyways, reglets, recesses, and the like, to prevent swelling and for easy removal.
- F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
- G. Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete. Securely brace temporary openings and patch forms to prevent loss of concrete mortar. Locate temporary openings on forms at inconspicuous locations.
- H. Chamfer exposed corners and edges as indicated, using specified chamfer strips fabricated to produce uniform smooth lines and tight edge joints.
- I. Form Ties: Unless otherwise indicated, provide ties so portion remaining within concrete after removal is 1 1/2" inside concrete and will not leave holes larger than 1" diameter in concrete surface.
- J. Provisions for Other Trades: Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses and chases from trades providing such items. Accurately place and securely support items built into forms.
- K. Pan Form Fabrication and Construction:
1. Factory fabricate pan form units to specified sizes and shapes as indicated on the drawings. Units shall be designed for easy removal without damaging placed concrete. Units shall be properly shored and adjoining pan units shall be blocked if required to prevent lateral or vertical deflection of formwork during concrete placement.
- Discontinue ribs between two adjacent joists that have differences in span larger than 33%, between a joist and an adjacent parallel wall, and between a joist and an adjacent parallel beam that is 1 1/2 or more times wider than the joist.

3.02 CLEANING AND TIGHTENING

- A. Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and all other debris just prior to concrete placement. Retighten forms and bracing prior to concrete placement as required to prevent mortar leaks and maintain proper alignment.

3.03 CLEANING AND RE-USE OF FORMS

- A. Forms reused in the work shall be repaired and cleaned. Split, frayed, delaminated, or otherwise damaged facing material will not be acceptable for exposed surfaces. Forms intended for successive concrete placement shall have surfaces cleaned, fins and laitance removed, and joints tightened to avoid surface offsets. New form coating compound shall be applied to reused forms. Thin form-coating compounds only with thinning agent of type, and in amount, and under conditions of form-coating compound manufacturer's directions. Do not allow excess form-coating material to accumulate in forms or to come into contact with in-place concrete surfaces against which fresh concrete will be placed. Apply in compliance with manufacturer's instructions. Coat steel forms with a non-staining, rust-preventative form oil or otherwise protect against rusting. Rust-stained steel formwork is not acceptable.

3.04 TOLERANCES

- A. Unless specified otherwise, all tolerances for concrete formwork shall conform to ACI Standard 117, "Standard Tolerances for Concrete Construction and Materials". Before concrete placement the Contractor shall check lines and levels of erected formwork and make any corrections and adjustments as required to ensure proper size and location of concrete members and stability of forming systems. During concrete placement the Contractor shall check formwork and supports to ensure that forms have not displaced and that completed work will be within specified tolerances.
- B. Prior to each concrete pour, the Contractor shall engage a qualified surveyor to verify that work is within specified tolerances. The surveyor shall report in writing to the Architect, Engineer and Contractor certifying that the work is acceptable or indicating any deviations from allowable tolerances.

3.05 SHORES AND SUPPORTS

A. Definitions

1. Shores: Vertical or inclined support members designed to carry the weight of formwork, concrete, and construction loads above.
2. Reshores: Shores placed snugly under a stripped concrete structural member after the original forms and shores have been removed from the member, thus requiring the member to carry its own weight and superimposed construction loads at the time of installation. Reshores are assumed to carry no load at the time of installation. After the installation of reshores, superimposed construction loads are assumed to be distributed among all members connected by reshores.
3. Backshores: Shores placed snugly under a stripped concrete structural member after the original formwork and shores have been removed from a small area without allowing the structural member to deflect or support its own weight or superimposed construction loads. It is assumed that backshores carry the same load as that carried by the original shores they replace.

Comply with requirements of ACI 301 for shoring, reshoring and backshoring in concrete construction and as herein specified where more stringent:

- B. Design: Shores and reshores or backshores must be designed to carry all loads transmitted to them. A rational analysis should be used to determine the number of floors to be shored, reshored, or backshored, subject to the minimums stated in the following paragraph, and to determine the loads transmitted to the floors, shores and reshores or backshores as a result of the construction sequence. The analysis should consider, but should not necessarily be limited to, the following:
1. Structural design load of the slab or member including live load, partition loads, and other loads for which the engineer designed the slab. The live load reduction factors for the design of certain members are shown on the structural drawings. The reduced live load and an allowance for construction loads shall be taken into consideration when performing the analysis.
 2. Dead load weight of the concrete and formwork.
 3. Construction live loads, such as placing crews and equipment or stored materials.
 4. Design strength of concrete specified.
 5. Cycle time between placement of successive floors.
 6. Strength of concrete at time it is required to support shoring loads from above.
 7. The distribution of loads between floors, shores, and reshores or backshores at the time of placing concrete, stripping formwork, and removal of reshoring or backshoring.
 8. Span of slab or structural member between permanent supports.
 9. Type of formwork systems, i.e., span of horizontal formwork components, individual shore loads, etc.
 10. Minimum age where appropriate.
 11. Alignment of shores. Where possible, shores for any floor shall be placed directly above previously placed shores so that load will be transferred directly to such shores.
- C. Structures with Three Supported Levels or Less: Extend shoring from soil supported slab or suitable subgrade to uppermost level for structures with three structurally supported levels or less.
- D. Structures with Greater than Three Supported Levels: Structures with greater than three supported levels shall have a minimum of two shored floors under the floor or roof being placed.

3.06 REMOVAL OF FORMS AND SUPPORTS

- A. Determination by Contractor's Registered Engineer: The Contractor's registered engineer shall determine and submit for Owner's record the time and sequence of formwork and shore removal subject to the criteria as specified below. The submittal shall clearly distinguish between reshoring and backshoring procedures.
- B. Curing and Stripping Concrete Cylinders: The General Contractor shall be responsible for making and curing stripping concrete cylinders, cured under field conditions, for the purpose of determining concrete strength at time of form and shore removal. Such cylinders shall be made by the Contractor and tested by his testing laboratory.
- C. Records of Weather Conditions: The General Contractor shall be responsible for keeping records of weather conditions to be used in the decision on when to remove forms.
- D. Formwork Not Supporting Concrete: Formwork not supporting concrete such as sides of beams, walls, columns and similar parts of the structure, may be removed after cumulatively (not necessarily consecutively) curing at not less than 50°F for 12 hours after placing concrete, provided the concrete is sufficiently hard so as not to be damaged by form removal operations and provided curing and protection operations are maintained. If ambient air temperatures remain below 50°F, if retarding agents are used, or if Type II and Type V portland cement is used, then this specified minimum period should be increased as required to safely remove the

forms without damage to the concrete. Where such forms also support formwork for slab or beam soffits, the removal times of the latter shall govern.

- E. Formwork Supporting Weight of Concrete: Formwork supporting weight of concrete such as beam soffits, joists, slabs and other structural elements shall not be removed until concrete has attained at least the following percentages of the design minimum 28 day compressive strength:

Joist Pans, Beam Bottoms	- 75%, but not less than 2800 psi
Slabs	- 75%, but not less than 2800 psi

END OF SECTION

SECTION 03 20 00

CONCRETE REINFORCEMENT

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections apply to work of this section.

1.02 STANDARDS

- A. The following Standards are listed in this specification:

ASTM A36	Standard Specification for Carbon Structural Steel
ASTM A82	Standard Specification for Steel Wire, Plain for Concrete Reinforcement
ASTM A185	Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
ASTM A416	Specification for Uncoated Seven Wire Stress Relieved Strand for Prestressed Concrete" and "Specification for Unbonded Single Strand Tendons" as published by the Post-Tensioning Institute
ASTM A496	Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement
ASTM A497	Standard Specification for Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement
ASTM A576	Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality
ASTM A615	Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A706	Specification for Low-Alloy Steel Deformed Bars for Concrete Reinforcement"
ASTM A767	Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement
ASTM A780	Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

1.03 DESCRIPTION OF WORK

- A. The work of this section includes labor, materials, hardware, equipment, transportation and services required to fabricate and place all reinforcement for cast-in-place concrete including bars, welded wire fabric, ties and supports shown on the drawings and as specified. Prestressing reinforcement is specified in Post-Tensioned Concrete and/or Precast Concrete sections of the specifications.

1.04 QUALITY ASSURANCE

- A. Codes and Standards: Comply with all provisions of the following codes, specifications and standards except where more stringent requirements are shown or specified:
1. ACI 301 - "Specifications for Structural Concrete for Buildings".
 2. ACI 117 - "Specifications for Tolerances for Concrete Construction and Materials."
 3. ACI 318 - " Building Code Requirements for Reinforced Concrete".
 4. Concrete Reinforcing Steel Institute (CRSI), "Manual of Standard Practice".

1.05 SUBMITTALS

- A. Shop Drawings: Submit shop drawings for all reinforcing steel and related accessories for the Engineer's approval. Shop drawings shall show arrangement and layout, bending and assembly diagrams, bar schedules, stirrup spacing, splicing and laps of bars and shall be prepared in accordance with CRSI Standards. Submit details for steel templates that are to be used when placing dowels for columns, plinths, or pilasters out of foundation elements or for placing anchor bolts for structural steel members.
- B. Mill Certificates: Submit mill certificates for all reinforcement signed by Contractor and producer for record.
- C. Product Data: Submit manufacturer's product data with application and installation instructions for proprietary materials and items, including mechanical splices, dowel bar substitute systems, and dowel bar sleeves.
- D. International Conference of Building Official (ICBO) Technical Reports: Submit technical reports of approval from ICBO for mechanical splice and dowel bar substitute systems.

1.06 PREINSTALLATION CONFERENCE

- A. The Reinforcing-Placing subcontractor shall attend the Pre-Concrete Conference conducted by the Concrete Contractor as described in Specification Section "Cast-in-Place Concrete".

1.07 TESTING AND INSPECTION

- A. Perform all tests and inspections of reinforcing steel as specified in the Laboratory Testing Section or other sections of these specifications.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Reinforcement:
 - 1. Reinforcing Steel: All reinforcing steel shall conform to the "Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement," ASTM A615 Grade 60 unless noted otherwise on the drawings..
 - 2. Weldable Reinforcing Steel: All reinforcing steel required to be welded shall conform to ASTM A 706 "Specification for Low-Alloy Steel Deformed Bars for Concrete Reinforcement".
 - 3. Galvanized Reinforcing Steel: Provide at the locations indicated on the drawings galvanized reinforcing bars according to ASTM A 767 Class II (2.0 oz. zinc PSF), hot dipped galvanized after fabrication and bending. Bars that are to be galvanized shall conform to paragraph 1 above.
 - 4. Deformed Bar Anchors: Deformed Bar Anchors shall conform to "Specification for Deformed Steel Wire for Concrete Reinforcement", ASTM A 496 with a minimum yield strength of 70,000 PSI. Standard ASTM A 615 Grade 60 or Grade 40 reinforcing bars may not be substituted for deformed bar anchors.
 - 5. Plain Steel Welded Wire Reinforcement: Welded plain-steel wire reinforcement shall conform to the "Specification for Welded Steel Wire Fabric for Concrete Reinforcement," ASTM A 185 with a yield strength of 65,000 PSI. Provide in flat sheets only.
 - 6. Wire: Smooth wire for spiral reinforcement shall conform to the "Specification for Steel Wire, Plain, for Concrete Reinforcement," ASTM A 82 with a minimum yield strength of 70,000 PSI.

7. Joint Dowel Bars: Smooth bars used to dowel across slab-on-grade construction joints shall conform to ASTM A615, Grade 40 or A36, plain-steel bars. Cut bars true to length with ends square and free of burrs.
 8. Dowel Bar Sleeves: Plastic or gage metal (26 ga. min.) sleeves with an inside diameter of 1/16 inch greater than the dowel bar that it encases, that have the strength, durability, and design to provide free movement of the dowel relative to the concrete slab and that are specifically manufactured for this purpose.
 9. Alternate Slab-on-Grade Joint Load Transfer Systems: A system that consists of flat, A36 plate that is saw cut into a square or rectangular shape and is embedded into or encased by a plastic sleeve that allows movement in both lateral directions but not in the vertical direction. An acceptable system is manufactured by PNA Construction Technologies and is known by the names "Diamond Dowel System" and "Load Plate Basket".
 10. Tie Wire: Tie wire shall be annealed steel tie wire, minimum 16 gauge. Provide only plastic coated or stainless steel tie wire in exposed concrete structures and all architectural concrete.
- B. Supports for Reinforcement: Provide supports for reinforcement including bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcing bars and welded wire fabric in place. Use wire bar type supports complying with CRSI recommendations.
1. Slabs-on-Grade: Use supports with sand plates or horizontal runners designed for use on ground.
 2. Exposed to View Concrete: Provide supports with legs which are plastic protected (CRSI, Class 1) or stainless steel protected (CRSI, Class 2).
- C. Coating Repair Materials: Repair damaged areas of epoxy-coated or galvanized reinforcement using the following products.
1. Zinc Repair Material: ASTM A780, zinc-based solder, paint containing zinc dust, or sprayed zinc shall be used to repair damaged areas of galvanized reinforcement.

2.02 SPLICES

- A. Tension Splices: Concrete members with mechanical anchorage splices developing 125% of the yield strength in tension shall have vertical bars with shear cut, flame cut, or saw cut ends. The following are acceptable mechanical anchorage splices:
- "Cadweld-Series C", Erico Products, Inc.
 - "Lenton Coupler", Erico Products, Inc.
 - "NMB Splice Sleeve", Splice Sleeve North America"
 - "Bar-Grip" and "ZAP Screwlok", BarSplice Products, Inc.
 - "BarLock, S-Series and L-Series", MBT Coupler System, Inc.
 - "Coupler Splice System", Dayton/Richmond, Inc.
 - "US/MC-SAE Mechanical Coupler", Dayton/Richmond, Inc.
 - "Dywidag Threadbar Coupler" Dywidag Systems International, USA, Inc.
 - or other Engineer-approved product.
- All splices shall be approved by the International Conference of Building Officials (ICBO) and shall have the ICBO Technical Report submitted for Engineer review.
- B. Splice Type and Lap Lengths: Required splice type and lap lengths are defined on the drawings. Lap splice lengths for unscheduled bars not shown otherwise on the drawings shall be 30 bar diameters minimum.
- C. Dowel Bar Replacement: All reinforcing steel bars shown on the drawings crossing concrete construction joint surfaces with inserts cast flush against the form and having dowels connected to the insert in a subsequent concrete pour shall conform to the following:

1. Splice connection at insert shall develop the full tensile capacity of the reinforcing steel.
2. The following are acceptable products:

"Lenton Form Saver", tapered thread dowel and insert, Erico Products, Inc.
"Dowel Bar Splicer", dowel bar substitution and rebar splice system (DB-SAE Splicer), Dayton/Richmond, Inc.
"B.P.I. Barsplicer System", BarSplice Products, Inc.
or other Engineer-approved product.

All splices shall be approved by the International Conference of Building Officials (ICBO) and shall have the ICBO Technical Report submitted for Engineer review.

- D. Hooked Anchorage Replacement: Reinforcing bar terminations shall be manufactured out of ASTM A576 material and shall develop the full yield strength of the bar when installed at the manufacturer's recommended depth. The bar shall be connected to the terminating device in such a way as to develop 125% of the yield strength of the bar. The following are acceptable products:

"Lenton Terminator", Erico Products, Inc.
"Grip-Twist Rebar Terminations", BarSplice Products, Inc.
or other Engineer-approved product.

All splices shall be approved by the International Conference of Building Officials (ICBO) and shall have the ICBO Technical Report submitted for Engineer review.

PART 3 EXECUTION

3.01 FABRICATION AND DELIVERY

- A. Bending and Forming: Fabricate bars of indicated sizes and accurately form to shapes and lengths indicated and required, by methods not injurious to materials. Do not heat reinforcement for bending. Bars with kinks or bends not scheduled will be rejected.
- B. Marking and Shipping: Bundle reinforcement and tag with suitable identification to facilitate sorting and placing. Transport and store at site so as not to damage material. Keep sufficient supply of tested, approved and proper reinforcement at the site to avoid delays. Maintain reinforcing bars free of mud, dirt, grease, or other coating.

3.02 PLACING REINFORCEMENT

- A. Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars", for details and methods of reinforcement placement and supports and as herein specified.
- B. Before placing and again before concrete is placed, clean reinforcement of loose rust and mill scale, earth, ice and other materials which reduce or destroy bond with concrete.
- C. Accurately position, support and secure reinforcement against displacement by formwork, construction, or concrete placement operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers and hangers, as required. Exercise particular care to maintain proper distance and clearance between parallel bars and between bars and forms. Provide metal spreaders and spacers to hold steel in position. Support steel at proper height upon approved chairs.
- D. Place reinforcement to obtain at least minimum coverages for concrete protection. Arrange, space and securely tie bars and bar supports to hold reinforcement in position during concrete

placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.

- E. Install welded wire reinforcement in as long lengths as practicable. Lap adjoining pieces at least one full mesh plus two inches and lace splices with wire. Offset end laps in adjacent widths to prevent continuous laps in either direction. Welded wire reinforcement shall be furnished and placed in flat sheets only.
- F. Coordinate with other trades and expedite materials and labor to avoid omissions and delay.
- G. Install waterproof membrane or moisture barrier as specified prior to placing steel for concrete slabs-on-grade.
- H. Extend reinforcement continuous through construction joints unless otherwise shown on the drawings or, if approved on the shop drawings, provide dowels of sufficient length to develop the full tension or compression strength of the bar as applicable.
- I. Slab-on-Grade Joint Dowel Bars: Support slab-on-grade joint dowel bars independently of support for slab reinforcement on soil supported slab bolsters or specially manufactured cradles such that dowel bar remains parallel to slab surface and at right angles to joint during concreting operations. Lightly coat the exposed end of the dowel with a paraffin-base lubricant, asphalt emulsion, form oil, or grease or use a dowel bar sleeve specifically manufactured for the purpose of preventing a bond between the dowel and the concrete.
- J. Alternate Slab-on-Grade Joint Load Transfer Systems: Install the alternate load transfer system in accordance with the manufacturer's instructions such that the largest plane of the flat plate is parallel to the plane of the subgrade on which the slab is bearing.
- K. Provide and place additional reinforcing steel at all sleeves and openings in beams, slabs and walls as specified on the drawings. Where sleeves or openings not shown on the drawings interrupt the reinforcement, consult with Engineer for instructions for placing and splicing of bars. Provide required additional reinforcing steel at no additional cost to the Owner.

3.03 REINFORCING STEEL SPACING AND COVERAGE

- A. Reinforcing Steel Coverage: Reinforcing steel coverage should conform to the requirements specified below. Cover specified shall be considered minimums that may require increasing where reinforcing steel intersects for different member types. Cover in structural members not specified below shall conform to the requirements of ACI 318-99 Section 7.7 unless specified otherwise on the drawings.

- 1. Foundation Members
 - a. Grade Beams - 1 1/2" top, 3" bottom, 2" sides
 - b. Basement Walls - 2" dirt face, 3/4" interior face
 - c. Foundation Retaining Walls - 2" both faces
 - d. Sump Walls, Pit Walls - 2" both faces
 - e. Drilled Piers - 3" sides
 - f. Interior Slab on Grade
 - 1" top cover for one layer of steel
 - 1" top cover, 3" bottom cover for two layers of steel
 - g. Exterior Slab on Grade
 - 2" top cover for one layer of steel
 - 2" top cover, 3" bottom cover for two layers of steel

2. Mild Reinforced Members, Interior Exposure (air conditioned space)
 - a. Structural Slabs - 3/4" top, 3/4" bottom
 - b. Joists (pans greater than 30") - 1 1/2" top cover, 1 1/2" side cover, 1 1/2" bottom cover (including stirrups where used)
 - c. Beams, Girders - 1 3/4" top cover, 1 1/2" side cover, 1 1/2" bottom cover (including primary steel and stirrups)
 - d. Columns - 1 1/2" (including column ties)
3. Mild Reinforced Members, Exterior Exposure (unconditioned air space)
 - a. Structural Slabs - 2" top cover, 2" bottom cover
 - b. Joists - 2 1/2" top cover, 2" side cover, 2" bottom cover (to primary reinforcing steel only)
 - c. Beams, Girders - 2 3/4" top cover, 2" side cover, 2" bottom cover, (to primary steel and stirrups)
 - d. Columns - 2" (including ties) face

The reinforcing steel detailer shall adjust reinforcing steel cage sizes at intersecting structural members as required to allow clearance for intersecting reinforcing bar layers with minimum specified cover.

B. Reinforcing Steel Spacing: Comply with the requirements of ACI 318-99, Section 7.6.

3.04 SPLICING REINFORCING STEEL

- A. Provide splice type (tension lap splice, compression lap splice, or mechanical anchorage tension splice) as indicated on the drawings. Splice reinforcing bars only at locations shown on the structural drawings and approved shop drawings. Unauthorized or unscheduled splices not approved by the Engineer in writing will not be accepted.
- B. All lap splices in reinforcing steel shall be contact lap splices unless detailed otherwise on the drawings.
- C. Maintain proper cover between reinforcing bars at splices.
- D. Lap unscheduled reinforcing bars not otherwise specified a minimum of 30 bar diameters at splices. Lap welded wire fabric a minimum of one full wire mesh plus two inches.
- E. Manufacturer of mechanical tension splice should be present for first day's installation.

3.05 WELDING REINFORCING STEEL

- A. Welding reinforcing steel is permitted only where specifically shown on the drawings. All welding shall conform to AWS D1.4 "Structural Welding Code - Reinforcing Steel". Only weldable reinforcing steel conforming to ASTM A706 or deformed bar anchors conforming to ASTM A496 shall be permitted. ASTM A615 bars may not be welded for structural use.
- B. Scheduled or detailed reinforcing steel shall not be tack welded for any reason.

3.06 SHRINKAGE AND TEMPERATURE REINFORCEMENT

- A. Provide shrinkage and temperature reinforcement (as required by ACI 318) at right angles to main top and bottom bars for all structural slabs unless detailed otherwise on the drawings.

3.07 PLACEMENT OF WELDED WIRE REINFORCEMENT

- A. Wherever welded wire reinforcement is specified as reinforcement in pan joist or other slabs, it shall be continuous and properly lapped one full wire spacing plus 2" across the entire concrete surface and not interrupted by beam or girders.

3.08 PLACEMENT OF COLUMN DOWELS AND ANCHOR BOLTS

- A. Dowels for columns, plinths, and pilasters and anchor bolts shall be accurately set using 1/8" thick steel templates.

3.09 REINFORCEMENT IN GRADE BEAMS

- A. **Unscheduled Grade Beam Reinforcement:** Unless shown otherwise on the drawings, all unscheduled grade beams shall be reinforced at a minimum with 2-#5 continuous top and bottom bars and #3 closed stirrups at 24" on center. Continuous top bars shall be lapped at midspan between supports with a class A tension lap. Continuous bottom bars shall lap 12" over supports.
- B. **Dowels to Slab:** Unless shown otherwise on the drawings, provide minimum #3 dowels x 2'-0" at 30" on center (90° bent bar, 1'-0" each side) from all grade beams to slabs.
- C. **Corner Bars:** Unless shown otherwise on the drawings, provide 1-#6 x 4'-0" (90° bent bar, 2'-0" each side) top and bottom in exterior face of grade beams at exterior corners.
- D. **Discontinuous Top and Bottom Bars:** Where a discontinuous grade beam intersects a continuous grade beam, the top bars of the discontinuous beam shall terminate into the continuous beam with a 90° hook. The bottom bars shall extend a minimum of 6" beyond the face of the continuous beam.
- E. **Bar Support for Grade Beam Cages:** Grade beam bottom steel shall be supported at 5'-0" maximum centers using beam bolsters that provide 3" bottom cover to the reinforcing steel. Beam bolsters used shall be designed and manufactured for support on soil.
- F. **Reinforcement around Sleeves through Grade Beams:** Unless detailed otherwise on the drawings, provide not less than 2-#5 x (opening width + 4'-0") (2'-0" each side of opening) above and below opening with 2 additional stirrups each side of opening.

3.10 REINFORCEMENT IN TOPPING SLABS

- A. Provide welded smooth wire reinforcement minimum 6 x 6 W1.4 x W1.4 in all topping slabs unless specified otherwise on the drawings.

3.11 REINFORCEMENT IN HOUSEKEEPING PADS

- A. Provide welded smooth wire reinforcement 6 x 6 W2.9 x W2.9 minimum in all housekeeping pads supporting mechanical equipment unless detailed otherwise on the drawings.

3.12 REINFORCEMENT IN SIDEWALKS

- A. Provide welded smooth wire reinforcement minimum 6 x 6 W1.4 x W1.4 in all sidewalks unless detailed otherwise on the Architectural or Structural Drawings.

3.13 MECHANICAL AND PLUMBING REQUIREMENTS

- A. Refer to Mechanical and Plumbing Drawings for formed concrete requiring reinforcing steel. Such reinforcement shall be furnished as part of the work of this section.

END OF SECTION

SECTION 03 30 00
CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.02 STANDARDS

- A. The following Standards are listed in this specification:

ASTM A36	Specification for Carbon Structural Steel
ASTM A153	Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A193-B7	Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature Services
ASTM A307	Specification for Carbon Steel Bolts and Studs, 60000 psi Tensile Strength
ASTM A354	Standard Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners
ASTM A563	Standard Specification for Carbon and Alloy Steel Nuts
ASTM A572	Standard Specification for High Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A588	Standard Specification for High-Strength Low-Alloy Structural Steel with 50 ksi Minimum Yield Point to 4 in. Thick
ASTM C33	Standard Specification for Concrete Aggregates
ASTM C39	Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C94	Specification for Ready Mixed Concrete
ASTM C150	Specification for Portland Cement
ASTM C192	Practice for Making and Curing Concrete Test Specimens in the Laboratory
ASTM C260	Specification for Air-Entraining Admixtures for Concrete
ASTM C309	Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C494	Standard Specification for Chemical Admixtures for Concrete
ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete"
ASTM C881	Specification for Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C989	Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
ASTM C1107	Standard Specification for Packages Dry, Hydraulic-Cement Grout (Non-Shrink)
ASTM C1218	Test Method for Water-Soluble Chloride in Mortar and Concrete
ASTM C1240	Standard Specification for Silica Fume for Use as a Mineral Admixture in Hydraulic-Cement Concrete, Mortar, and Grout
ASTM C1315	Specification for Liquid Membrane-Forming Compounds Having Special Properties for Coring and Sealing Concrete
ASTM D1751	Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D1752	Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction

ASTM D2240	Test Method for Rubber Property – Durometer Hardness
ASTM D4397	Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications
ASTM D4745	Specification for Filled Compounds of Polytetrafluoroethylene (PTFE) Molding and Extrusion Materials
ASTM E154	Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Wall, or as Ground Cover
ASTM E1155	Standard Test Method for Determining Floor Flatness and Levelness Using the F-Number System
ASTM E 1643	Standard Practice for Installation of Water Vapor Retarders used in Contact with Earth or Granular Fill Under Concrete Slabs.
ASTM E1745	Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs
ASTM F1554	Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

1.03 DESCRIPTION OF WORK

- A. Extent of concrete work is shown on drawings, including schedules, notes and details which show size and location of members and type of concrete to be poured. Furnish all labor, materials, services, equipment and hardware required in conjunction with or related to the forming, delivery and pouring of all poured-in-place concrete work.
- B. Concrete paving and walks are specified in Division 2.
- C. Concrete Formwork, Reinforcement, Architectural Concrete, Precast Concrete, and Post-Tensioned Concrete are specified in other Division-3 sections.

1.04 QUALIFICATIONS

- A. The concrete supplier shall have a minimum of five years experience in manufacturing ready-mixed concrete products complying with ASTM C94 requirements for production facilities and equipment. The supplier must be certified according to the National Ready Mixed Concrete Association's Certification of Ready Mixed Concrete Production Facilities.
- B. The concrete contractor shall have a minimum of five years experience with installation of concrete similar in material, design and extent to that indicated for this Project and whose work has resulted in construction with a record of successful -service performance.

1.05 QUALITY ASSURANCE

The Contractor is responsible for quality control and quality assurance, including workmanship and materials furnished by his subcontractors and suppliers.

- A. Codes and Standards: Comply with provisions of following codes, specifications and standards, except where more stringent requirements are shown or specified:
 - 1. ACI 301 - "Specifications for Structural Concrete for Buildings".
 - 2. ACI 117 - 'Specifications for Tolerances for Concrete Construction and Materials."

3. ACI 318 - " Building Code Requirements for Reinforced Concrete".
4. Concrete Reinforcing Steel Institute (CRSI), "Manual of Standard Practice".

B. Document Conflict and Precedence: In case of conflict among documents, including architectural and structural drawings and specifications, notify the Architect/Engineer prior to submitting proposal. In case of conflict between and/or among the structural drawings and specifications, the strictest interpretation shall govern, unless specified otherwise in writing by the Architect/Engineer.

C. Inspection and Testing of the Work: Materials and installed work may require testing and retesting, as directed by the Architect/Engineer, at any time during progress of work. Allow free access to material stockpiles and facilities. Tests, not specifically indicated to be done at the Owner's expense, including retesting of rejected materials and installed work, shall be done at the Contractor's expense. See Testing Laboratory section of the Specifications.

Inspection or testing by the Owner does not relieve the Contractor of his responsibility to perform the Work in accordance with the Contract Documents.

D. Acceptance Criteria for Concrete Strength: The strength level of an individual class of concrete shall be considered satisfactory if both the following requirements are met:

1. The average of all sets of three consecutive strength tests equal or exceed the required f'_c .
2. No individual strength test falls below the required f'_c by more than 500 psi.

A strength test shall be defined as the average strength of two cylinder breaks tested at the strength age indicated on the drawings for that class of concrete.

E. Responsibility for Selection and Use of Concrete Admixtures and Chemical Treatments: The Contractor shall be responsible for selecting admixtures and surface treatments that are compatible with the intended use of the concrete including all final surface treatments called for within this or other specifications or on the structural or architectural drawings. The Contractor is responsible for following the manufacturer's instructions for the use of their product including abiding by any limitations placed by the manufacturer on the use of any of its products.

F. Survey for Anchor Rods and Reinforcing Steel Dowels: The Contractor shall use a qualified, licensed professional engineer/land surveyor to lay out the proper location of all embedded anchor rods and reinforcing steel dowels for columns above before they are encased in concrete. The surveyed locations of such elements shall be submitted to the Architect/Engineer for record.

1.06 PREINSTALLATION CONFERENCES

A. Mix Design Conference: At least 30 days prior to submittal of concrete design mixes, the Contractor shall hold a meeting or telephone conference to review the detailed requirements for preparing the concrete mix designs. Participants shall include representatives from the Contractor, Owner's Testing Laboratory, Concrete Supplier, and Engineer.

B. Pre-Concrete Conference:

1. At least 7 days prior to beginning concrete work, the Contractor shall conduct a meeting to review the proposed mix designs and to discuss required methods and procedures to produce concrete construction of the required quality. Also review requirements for submittals, status of coordinating work and availability of materials. Establish work progress schedule and procedures for materials inspection, testing and certifications. The contractor shall send a pre-concrete conference agenda to all attendees 7 days prior to the scheduled date of the conference.

2. The Contractor shall require responsible representatives of every party who is concerned with the concrete work to attend the conference, including but not limited to the following:

Contractor's Superintendent
Laboratory responsible for the concrete design mix
Laboratory responsible for field quality control
Concrete Subcontractor
Ready-Mix Concrete Producer
Owner's and Architect's/Engineer's Representative

3. Minutes of the meeting shall be recorded, typed and printed by the Contractor and distributed by him to all parties concerned within 5 days of the meeting. One copy of the minutes shall be transmitted to the following for information purposes:

Owner's Representative
Architect
Engineer-of-Record

1.07 SUBMITTALS

- A. Product Data: Submit manufacturer's product data with application and installation instructions for proprietary materials and items, including admixtures, patching compounds, epoxies, grouts, waterstops, joint systems, curing compounds, dry-shake finish materials, hardeners, sealers and others as requested by Architect/Engineer.
- B. Samples: Submit samples of materials specified if requested by Architect/Engineer, including names, sources and descriptions.
- C. Mix Designs: Submit mix designs and the Concrete Mix Design Submittal Form located at the back of this specification section for each class of concrete that is to be provided for the project as specified herein. Submit the qualifying test data that supports each mix design as required herein. For any concrete mix that contains fly ash, submit evidence of satisfactory performance of the mix on past projects using the same percentage level of fly ash replacement with identical sources of materials.
- D. Material and Mill Certificates: Provide material and mill certificates as specified herein and in the Testing Laboratory section of the Specifications. The Manufacturer and Contractor shall sign the material and mill certificates certifying that each material item complies with specified requirements. Provide certification from admixture manufacturers that chloride ion content complies with specified requirements.
- E. Construction Joints: Submit drawing of proposed construction joint locations in concrete for slab on grade, mat foundations, structural floors, roofs and walls. Submit any additional or changed reinforcing that is required at construction joints that differs from that shown on the drawings.
- F. Minutes of preconstruction conference.
- G. Surveys: Submit report certifying that all anchor rods and reinforcing dowels into columns above are in their proper location prior to placing of concrete.

1.08 PROVISION FOR OTHER WORK

- A. Provide for installation of inserts, hangers, metal ties, anchors, bolts, angle guards, dowels, thimbles, slots, nailing strips, blocking, grounds and other fastening devices required for attachment of work. Properly locate in cooperation with other trades and secure in position before

concrete is poured. Do not install sleeves in any concrete slabs, beams or columns except where shown on the drawings or upon written approval of the Architect/Engineer.

- B. Protect adjacent finish materials against damage and spatter during concrete placement.

PART 2 PRODUCTS

2.01 CONCRETE MATERIALS

Refer to the drawings for classes and strengths of concrete required.

- A. Portland Cement: ASTM C 150, Type I or Type III, or ASTM C 1157, Type GU or HE unless otherwise approved by the Architect/Engineer.

Use one brand of cement, for each class of concrete, throughout the project, unless approved otherwise by the Architect/Engineer and the Owner's Testing Laboratory. Submit mill certificates certifying conformance to this specification for each brand and type of cement.

- B. Low-alkali cement: Cement that has the additional requirement that equivalent alkalies ($\text{Na}_2\text{O} + 0.658\text{K}_2\text{O}$) do not exceed 0.60% according to ASTM C150-00, Table 2.

- C. Fly Ash: ASTM C 618, Class C or F.

- D. Silica Fume: ASTM C1240, Amorphous Silica.

- E. Ground Granulated Blast-Furnace Slag Cement: ASTM C989, Grade 100 or 120 or ASTM C 595, Type IS or Type S.

- F. Normal Weight Aggregates: ASTM C33, and as herein specified. Submit material certificates certifying conformance to this specification for each source of aggregate.

1. If required by the provisions of this specification in the section entitled "Proportioning and Design of Concrete Mixes", submit certification that aggregate does not contain any deleterious materials that react with alkalis in the concrete mix to cause excessive expansion of the concrete for concrete that is exposed to wetting, has extended exposure to humid atmosphere, or is in contact with moist ground. This includes the following locations in this project:

- G. Water: Clean, fresh, drinkable, free of oils, acids or organic matter harmful to concrete.

- H. Air-Entraining Admixture: ASTM C260. Provide air entrainment as specified in Table 4.2.1. of ACI 318-99 in all concrete exposed to freezing and thawing. Interior steel troweled surfaces subjected to vehicular traffic shall not have more than 3% entrained air. Surfaces scheduled to receive hardeners shall not have more than 3% entrained air.

Subject to compliance with requirements, provide one of the following products and manufacturers:

"Darex-AEA" or "Daravair"; W. R. Grace & Co.

"MBAE90" or "Micro-Air"; Master Builders

"Sika AER"; Sika Corporation

"Air Mix" or "AEA-92"; The Euclid Chemical Company, Inc.

"Boral Air 30" or "Boral Air 40", Boral Material Technologies, Inc.

Submit manufacturer's certification that product conforms to the requirements specified and is compatible with all other admixtures to be used.

- I. Water-Reducing Admixture: ASTM C494, Type A. See maximum permissible chloride ion content in concrete specified below.

Subject to compliance with requirements, provide one of the following products and manufacturers:

"Pozzolith 322N" or "Polyheed 997"; Master Builders
"Plastocrete 161"; Sika Chemical Corp.
"Eucon WR-75 or WR-91"; The Euclid Chemical Company, Inc.
"WRDA with Hycol"; W.R. Grace & Co.
"Boral NW" or "Boral LW", Boral Material Technologies, Inc.

Submit manufacturer's certification that product conforms to the requirements specified and is compatible with all other admixtures to be used.

- J. Mid-Range Water-Reducing Admixture: ASTM C494, Type A and Type F. See maximum permissible chloride ion content in concrete specified below.

Subject to compliance with requirements, provide one of the following products and manufacturers:

"Polyheed 997", Master Builders
"Eucon MR", The Euclid Chemical Company, Inc.
"Sikament HP", Sika Chemical Corp.
"Mira 70", W.R. Grace & Co.
"Boral X15" or "Boral X20", Boral Material Technologies, Inc.

Submit manufacturer's certification that product conforms to the requirements specified and is compatible with all other admixtures to be used.

- K. High-Range Water-Reducing Admixture (Super Plasticizer): ASTM C494, Type F or Type G. See maximum permissible chloride ion content in concrete specified below.

Subject to compliance with requirements, provide one of the following products and manufacturers:

"ADVA" or "Daracem"; W.R. Grace & Co.
"Rheobuild 1000" or "Rheobuild 3000FC"; Master Builders
"Sikament"; Sika Chemical Corp.
"Eucon 37 or Eucon 537"; The Euclid Chemical Company, Inc.
"Boral SP" or "Boral RD", Boral Material Technologies, Inc.

Submit manufacturer's certification that product conforms to the requirements specified and is compatible with all other admixtures to be used.

- L. Water-Reducing, Accelerator Admixture (Non-Corrosive, Non-Chloride): ASTM C494, Type C or E. See maximum permissible chloride ion content in concrete specified below.

Subject to compliance with requirements, provide one of the following products and manufacturers:

"Polarset"; W.R. Grace & Co.
"Pozzutec 20"; Master Builders
"Accelguard 80"; The Euclid Chemical Company, Inc.
"Plastocrete 161FL", Sika Chemical Co.
"Boral AcN", Boral Material Technologies, Inc.

Submit manufacturer's certification that product conforms to the requirements specified and is compatible with all other admixtures to be used.

- M. Water-Reducing, Retarding Admixture: ASTM C 494, Type D. See maximum permissible chloride ion content in concrete specified below.

Subject to compliance with requirements, provide one of the following products and manufacturers:

"Daratard-17"; W.R. Grace & Co.
"Pozzolith 100XR" or "Pozzolith 300R; Master Builders
"Plastiment"; Sika Chemical Co.
"Eucon Retarder 75"; The Euclid Chemical Company, Inc.
"Boral R-Series", Boral Material Technologies, Inc.

Submit manufacturer's certification that product conforms to the requirements specified and is compatible with all other admixtures to be used.

- N. Shrinkage Reducing Admixture: An admixture that reduces drying shrinkage by reducing the capillary tension of pore water.

Subject to compliance with requirements, provide one of the following products and manufacturers:

"Eclipse"; Grace Construction Products
"Tetraguard AS20"; Master Builders

- O. Calcium Chloride and Chloride Ion Content:

1. Calcium chloride or admixtures containing more than 0.5% chloride ions by weight of the admixture are not permitted.
2. The maximum water soluble chloride ion concentration in hardened concrete at ages from 28 to 42 days contributed from all ingredients including water, aggregates, cementitious materials, and admixtures shall not exceed the limits specified in ACI 318-99 Table 4.4.1. Water-soluble chloride ion tests shall conform to ASTM C1218.

The Concrete Supplier shall certify on the Mix Design Submittal Form that the chloride ion content in all concrete mix designs used on the project will not exceed limits stated above.

- P. Certification: Written conformance to all the above mentioned requirements and the chloride ion content of the admixture as tested by an accredited laboratory will be required from the admixture manufacturer at the time of mix design review by the Engineer.

2.02 RELATED MATERIALS

- A. Waterstops: Provide waterstops at all construction joints and other joints in all foundation walls below grade and where shown on the drawings. Size to suit joints. Provide flat, dumbbell type or centerbulb type.

1. Preformed Plastic Waterstops: Federal Specifications SS-S-210A "Sealing Compound for Expansion Joints".

Manufacturers: Synko-Flex Products, Inc.

2. Bentonite Waterstop RX manufactured by American Volclay Products.

B. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 oz. per sq. yd., complying with AASHTO M 182, Class 2.

C. Moisture-Retaining Cover: One of the following, complying with ANSI/ASTM C 171:

1. Waterproof paper.
2. Polyethylene film.
3. Polyethylene-coated burlap.

D. Non-Oxidizing Metallic Floor Hardener: Packaged dry, combination of materials consisting of Portland Cement, non-rusting aggregate and plasticizing admixtures.

"Diamond Plate," Euclid Chemical Company

"Lumiplate," ChemRex, Inc., MBT Protection and Repair Division

E. Liquid Membrane-Forming Curing and Curing and Sealing Compounds:

1. Water-Based Dissipating Resin Type Curing Compound: Curing Compound shall be a dissipating resin type, which chemically breaks down after approximately 4 weeks. Membrane forming compound shall meet ASTM C309, Types 1 and 1D Class B.

Products: Subject to compliance with requirements, provide one of the following:

"Kurez DRVox", Euclid Chemical Company

"L&M Cure R", L&M Construction Chemicals

Submit manufacturer's certification that product conforms to the requirements specified and is compatible with any covering or surface treatments to be applied. Submit any instructions that must be followed prior to any subsequent surface treatments and floor coverings.

2. High Solids, Water-Based Acrylic Curing and Sealing Compound with Moderate Yellowing Characteristics: Water-Based membrane-forming curing and sealing compound conforming to ASTM C 1315, Type 1, Class B, classified as low odor. Product shall provide a maximum moisture loss of 0.030 Kg/m² in 72 hours when applied at a coverage rate of 300 sf/gallon. Do not apply to surfaces that are to receive subsequent cementitious toppings, sealers, hardeners, ceramic tile, resilient flooring, vinyl-backed carpet, wood, or terrazzo, epoxy overlays or adhesives, or other coating or finishing products.

Products: Subject to compliance with above requirements, provide one of the following products or equivalent products:

"Safe Cure and Seal (J-19)"; Dayton Superior Corp.

"Super Aqua-Cure VOX"; Euclid Chemical Co.

"Dress & Seal, 30 WB"; L & M Construction Chemicals, Inc.

"Masterkure 200W"; ChemRex, Inc., MBT Protection and Repair Division

Submit manufacturer's certification that product conforms to the requirements specified and is compatible with any covering or surface treatments to be applied. Submit any instructions that must be followed prior to any subsequent surface treatments.

3. High Solids, Water-Based, Non-Yellowing Curing and Sealing Compound: Water based membrane-forming curing and sealing compound, acrylic type, complying with ASTM C1315, Type 1, Class A classified as low odor. Do not apply to surfaces that are to receive subsequent cementitious toppings, sealers, hardeners, ceramic tile resilient flooring, vinyl-backed carpet, wood, terrazzo, epoxy overlays or adhesives, or other coating or finishing products.

Products: Subject to compliance with requirements, provide one of the following:

"Super Diamond Clear Vox", Euclid Chemical Company
"Lumiseal 30 WB", L&M Construction Chemicals
"Kure 1315", Sonneborn-ChemRex

Submit manufacturer's certification that product conforms to the requirements specified and is compatible with any covering or surface treatments to be applied. Submit any instructions that must be followed prior to any subsequent surface treatments.

- F. Chemical Curing/Floor Hardener Compound: Sodium silicate based compound which reacts with concrete constituents to harden the surface, resulting in a surface having a maximum abrasion coefficient of 0.25 cm³/cm² when tested in accordance with ASTM C 418.

Products: Subject to compliance with requirements, provide one of the following:

"Eucosil," Euclid Chemical Co.
"Sonosil," Sonneborn-ChemRex
"Day-Chem S.1-Cure (J-13), Dayton Superior
"Chem Hard;" L & M Construction Co.

Submit manufacturer's certification that product conforms to the requirements specified and is compatible with all coverings and surface treatments to be applied. Submit any instructions that must be followed prior to any subsequent surface treatments.

- G. Evaporation Control: Monomolecular film forming compound applied to exposed concrete slab surfaces for temporary protection from rapid moisture loss in hot weather conditions.

Products: Subject to compliance with requirements, provide one of the following:

"Eucobar"; Euclid Chemical Company
"E-Con"; L & M Construction Chemical, Inc.
"Confilm"; ChemRex, Inc., MBT Protection and Repair Division
"Sure Film (J-74)", Dayton Superior
"SikaFilm", Sika Chemical Co.

Submit manufacturer's certification that product conforms to the requirements specified and is compatible with all coverings and surface treatments to be applied. Submit any instructions that must be followed prior to any subsequent surface treatments.

- H. Chemical Hardener: Colorless aqueous solution containing a blend of magnesium fluosilicate and zinc fluosilicate combined with a wetting agent, containing not less than 2 lbs. of fluosilicates per gal.

Products: Subject to compliance with requirements, provide one of the following:

"Surfhard"; Euclid Chemical Co.
"Lapidolith"; Sonneborn-Chem-Rex
"Day-Chem Hardener (J-15)," Dayton Superior
"Fluohard", L & M Construction Chemical, Inc.

Submit manufacturer's certification that product conforms to the requirements specified and is compatible with all coverings or surface treatments to be received. Submit any instructions that must be followed prior to any subsequent surface treatments.

- I. Water and Chloride Ion Repelling Penetrating Sealer: Clear, solvent based Silane or Siloxane penetrating sealer which reacts chemically with the concrete surface to function as a Chloride Ion screen with a minimum 90% factor when tested in accordance with NCHRP #244 and applied in accordance with the manufacturer's recommendation.

Products: Subject to compliance with requirements, provide one of the following:

"Euco-Guard 100 or 200", Euclid Chemical Co.
"Masterseal SL 40%", ChemRex, Inc., MBT Protection and Repair Division
"Penetrating Sealer 40-VOC", Sonneborn-ChemRex

- J. Water and Chloride Ion Repelling Penetrating Sealer: Clear, water based Silane or Siloxane penetrating sealer which reacts chemically with the concrete surface to function as a Chloride Ion screen with a minimum 83% factor when tested in accordance with NCHRP #244, Series II and applied in accordance with the manufacturer's recommendation.

Products: Subject to compliance with requirements, provide one of the following:

"Euco-Guard Vox", Euclid Chemical Co.
"Sikaguard 701W", Sika Chemical Co.
"Aquapel or Aquapel Plus" L&M Construction Chemicals"
"Enviroseal 20" Hydrozo - Chemrex

- K. Bonding Compound: Polyvinyl acetate or acrylic base, for use in cosmetic and/or nonstructural repairs.

Products: Subject to compliance with requirements, provide one of the following:

1. Acrylic or Styrene Butadiene:

"Day-Chem Ad Bond (J-40)"; Dayton Superior
"SBR Latex"; Euclid Chemical Co.
"Daraweld C"; W. R. Grace
"Acrylic Additive," Sonneborn Chem-Rex, Inc.
"SikaLatex", Sika Chemical Co.

2. Polyvinyl Acetate (Interior Use Only)

"Euco Weld"; Euclid Chemical Co.
"Everweld"; L & M Construction Chemicals, Inc.
"Superior Concrete Bonder (J-41)," Dayton Superior

- L. Epoxy Products: Two component material suitable for use on dry or damp surface, complying with ASTM C 881, for use in all structural concrete repairs.

1. Products for Crack Repair:

"Sikadur 35 Hi Mod LV"; Sika Chemical Company – injection type
"Sikadur 52", Sika Chemical Company – injection type
"Sikadur 55 SLV", Sika Chemical Company – gravity feed
"Eucopoxy Injection Resin," Euclid Chemical Company
"Sure-Inject (J-56)," Dayton Superior
"Epofil SLV", Sonneborn-ChemRex

2. Products for Epoxy Mortar Patches:

"Sikadur Lo-Mod LV"; Sika Chemical Corporation
"Euco 452 LV," Euclid Chemical Company
"Sure Grip Epoxy Grout (J-54)," Dayton-Superior
"Epofil", Sonneborn-ChemRex

3. Products for Epoxying Bolts or Reinforcing Steel into Concrete: Conform to ASTM C881-90, Type IV, Grade 3, Class A, B, & C except gel times.

"Sikadur 31 Hi-Mod Gel"; Sika Corporation
"Euclid 452 Gel", Euclid Chemical Company
"Sure Anchor I (J-S1)", Dayton Superior
"Epo Gel" or "Rapid Gel", Soneborn Chem-Rex
"HIT RE 500", Hilti, Inc.
"Epcon C6 System", ITW Ramset/Red Head
"Power-Fast Injection Gel", Powers Rawl
"Epoxy-Tie ET", Simpson Strong-Tie Co.

4. Products for Epoxying Steel Plates to Concrete: Conform to ASTM C881-90, Type IV, Grade 3, Class A, B, & C except gel times.

"Sikadur 31 Hi-Mod Gel"; Sika Corporation
"Euclid 452 Gel," Euclid Chemical Company
"Sure Anchor I (J-S1)," Dayton Superior
"Epo Gel" or "Rapid Gel," Soneborn Chem-Rex

Substitutions may be considered provided complete technical information and job references are furnished to the Engineer for approval prior to commencement of work.

M. Self-Leveling Mortars, Underlayment Compound: Freeflowing, self-leveling, pumpable cementitious base compound.

Products: Unless specified otherwise, provide one of the following:

"Sonoflow," Sonneborn Chem-Rex, Inc.
"Sikatop 111"; Sika Chemical Co.
"Flo-Top" or "Flo-Top 90"; Euclid Chemical Co.
"Levelayer I," Dayton Superior

N. Polymer Patching Mortar: Polymer and microsilica modified cementitious based compounds.

Products:

Horizontal Application

"Thin Top Supreme, Concrete Top Supreme," Euclid Chemical
"Sikatop 121 or 122," Sika Chemical
"Emaco R310CI," ChemRex, Inc., MBT Protection and Repair Division

"Sonopatch 100 or 300", Sonneborn-ChemRex

Vertical or Overhead Application

"Verticoat/Verticoat Supreme," Euclid Chemical

"Sikatop 123," Sika Chemical

"Emaco R320CI," ChemRex, Inc., MBT Protection and Repair Division

"Sonopatch 200", Sonneborn-ChemRex

- O. High Strength Flowing Repair Mortar: For forming and pouring structural members, or large horizontal repairs, provide flowable one-part, high strength microsilica polymer modified repair mortar with 3/8" aggregate. The product shall achieve 9000 psi @ 28-days at a 9-inch slump.

Products:

"Road Patch", Sonneborn-ChemRex

- P. Anti-Corrosive Epoxy/Cementitious Adhesive: Water-based epoxy/cementitious compound for adhesion and corrosion protection or reinforcing members (20 hour maximum open time).

Products:

"Corr-Bond," Euclid Chemical Co.

"Armatec 110," Sika Chemical Co.

"Sonoprep", Sonneborn-ChemRex

- Q. Expansion Bolts in Concrete:

1. ICBO Approval: Only concrete anchors approved by the International Conference of Building Officials (ICBO) with a published Research Report shall be approved for use.
2. Type: All expansion bolts in concrete shall be only wedge type expansion or undercut bolts.
3. Interior Use: All expansion bolts, nuts and washers for use in interior conditioned environments free of potential moisture shall be manufactured from carbon steel zinc plated in accordance with Federal Specification QQ-Z-325C, Type II, Class 3.
4. Exterior or Exposed Use: All expansion bolts, nuts and washers for use in exposed or potentially wet environments, or for attachment of exterior cladding materials shall be galvanized or stainless steel. Galvanized bolts, nuts and washers shall conform to ASTM A 153. Stainless steel bolts shall be manufactured from 300 series stainless steel and nuts and washers from 300 series or Type 18-8 stainless steel.
5. Nuts and Washers: Nuts and washers shall be furnished from the manufacturer and used with the bolts.
6. Acceptable Products and Manufacturers:

"Kwik-Bolt II" or HSL Heavy Duty Sleeve Anchor"; Hilti Fastening Systems

"Trubolt Wedge Anchors," ITW Ramset/Red Head

"Power Stud or Power Bolt," Powers Fasteners, Inc.

"Sleeve-All", Simpson Strong-Tie Co., Inc.

Other manufacturers will be acceptable only if approved by ICBO with an ICBO Research Report submitted for Engineer review.

- R. Adhesive Bolts in Concrete- Sealed Capsule Type:

1. Type: Adhesive bolts in concrete shall consist of a specially prepared threaded steel rod meeting the requirements of ASTM A 307, A36, or A193-B7 and a sealed capsule containing

- a two part system of modified vinylester resin and hardener. Adhesive anchors containing polyester resin shall not be used.
2. Exterior Use: Adhesive bolts used in exterior, exposed, potentially wet environments and for attachment of exterior cladding materials shall have threaded rods manufactured from ASTM A 153 galvanized steel or 300 series stainless steel. Nuts and washers shall also be galvanized or stainless steel.
 3. Nuts and Washers: Nuts and washers shall be furnished from the manufacturer and used with the bolts.
 4. Products: Subject to compliance with requirements, provide one of the following:

"HVA Adhesive System"; Hilti Fastening Systems.
"Chem-Stud" or "Hammer-Capsule", Powers Fasteners, Inc.
"Maxima 7" or "Impact", ITW Ramset/Red Head
"VGC 50", Simpson Strong-Tie Co., Inc.

Other manufacturers will be acceptable only if approved by ICBO with an ICBO Research Report submitted for Engineer review.

S. Adhesive Bolts in Concrete – Two-Part Injectable Type:

1. Type: Adhesive bolts in concrete shall consist of a threaded rod steel rod meeting the requirements of ASTM A307, A36 or A193-B7 and a two component adhesive system contained in side by side packs connected to a mixing nozzles which thoroughly mixes the components as it is injected into the hole.
2. Exterior Use: Adhesive bolts used in exterior, exposed, potentially wet environments and for attachment of exterior cladding materials shall have threaded rods manufactured from ASTM A 153 galvanized steel or 300 series stainless steel. Nuts and washers shall also be galvanized or stainless steel.
3. Nuts and Washers: Nuts and washers shall be furnished from the manufacturer and used with the bolts.
4. Products: Subject to compliance with requirements provide one of the following:

"Epcon A7", ITW Ramset/Red Head
"HIT HY-150", Hilti Fastening Systems
"Acrylic-Tie", Simpson Strong-Tie Co., Inc.
"Power-Fast", Powers Fasteners, Inc.

T. Anchor Rods:

1. All anchor rods shall conform to ASTM F1554 unless noted otherwise on the drawings and shall be of the yield strength as specified below as appropriate for the types and at the locations as specified on the drawings:
 - a. ASTM F1554, Grade 36 (1/4 inch to 4 inches in diameter).
2. Anchor rods used with galvanized baseplates shall be galvanized.
3. Nuts: All nuts with anchor rods shall be heavy hex head conforming to ASTM A563.
4. Washers: Washers for all base plates shall be 1/4" thick plates extending minimum 1" from edge of base plate holes on each side with holes 1/16 inch larger than the nominal bolt diameter. Washers shall conform to ASTM A36 steel.

U. Reglets: Where resilient or elastomeric sheet flashing or bituminous membrane are terminated in reglets, provide reglets of not less than 26 gage galvanized sheet steel. Fill reglet or cover face opening to prevent intrusion of concrete or debris.

V. Carton Forms: Carton forms shall be manufactured using corrugated paper material with a moisture resistant exterior surface and specifically designed for foundation support. Carton forms

shall be designed to support the wet weight of the concrete that is shown by the details to be poured on top of the form but not less than 600 psf. Refer to the Reinforced Concrete General Notes for the restriction on horizontal construction joints. The forms shall be designed in such a way that the bottom of the form will collapse when acted upon by upward movement of the soil.

1. Form Configuration: Carton forms shall be of a vertical cellular configuration only, except as permitted by item 4 below, and shall be rectangular as shown on the details. The depth of the carton forms is shown on the details. Forms shall be manufactured to fit snugly against round piers and shall be baffled in such a way as to prevent concrete from flowing back into the form during the concrete pour. The Contractor shall use expandable foam to fill all gaps and holes between carton forms and at intersections with foundations.
2. Carton forms shall be kept dry and protected until concrete is poured. Wet, compressed, or deteriorated carton forms shall not be used. Do not wrap or cover carton forms with polyethylene sheets or permanent waterproof cover as that will prevent proper deterioration of the forms.
3. Technical data and brochures on carton forms shall be submitted for Engineer's review.
4. Other types of forms using different types of paper and different configurations will be accepted if it can be shown by independent tests that the form will properly function and will deteriorate due to moisture in an appropriate time frame.
5. For slab conditions, cover carton forms with a 1/4 inch masonite protection cover board to prevent puncture and other damage during construction.
6. Products: Subject to requirements, acceptable manufacturers include but are not limited to the following:

SureVoid Products, Inc., Englewood, CO

W. Contraction and Construction Joint-Filler Material for Slabs-on-Grade: Provide a 2-component semi-rigid, 100% solids epoxy having a minimum shore A hardness of 75 when tested in accordance with ASTM D2240. Subject to compliance with requirements, provide one of the following:

"Euco 700", Euclid Chemical Co., Inc.

"Spec-Joint CJ"; Conspec Marketing and Manufacturing Co., Inc.

"Masterfill 300 I", ChemRex, Inc., MBT Protection and Repair Division

X. Bondbreaker for Construction Joints in Slabs-on-Grade: A dissipating bondbreaking compound containing no silicones, resins, or waxes, and that conforms to ASTM C309. Subject to compliance with requirements, acceptable manufacturers include the following:

"Sure-Lift", Dayton Superior Corporation, Inc.

"Tilt-Eez", Conspec Marketing and Manufacturing Co., Inc.

Y. Joint-Filler Strips for Isolation Joints in Slabs-on-Grade: ASTM D1751, asphalt-saturated cellulosic fiber, or ASTM D1752, cork or self-expanding cork

Z. Extruded Polystyrene Fill under Topping Slabs or Slabs-on-Grade: Provide rigid, cellular polystyrene boards that conform to ASTM C 578, Type VI. Subject to compliance with requirements, acceptable manufacturers include the following:

"STYROFOAM Brand High Load 40", Dow Chemical Company

2.03 PROPORTIONING AND DESIGN OF CONCRETE MIXES

The Contractor shall submit for approval by the Engineer and Owner's Testing Laboratory, at least 15 working days prior to the start of construction, concrete mix designs and the Concrete Mix Design Submittal Form located at the end of this specification section for each class of concrete

indicated on the structural drawings and in the Specifications. The Contractor shall not begin work with a particular mix until that mix design has been approved.

- A. Mix Design Conference: At least 30 days prior to submittal of concrete design mixes, the Contractor shall hold a meeting or telephone conference to review the detailed requirements for preparing the concrete mix designs. Participants shall include representatives from the Contractor, Owner's Testing Laboratory, Concrete Supplier, and Engineer.
- B. The Contractor, acting in conjunction with his Concrete Supplier and his Testing Laboratory, shall submit in writing, with his mix designs, the method used to select mix proportions. Either of the following methods, as outlined in ACI 318, may be used.
1. Field Experience Method
 2. Laboratory Trial Mixture Method

When field experience methods are used to select concrete proportions, establish proportions as specified in ACI 301 and ACI 211. When Laboratory trial batches are used to select concrete proportions, the procedure as outlined in ACI 318 shall be followed. Prepare test specimens in accordance with ASTM C192 and conduct strength tests in accordance with ASTM C39. Proportioning without field experience or trial mixtures is not permitted.

- C. Required types of concrete and compressive strengths shall be as indicated on the Structural Drawings.

- D. All mix designs shall state the following information:

1. Mix design number or code designation by which the Contractor shall order the concrete from the Supplier.
2. Structural member for which the concrete is designed (i.e., columns, shear walls, footings, etc.).
3. Wet and dry unit weight.
4. 28 day compressive strength.
5. Aggregate type, source, size, gradation, fineness modulus.
6. Cement type and brand.
7. Fly ash or other pozzolan type and brand (if any).
8. Admixtures including air entrainment, water reducers, accelerators, and retarders.
9. Design Slump.
10. Proportions of each material used.
11. Water cement ratio and maximum allowable water content.
12. Method by which the concrete is intended to be placed (bucket, chute, or pump).
13. Required average strength qualification calculations per ACI 318 5.3.1 and 5.3.2. Submit separate qualification calculations for each production facility that will supply concrete to the project.
14. Documentation of Average strength (trial mix data or field test data) per ACI 318 5.3.3. When field test data is used to qualify average strength, submit separate documentation for each production facility that will supply concrete to the project.
15. Field test data submitted for qualification of average strength under ACI 318 5.3.1, 5.3.2 and 5.3.3 shall include copies of the Concrete Testing Agency's reports from which the data was compiled.
16. All other information requested in the Concrete Mix Design Submittal Form located at the end of this specification section.

- E. Concrete Suppliers Record of Quality Control: The concrete supplier's past record of quality control shall be used in the design of the concrete mixes to determine the amount by which the average concrete strength f_{cr} should exceed the specified strength f'_c as outlined in ACI 318. If a

suitable record of test results is not available, the average strength must exceed the design strength by the amount as specified in ACI 318. After sufficient data becomes available from the job, the statistical methods of ACI 214 may be used to reduce the amount by which the average strength must exceed f'_c as outlined in ACI 318.

- F. Low Alkali Concrete: The total alkali contribution from cementitious materials in the concrete mix shall not exceed 4.0 pounds per cubic yd of concrete unless the aggregate used is certified to contain no deleterious materials that react with alkalis in the concrete mix as defined in ASTM C33. This requirement may be met by the use of low-alkali cement.
- G. Fly Ash: Fly ash replacement of cement shall not exceed 25% unless otherwise approved. Approval for higher levels will be based on showing experience of satisfactory performance on other projects using materials from identical sources as proposed for this project. Submit evidence of such experience on other projects.
- H. Aggregate: Provide aggregates from a single source for exposed concrete. For exterior exposed surfaces, do not use fine or coarse aggregates containing spalling-causing deleterious substances. Combined aggregate gradation for slabs and other designated concrete shall be 8% - 18% for large top size aggregates (1 1/2 in.) or 8% - 22% for smaller top size aggregates (1 in. or 3/4 in.) retained on each sieve below the top size and above the No. 100.
- I. Admixtures:
 - 1. Admixtures to be used in concrete shall be subject to the approval of the Engineer and Owner's Testing Laboratory.
 - 2. Quantities of admixtures to be used shall be in strict accordance with the manufacturers instructions.
- J. Adjustments of Concrete Mixes: Mix design adjustments may be requested by the Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant. Such mix design adjustments shall be provided at no additional cost to the Owner. Any adjustments in approved mix designs including changes in admixtures shall be submitted in writing with the specified Concrete Mix Design Submittal Form to the Engineer and Owner's Testing Laboratory for approval prior to field use.
- K. Chloride Ion Content: A written submittal shall be made with each mix design proposed for use on the project that the chloride ion content from all ingredients including admixtures will not exceed the limits specified in this section of the Specifications.

2.04 CONCRETE MIXES

- A. Ready-Mix Concrete: Comply with requirements of ANSI/ASTM C 94, "Ready Mixed Concrete" and Testing Laboratory section of the specifications.

PART 3 EXECUTION

3.01 SLUMP LIMIT

- A. The slump, as measured in the field where concrete cylinders are taken, shall be within plus or minus 1 inch of the design slump noted on the Mix Design Submittal Form. Water may be added to the concrete in the field only to the extent that the prescribed water-cement ratio noted in the Mix Design Submittal Form is not exceeded.

3.02 MOISTURE RETARDER INSTALLATION

1. Install moisture retarder in accordance with ASTM E 1643 and manufacturer's instructions.
2. Seal all joints in the field with the specified pressure sensitive tape. Heat-welded joints fabricated in a shop prior to delivery is an acceptable method to minimize the number of field joints.
3. Seal all pipe penetrations through the moisture retarder with a boot made from the moisture retarder material and tape.

3.03 JOINTS IN CONCRETE

A. Construction Joints: Locate and install construction joints as indicated on the drawings or if not shown on drawings, located so as not to impair strength and appearance of the structure, as acceptable to Architect/Engineer.

1. Keyways: Provide keyways with a depth of one tenth of the member thickness (1 1/2" minimum or as shown on the drawings) in construction joints only where shown on the drawings.
2. Joint Construction: Place construction joints in the center one third of suspended spans and grade beams and as shown on the drawings for slabs-on-grade and walls unless shown otherwise. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise shown on the drawings. Dowels that cross construction joints shall be supported during concreting operations so as to remain parallel with the slab or wall surface and at right angles to the joint. Submit all construction joint locations as a shop drawing submittal.
3. Waterstops: Provide waterstops in construction joints as indicated on the Architectural and Structural Drawings. Install waterstops to form continuous diaphragm in each joint. Make provisions to support and protect exposed waterstops during progress of work. Fabricate field joints in waterstops in accordance with manufacturer's printed instructions.
4. Isolation Joints in Slabs-on-Ground: Construct isolation joints (without dowels) in slabs-on-ground at points of contact between slabs on ground and vertical surfaces only where specifically detailed on the drawings. Install joint-filler strips at joints where indicated. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated on the drawings. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together. Provide construction joints with dowels at all locations unless isolation joints are detailed.
5. Contraction (Control) Joints in Slabs-on-Ground: Maximum joint spacing shall be 36 times the slab thickness or 20 feet, whichever is less and at a minimum on column lines unless otherwise noted on the drawings. Use one of the two following methods (sawed or formed) to create the joints.
 - a. Sawed Joints
 - (1) Primary Method: Early-Entry, dry-cut method, by Soff-Cut International, Corona, CA (800) 776-3328. Finisher must have documented successful experience in the use of this method prior to this project. Install cuts within 1 to 4 hours after final finish as soon as the concrete surface is firm enough to not be torn or damaged by the blade at each saw cut location. Use 1/8 inch thick blade, cutting 1 1/4" inch into the slab.
 - (2) Optional Method (where Soff-Cut System method equipment is not available): Use a conventional saw to cut joints within 4 to 12 hours after finishing as soon as the concrete has hardened sufficiently to prevent aggregates from being dislodged by the saw. Complete cutting before shrinkage stresses become sufficient to produce cracking. Use 1/8 inch thick blade, cutting to a depth of 1/4 of the slab thickness but not less than 1 inch.
 - b. Formed Joints: Form contraction joints by inserting premolded plastic hardboard or fiberboard strip into fresh concrete until top surface of strip is flush with slab surface. The depth is to be 1/4 the slab thickness, but not less than 1 inch. Tool slab edges round on

each side of insert. After concrete has cured, remove inserts and clean groove of loose debris.

- c. Joint Filler: Provide in both contraction and saw-cut construction joints when specified.
 - (1) Remove dirt and debris from the joint by vacuuming immediately prior to filling joint. Clean the joint of curing compounds and sealers.
 - (2) Filler material shall be applied to the joints when the building is under permanent temperature control, but no less than 90 days after slab construction.
 - (3) Strictly following the manufacturer's recommended procedure for installing filler material.
- d. The Contractor shall protect the joints from damage caused by wheeled traffic or other sources during construction until a joint-filler material (if specified) has been installed.

3.04 INSTALLATION OF EMBEDDED ITEMS

- A. General: Set and build into work anchorage devices and other embedded items required for other work that is attached to, or supported by, cast-in-place concrete. Use setting drawings, diagrams, instructions and directions provided by suppliers of items to be attached thereto unless directed otherwise by these specifications. Install reglets to receive top edge of foundation sheet waterproofing where specified by the Architect, and to receive thru-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, relieving angles and other conditions.
- B. Anchor Rods: Furnish anchor rods and other connectors required for securing structural steel to foundations and other in-place work as shown on the drawings. Furnish 1/8" minimum steel templates for presetting bolts and other anchors to accurate locations as shown on the drawings.
- C. Edge Forms and Screed Strips for Slabs: Set edge forms or bulkheads and intermediate screed strips for slabs to obtain required elevations and contours in finished slab surface. Provide and secure units sufficiently strong to support types of screed strips by use of strike-off templates or accepted compacting type screeds.
- D. Do not install sleeves in concrete slabs, pier caps, footings or walls except where shown on the structural drawings or approved by the Architect and Engineer.
- E. Securely fasten embedded plates, angles, anchor rods and other items to be built into the concrete to the formwork or hold in place with templates. Insertion of these items into concrete after casting is prohibited.

3.05 CONCRETE PLACEMENT

- A. Preplacement Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel and items to be embedded or cast-in. Notify other crafts to permit installation of their work; cooperate with other trades in setting such work. Moisten wood forms immediately before placing concrete where form coatings are not used.
- B. Coordinate the installation of joint materials and moisture barriers with placement of forms and reinforcing steel.
- C. Comply with ACI 301 and as herein specified.
 - 1. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as herein specified. Deposit concrete as nearly as practicable to its final location to avoid segregation. Spread concrete using short-handled, square-ended shovels, or come-alongs.

2. Placing Concrete in Forms: Deposit concrete in forms in horizontal layers not deeper than 24" and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.
3. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding or tamping. Use internal vibrators of the largest size and power that can properly be used in the work as described in the table entitled "Range of characteristics, performance, and applications of internal vibrators" found in ACI 301.
4. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than visible effectiveness of machine. Place vibrators to rapidly penetrate placed layer and at least 6" into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of mix.
5. Placing Concrete Slabs: Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until the placing of a panel or section is completed. Place concrete for beams, girders, brackets, column capitals, haunches, and drop panels at the same time as concrete for slabs. Do not place concrete over columns and walls until concrete in columns and walls is no longer plastic and has been in place at least one hour.
6. Consolidate concrete during placing operations so that concrete is thoroughly worked around reinforcement and other embedded items and into corners of forms, eliminating air and stone pockets that may cause honeycombing, pitting, or planes of weakness.
7. Bring slab surfaces to correct level with straightedge and strikeoff. Use highway straightedges, bull floats or darbies to smooth surface free of humps or hollows before excess moisture or bleedwater appears on the surface. Do not disturb slab surfaces prior to beginning finishing operations.
8. Maintain reinforcing in proper position during concrete placement operations.
9. Placing Concrete by Pump: If concrete is placed by using a pump, the grout used for pump priming must not become a part of the completed structure unless an engineered grout design mix and grout location are approved in advance by the Engineer.

3.06 FINISH OF FORMED SURFACES

- A. Rough Form Finish: Provide rough form finish for formed concrete surfaces not exposed-to-view in the finish work and in parking garages unless otherwise indicated. This is the concrete surface having texture imparted by form facing material used, with tie holes and defective areas repaired and patched and fins and other projections exceeding 1/4" in height rubbed down or chipped off.
- B. Smooth Form Finish: Provide smooth form finish for formed concrete surfaces exposed-to-view (except parking garage, unless noted otherwise), or that are to be covered with a coating material applied directly to concrete, or a covering material applied directly to concrete, such as waterproofing, dampproofing, painting, veneer plaster or other similar system or to a surface that is to receive a smooth rubbed finish or grout cleaned finish. This is as-cast concrete surface obtained with selected form facing material, arranged orderly and symmetrically with a minimum of seams. Repair and patch defective areas with fins or other projections exceeding 1/8 inch in height removed and smoothed.
- C. Related Unformed Surfaces: At tops of walls, horizontal offsets and similar unformed surfaces occurring adjacent to formed surfaces, strike-off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.07 MONOLITHIC SLAB FINISHES

Place, consolidate, strike off, and level concrete, eliminating high spots and low spots, before proceeding with any other finish operation. Do not add water to the surface of the concrete during finishing operation.

- A. Scratch Finish: Apply scratch finish to monolithic slab surfaces that are to receive concrete floor topping or mortar setting beds for tile, portland cement terrazzo and other bonded applied cementitious finish flooring material, and as otherwise indicated. After placing slabs, plane surface to tolerance specified below. Slope surfaces uniformly to drains where required. After leveling, roughen surface before final set, with stiff brushes, brooms or rakes.
- B. Float Finish: Apply float finish to monolithic slab surfaces to receive trowel finish and other finishes as hereinafter specified, and slab surfaces which are to be covered with membrane or elastic waterproofing, membrane or elastic roofing, or sand-bed terrazzo, and as otherwise indicated. After screeding, consolidating and leveling concrete slabs, do not work surface until ready for floating. Begin floating, using a hand float, a bladed power float equipped with float shoes, or a powered disk float, when the bleed water sheen has disappeared and the concrete surface has stiffened sufficiently to permit the operation. Check and level surface plane to a tolerance as specified below. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth, granular texture.
- C. Trowel Finish: Apply trowel finish to monolithic slab surfaces to be exposed-to-view, and slab surfaces to be covered with resilient flooring, carpet, ceramic or quarry tile, paint or other thin film finish coating system. After floating, begin first trowel finish operation by hand or power-driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over surface. Consolidate concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance, and with a level surface to a tolerance as specified below. Grind smooth surface defects which would telegraph through applied floor covering system.
- D. Trowel and Fine Broom Finish: Where ceramic or quarry tile is to be installed with thin-set mortar, apply trowel finish as specified above, then immediately follow with slightly scarifying surface by fine brooming.
- E. Slip-Resistive Broom Finish: Apply slip-resistive broom finish to garage floors and ramps less than 6% slope, exterior concrete platforms, steps and ramps and elsewhere as indicated. Immediately after float finishing, slightly roughen concrete surface by brooming with fiber bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.
- F. Chemical-Hardener Finish: Apply chemical-hardener finish to interior concrete floors where indicated. Apply liquid chemical-hardener after complete curing and drying of the concrete surface. Apply proprietary chemical hardeners, in strict accordance with manufacturer's printed instructions.

After final coat of chemical-hardener solution is applied and dried, remove surplus hardener by scrubbing and mopping with water.

- G. Slip-Resistive Aggregate Finish: Apply slip-resistive aggregate finish to concrete stair treads, platforms, ramps and elsewhere as indicated on the Architect's or Structural Drawings.

After completion of float finishing, and before starting trowel finish, uniformly spread 25 lbs. of dampened slip-resistive aggregate per 100 sq. ft. of surface. Tamp aggregate flush with surface using a steel trowel, but do not force below surface. After broadcasting and tamping, apply trowel finishing as herein specified.

After curing, lightly work surface with a steel wire brush, or an abrasive stone, and water to expose slip-resistive aggregate.

- H. Non-Oxidizing Metallic Floor Hardener: Slabs in areas noted on the drawings shall receive an application of the non-oxidizing, metallic floor hardener applied at the rate of 150 lbs. Per 100 sq.

ft. Immediately following the first floating operation, uniformly distribute approximately 2/3 of the required weight of the hardener over the concrete surface by mechanical spreader and embedded by means of power floating. The hardener shall be floated in and the second application made. The surface shall be floated again to properly bond the hardener to the base concrete slab. The surface shall then be troweled at least twice to a smooth dense finish.

3.08 CONCRETE FINISH MEASUREMENT AND TOLERANCES

A. Definitions:

1. Flatness - a measure of a concrete surfaces curvature or deviation from a planar surface. Concrete surfaces that are not flat are wavy or bumpy.
2. Levelness - A measure of a concrete surfaces tilt or inclination from a horizontal plane. Concrete surfaces that are not level are sloped or tilted.
3. F_F Flatness F-Number - The flatness F-Number F_F measures floor curvature or flatness and for any floor section or overall floor area is defined as follows:

$$F_F = \frac{4.57}{(3 \times S_q) + \bar{q}}$$

Where $\bar{q}$ is the mean value and S_q the standard deviation of all floor q readings. A q reading is defined as the difference in slope between three successive points along any test measurement line on the floor surface that are twelve inches apart.

4. F_L Levelness F-Number - The levelness F-Number F_L measures floor inclination from a horizontal plane and for any floor section or overall area is defined as follows:

$$F_L = \frac{12.5}{(3 \times S_z) + \bar{z}}$$

Where $\bar{z}$ is the mean value and S_z the standard deviation of all floor z readings. A z reading is defined as the difference in elevation between two successive points along any test measurement line on the floor surface that are 10 feet (120") apart.

Measurement of F_L is not applicable for floors that are intentionally inclined or cambered, for elevated structural floors that can deflect from the time the floor is poured to the time it is measured, and for unshored form surfaces.

- B. Measurement Standard: All floors should be measured for flatness and levelness according to ASTM E 1155 "Standard Test Method for Determining Floor Flatness and Levelness Using the F-Number System".
- C. Time Period for Measurement and Reporting: Measurement of the finished concrete surface profile for any test section shall be made when requested by the Owner's Representative at his option. All measurements shall be made by the Owner's Testing Laboratory or designated party within 24 hours after completion of finishing operations. For structural elevated floors measurement shall also be made prior to removal of forms and shores. The Contractor shall be notified immediately after the measurements of any section are complete and a written report of the floor measurement results shall be submitted within 72 hours after finishing operations are complete. The Contractor shall take immediate action to correct any work that is outside specified tolerances as outlined later in this section.

D. Measuring Equipment: The concrete surface profile shall be measured using equipment manufactured for the purpose such as a Dipstick Floor Profiler as manufactured by the Edward W. Face Company in Norfolk, Virginia, F-Meters manufactured by Allen Face & Company in Norfolk, Virginia, optical, or laser means or other method specified in ASTM E 1155.

E. Two-Tiered Measurement Standard: Each floor test section and the overall floor area shall conform to the two-tiered measurement standard as specified herein.

1. Minimum Local Value (MLV). The minimum local F_F/F_L values represent the absolute minimum surface profile that will be acceptable in any one floor test section.
2. Specified Overall Value (SOV). The specified overall F_F/F_L values represent the minimum values acceptable for all combined floor test sections representing the overall floor.

SOV and MLV F_F/F_L values are specified later in this section for each portion of the structure.

F. Floor Test Sections: For purposes of this specification a floor test section is defined as the smaller of the following areas:

1. The area bounded by column and/or wall lines.
2. The area bounded by construction and/or control joint lines.
3. Any combination of column lines and/or control joint lines.

Test sample measurement lines within each test section shall be multidirectional along two orthogonal lines as defined by ASTM E 1155.

The precise layout of each test section shall be determined by the Owner's testing agency and shall be submitted for Architect/Engineer review and approval.

G. Tolerance on Floor Elevations: Construction tolerance on absolute floor elevation from the specified elevation as shown on the drawings shall be as specified below, taken from ACI 117:

1. Slab-on-Grade Construction - $\pm 3/4"$.
2. Top surfaces of formed slabs measured prior to removal of supporting shores - $\pm 3/4"$.
3. Top surfaces of all other slabs - $\pm 3/4"$.

The tolerance on relative elevation difference between points on the floor shall be defined by the F_L Levelness F-Number as prescribed below.

H. Construction Requirements to Achieve Specified Floor Finish Tolerances:

1. Forms shall be properly leveled, in good condition and securely anchored including special attention to ends and transitions.
2. Bearing surfaces for straightedges such as form edges or previously poured slabs shall be kept clean of laitance, sand, gravel, or other foreign elements.
3. Screeds shall be maintained in good condition with true round rolling wheels and level cutting edges. The use of optical sighting equipment such as lasers is recommended for checking levelness and straightness. The Contractor shall promptly adjust or replace equipment when test results indicate substandard work.
4. Highway straightedges are recommended for use in lieu of bullfloats for all slab placement and finishing operations.

I. Contractor Responsibility for Concrete Floor Finish Requirements: Floor finish requirements shown below (flatness and levelness tolerances) are minimum requirements that apply unless stricter requirements are contained in instructions for installation of applied floor products in which

case the Contractor is responsible for attaining the values prescribed by the manufacturer of such products.

J. Concrete Floor Finish Tolerance for Slab-on-Grade Construction:

1. Concrete Placement: Concrete shall be placed and screeded to predetermined marks set to elevations prescribed on the drawings.
2. Tolerance:
 - a. Slabs in nonpublic areas, mechanical rooms, surfaces to received raised computer flooring, surfaces to have thick-set tile or a topping, and parking structures:
Specified Overall Value - F_F20/F_L15
Minimum Local Value - F_F15/F_L10
 - b. Carpeted Areas:
Specified Overall Value - F_F25/F_L20
Minimum Local Value - F_F17/F_L15
 - c. Exposed slabs in public spaces, slabs to receive thin-set flooring:
Specified Overall Value - F_F35/F_L25
Minimum Local Value - F_F24/F_L17

K. Concrete Floor Finish Tolerance - Unshored Metal Deck on Shored or Unshored Steel Beam or Open-Web Joist Floor Construction:

1. Concrete Placement: Concrete over metal deck shall be placed and screeded level and flat to the tolerance specified below, maintaining at least the minimum slab thickness at all locations as specified on the drawings. The Contractor shall increase the slab thickness as required to compensate for metal deck deflection, and in unshored beam construction, residual beam camber and beam deflection in order to achieve a level and flat floor within specified tolerances.
2. Finish Tolerance of Random Traffic Floor Surfaces:
 - a. Slabs in nonpublic areas, mechanical rooms, surfaces to received raised computer flooring, surfaces to have thick-set tile or a topping, and parking structures: Conventional
 - b. Carpeted Areas: Moderately Flat
 - c. Exposed slabs in public spaces, slabs to receive thin-set flooring: Flat
 - d. Movie or Television studios: Super Flat
 - e. Eighty percent (80%) of the final floor surface shall fall within an envelope of 0.75" centered about the mean elevation of all the readings. (± 0.375 about mean). The mean elevation of all readings shall not deviate from the specified design grade by more than ± 0.375 ".

L. Remedial Measures for Slab Finish Construction Not Meeting Specified Tolerances:

1. Application of Remedial Measures. Remedial measures specified herein are required whenever either or both of the following occur:
 - a. The composite overall values of F_F or F_L of the entire floor installation measure less than specified values.
 - b. Any individual test section measures less than the specified absolute minimum F_F or F_L value.
2. Modification of Existing Surface:
 - a. If, in the opinion of the Architect/Engineer or Owner's Representative, all or any portion of the substandard work can be repaired without sacrifice to the appearance or serviceability of the area, then the Contractor shall immediately undertake the approved repair method.
 - b. The Contractor shall submit for review and approval a detailed work plan of the proposed repair showing areas to be repaired, method of repair and time to effect the repair.

- c. Repair method(s), at the sole discretion of the Architect/Engineer or Owner's Representative, may include grinding (floor stoning), planing, retopping with self leveling underlayment compound or repair topping, or any combination of the above.
 - d. The Architect/Engineer or Owner's Representative maintains the right to require a test repair section using the approved method of repair for review and approval to demonstrate a satisfactory end product. If, in the opinion of the Architect/Engineer or Owner's Representative, the repair is not satisfactory an alternate method of repair shall be submitted or the defective area shall be replaced.
 - e. The judgment of the Architect/Engineer or Owner's Representative on the appropriateness of a repair method and its ability to achieve the desired end product shall be final.
 - f. All repair work shall be performed at no additional cost to the Owner and with no extension to the construction schedule.
3. Removal and Replacement:
- a. If, in the opinion of the Architect/Engineer or Owner's Representative, all or any portion of the substandard work cannot be satisfactorily repaired without sacrifice to the appearance or serviceability of the area, then the Contractor shall immediately commence to remove and replace the defective work.
 - b. Replacement section boundaries shall be made to coincide with the test section boundaries as previously defined.
 - c. Sections requiring replacement shall be removed by sawcutting along the section boundary lines to provide a neat clean joint between new replacement floor and existing floor.
 - d. The new section shall be reinforced the same as the removed section and doweled into the existing floor as required by the Engineer. No existing removed reinforcing steel may be used. All reinforcing steel shall be new steel.
 - e. Replacement sections may be retested for compliance at the discretion of the Architect/Engineer or Owner's Representative.
 - f. The judgment of the Architect/Engineer or Owner's Representative on the need for replacement shall be final.
 - g. All replacement work shall be performed at no additional cost to the Owner and with no extension to the construction schedule.

3.09 CONCRETE CURING AND PROTECTION

A. General:

- 1. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Maintain concrete with minimal moisture loss at a relatively constant temperature for the period necessary for hydration of the cement and hardening of concrete. In hot, dry and windy weather protect concrete from rapid moisture loss exceeding 0.2 lb./sq. ft. x hr before and during finishing operations with an evaporation control material. Apply in accordance with manufacturer's instructions after screeding and bull floating, but before power floating and troweling.
- 2. Curing shall commence as soon as free water has disappeared from the concrete surface after placing and finishing. The curing period shall be 7 days for all concrete except high early strength concrete which shall be cured for 3 days minimum.

Alternatively, curing times may be reduced if either of the following provisions is complied with:

- a. If tests are made of cylinders kept adjacent to the structure and cured by the same methods, curing measures may be terminated when the average compressive strength has reached 70% of the specified 28 day compressive strength.

- b. If the temperature of the concrete is maintained at a minimum of 50°F for the same length of time required for laboratory cured cylinders of the same concrete to reach 85% of the 28 day compressive strength, then curing may be terminated thereafter.
 3. Curing shall be in accordance with ACI 301 procedures. Avoid rapid drying at the end of the curing period.
- B. Curing Formed Surfaces: Where wooden forms are used, cure formed concrete surfaces, including undersides of beams, supported slabs and other similar surfaces by moist curing with forms in place for full curing period or until forms are removed. When forms are removed, continue curing by one or a combination of the methods specified below, as applicable.
 1. Columns and Shearwalls Not Exposed to View: Moist cure in forms or by one or a combination of methods 1, 2, or 3 specified below. Use a high –solids, liquid membrane-forming curing and sealing compound conforming to ASTM C1315, type I, Class A or B for method 3.
 2. Columns and Shearwalls Exposed to View: Moist cure in forms or by one or a combination of methods 1, 2 or 3 specified below. Use a high-solids, non-yellowing, liquid membrane-forming curing and sealing compound conforming to ASTM C1315, type 1, class A for method 3.
 3. Sides and Soffits of Beams and Pan-Joist Ribs, Soffits of Slabs: Moist cure in forms or by one or a combination of methods 1, 2 or 3 specified below. Use a liquid membrane-forming dissipating resin curing compound conforming to ASTM C309, type 1, class A or B for method 3.
 4. Basement Walls, Sides of Exterior Retaining Walls: Moist cure in forms or by one or a combination of methods 1, 2 or 3 specified below. Use a liquid membrane-forming dissipating resin curing compound conforming to ASTM C309, type 1, class A or B for method 3.
- C. Curing Unformed Surfaces: Cure unformed surfaces, such as slabs, floor topping and other flat surfaces by one or a combination of the methods specified below, as applicable. The Contractor shall choose a curing method that is compatible with the requirements for subsequent material usage on the concrete surface.
 1. Floors Directly Exposed to Vehicular or Foot Traffic not in Parking Areas: Apply two coats of a high-solids, liquid membrane-forming curing and sealing compound conforming to ASTM C1315, type 1, Class A in accordance with method 3 as specified below.
 2. Floors that are to receive subsequent cementitious toppings, sealers, hardeners, ceramic tile, acrylic terrazzo, vinyl composition tile, sheet vinyl, linoleum, vinyl-backed carpet, rubber, athletic flooring, synthetic turf, wood, epoxy overlay or adhesive, or other coating or finishing products: Cure using methods 2 or 3 as specified below. Use a water-based dissipating resin type curing compound conforming to ASTM C309, type 1, class A or B for method 3.
 3. All Other Surfaces: Cure using methods 1,2 or 3 as specified below. Use a water-based dissipating resin type curing compound conforming to ASTM C309, type 1, class A or B for method 3.
- D. Curing Methods:
 1. Method 1 - Moisture Curing: Provide moisture curing by one of the following methods:
 - a. Keep concrete surface continuously wet by covering with water.
 - b. Continuous water-fog spray.
 - c. Covering concrete surface with specified absorptive cover, thoroughly saturating cover with water and keeping continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with 4" lap over adjacent absorptive covers.

2. Method 2 - Moisture-Cover Curing: Provide moisture-cover curing as follows:

Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 3" and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape. Water may be added to concrete surface to prevent drying before the cover is installed, but the surface shall not be flooded with water.

3. Method 3 – Curing or Curing and Sealing Compound: Provide curing, curing/hardener, liquid membrane-forming curing, or curing and sealing compound as follows:

Apply specified compound to concrete slabs as soon as final finishing operations are complete (within 2 hours and after surface water sheen has disappeared). Apply uniformly in continuous operation by power-spray or roller in accordance with manufacturer's directions. Do not allow to puddle. Recoat areas subjected to heavy rainfall within 3 hours after initial application. Maintain continuity of coating and repair damage during curing period. Apply second coat for sealing 2 to 3 hours after the first coat was applied.

Do not use membrane-forming curing and sealing compounds on surfaces which are to be covered with coating material applied directly to concrete, liquid floor hardener, waterproofing, dampproofing, membrane roofing, flooring (such as ceramic or quarry tile, glued-down carpet, vinyl composition tile, linoleum, sheet vinyl, rubber, athletic flooring, synthetic turf, or wood), paint or other coatings and finish materials. Dissipating resin type cures are acceptable in these locations.

3.10 HOT OR OTHER ADVERSE WEATHER CONCRETING

A. Definition:

1. Conditions warranting hot weather concreting practices are defined as any combination of high air temperature, low relative humidity and wind velocity tending to impair the quality of fresh or hardened concrete or otherwise result in abnormal properties. If conditions cause an evaporation rate of 0.2 lb./sq. ft./hr. as calculated by Figure 2.1.5 in ACI 305R-99, then precautions shall be taken to prevent plastic shrinkage cracks from occurring.
2. The maximum acceptable concrete temperature at the truck discharge point shall be 95°F.

B. Specification: Hot weather concreting practices specified below shall be followed, all or in part as required, to limit the concrete temperature at the truck discharge point to 95°F or lower.

C. Records: Under hot weather conditions, the Contractor shall keep records of outside air temperature, concrete temperature at truck discharge and general weather conditions.

D. Hot Weather Concreting Requirements: The following items, all or in part as required, shall be followed to limit the concrete temperature to 95°F or lower and to minimize the possibility of plastic shrinkage cracks from developing.

1. Design the concrete mixes specifically for hot weather conditions replacing some cement with fly ash or other pozzolan and using a water reducing retarding admixture (ASTM C 494 Type D).
2. Use the largest size and amount of coarse aggregate compatible with the job.
3. Use sunshades and/or windbreaks.
4. Delay construction of indoor slabs-on-grade until the walls and roof are constructed.
5. Cool and shade aggregate stockpiles.
6. Use ice as part of the mixing water or cool the water with liquid nitrogen.

7. Limit the number of revolutions at mixing speed to 125 maximum.
8. Reduce time between mixing and placing as much as possible.
9. Do not add water to ready-mixed concrete at the job site unless it is part of the amount required initially for the specified water-cement ratio and the specified slump.
10. Schedule concrete placement for early morning, late afternoon, or night.
11. Have all forms, equipment and workers ready to receive and handle concrete.
12. Maintain one standby vibrator for every three vibrators used.
13. Keep all equipment and material cool by spraying with water including exteriors of forms, reinforcing steel, subgrade, chutes, conveyors, pump lines, tremies, and buggies.
14. Protect slab concrete at all stages against undue evaporation by applying a fog spray or mist above the surface or applying a monomolecular film. Where high temperatures and/or placing conditions dictate, use water-reducing retarding admixture (Type D) in lieu of the water-reducing admixture (Type A) as directed by the Owner's Testing Laboratory.
15. Provide continuous curing, preferably with water, during the first 24 hours using wet burlap, cotton mats, continuous spray mist, or by applying a curing compound meeting ASTM C 1315. Continue curing for 3 days minimum.
16. Cover reinforcing steel with water soaked burlap so that steel temperature will not exceed ambient air temperature immediately before placement of concrete.
17. As soon as possible, loosen forms and run water down the inside. When forms are removed, provide a wet cover to newly exposed surfaces.

3.11 COLD OR OTHER ADVERSE WEATHER CONCRETING

A. Definition:

1. Concrete shall not be placed when the outside air temperature is 40°F or less unless cold weather concreting practices are followed as specified below.
2. Cold weather concreting practices should also be followed whenever the following conditions exist for more than three successive days:
 - a. the average daily air temperature is less than 40°F, and
 - b. the air temperature is not greater than 50°F for more than one half of any 24 hour period.

The average daily air temperature is the average of the highest and lowest temperature occurring during the period from midnight to midnight.

3. The temperature of concrete mixed and delivered to the job site shall conform to the following requirements:

<u>Air Temperature</u>	<u>Min. Concrete Temperature</u>
Above 30°F	60°F
0°F to 30°F	65°F
Below 0°F	70°F

4. The minimum temperature of concrete during placement and curing shall be 55°F.
5. The maximum concrete temperature heated by artificial means at point of placement shall not exceed 90°F.

B. Records: Under cold weather conditions, the Contractor shall keep records of outside air temperature, concrete temperature as placed and general weather conditions.

C. Cold Weather Concreting Requirements: The following items, all or in part as required, should be followed to assure acceptable concrete in cold weather conditions:

1. Design the concrete mix suitable for cold weather. Use air entrainment (where not prohibited) and obtain high early strength by using a higher cement content, a high early strength cement (Type III), or a specified non-chloride accelerator (ASTM C 494 Type C or E).
2. Protect the concrete during curing period using insulating blankets, insulated forms, enclosures and/or heaters.
3. Concrete cured in heated enclosures shall have heaters vented to prevent exposure of concrete and workmen to noxious gases.
4. Frozen subgrade shall be thawed prior to concrete placement and snow and ice shall be removed from forms.
5. Concrete shall be protected and cured at 50°F for seven days minimum if normal concrete (Type I cement) is used and for three days minimum if high early strength concrete (concrete with Type III cement, 100 pounds cement added per cubic yard concrete, or a non-chloride accelerator added).
6. Concrete not loaded during construction shall be protected a minimum of 3 days for normal concrete and 2 days for high early strength concrete to obtain safe form stripping strength. Concrete fully loaded during construction shall be protected for whatever time period is required to obtain the required strength as determined by nondestructive strength tests (Windsor probe, Swiss Hammer Test) on the in-place concrete.
7. Heat the mixing water and then blend hot and cold water to obtain concrete no more than 10°F above the required temperature.
8. Heat the aggregates by circulating steam in pipes placed in the storage bins for air temperatures consistently below 32°F. When either water or aggregate is heated to over 140°F combine them in the mixer first to obtain a maximum temperature of the mixture not to exceed 140°F in order to prevent flash set of the concrete.
9. Uniformly thaw aggregates far in advance of batching to prevent moisture variations in the stockpile.
10. Cover warmed stockpiles with tarps to retain heat.
11. Place air entraining admixture in the batch after the water temperature has been reduced by mixing with cooler solid materials.
12. Use wind screens to protect concrete from rapid cooling.
13. Place vertical pump lines inside the building, if possible, for concrete being pumped.
14. Maintain artificial heat as low as possible to reduce temperature stresses during cooling.
15. Avoid water curing of concrete except for parking garage structures. Apply the required curing compound to unformed surfaces as soon as possible to prevent drying of concrete from heated enclosures.
16. Delay form stripping as long as possible to help prevent drying from heated enclosures and to reduce damage to formed surfaces caused by premature stripping.
17. Provide triple thickness of insulating materials at corners and edges vulnerable to freezing.
18. Wrap protruding reinforcing bars with insulation to avoid heat drain from the warm concrete.
19. Gradually reduce the heat at the end of the heating period to reduce likelihood of thermal shock.

3.12 MISCELLANEOUS CONCRETE ITEMS

- A. Filling-In: Fill-in holes and openings left in concrete structures for passage of work by other trades, unless otherwise shown or directed, after work of other trades is in place. Mix, place and cure concrete as herein specified, to blend with in-place construction. Provide other miscellaneous concrete filling shown or required to complete work.
- B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and steel-troweling surfaces to a hard, dense finish with corners, intersections and terminations slightly rounded.
- C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations, as shown on drawings. Set anchor bolts for machines and equipment to template at correct

elevations, complying with certified diagrams or templates of manufacturer furnishing machines and equipment.

- D. Grout base plates and foundations as indicated, using specified non-shrink, non-metallic grout. Use high-flow grout where high fluidity and/or increased placing time is required. This grout shall be used for all base plates larger than 10 square feet.
- E. Steel Pan Stairs: Provide concrete fill for steel pan stair treads and landings and associated items. Cast-in safety inserts and accessories as shown on drawings. Screed, tamp and finish concrete surfaces as scheduled.
- F. Installation of Adhesive Anchors Using Injectable Epoxy or Adhesive: A representative of the adhesive manufacturer shall be present for the first three holes that are drilled and filled with adhesive. After drilling the hole to the diameter and depth recommended by the manufacturer, clean the hole with a wire or nylon brush. Blow the dust out of the hole using compressed air with a nozzle that reaches to the bottom of the hole. When using adhesive from a new pack, the adhesive that is discharged from the mixing nozzle should be a uniform gray color before any adhesive is installed in the hole. Fill the hole with adhesive starting from the very bottom of the hole until the hole is about 2/3 full. Do not leave an air pocket at the bottom of the hole. Insert the anchor rod or dowel by slowly twisting it into the hole.

3.13 CONCRETE SURFACE REPAIRS

A. Definition - Defective Areas:

- 1. Formed Surfaces: Concrete surfaces requiring repairs shall include all honeycombs, rock pockets and voids exceeding 1/4" in any dimension, holes left by tie rods or bolts, cracks in excess of 0.01" and any other defects that affect the durability or structural integrity of the concrete.
- 2. Unformed Surfaces: Concrete surfaces requiring repair shall include all surface defects such as crazing, cracks in excess of 0.01" wide or cracks which penetrate to reinforcement or through the member, popouts, spalling and honeycombs.

B. Classification:

- 1. Structural Concrete Repair: Major defective areas in concrete members that are load carrying (such as shear walls, beams, joists and slabs), are highly stressed, and are vital to the structural integrity of the structure shall require structural repairs. Structural concrete repairs shall be made using a two-part epoxy bonder, epoxy mortar or specified polymer repair mortar. The Engineer shall determine the locations of required structural concrete repairs.
- 2. Cosmetic Concrete Repair: Defective areas in concrete members that are non-load carrying and minor defective areas in load carrying concrete members shall require cosmetic concrete repair when exposed to view and not covered up by architectural finishes. Cosmetic concrete repairs may be made using a polymer repair mortar and compatible bonding agent. The Architect/Engineer shall determine the locations of required cosmetic concrete repairs. Stains and other discolorations that cannot be removed by cleaning and are exposed to view will require cosmetic repair. Cosmetic concrete repair in exposed-to-view surfaces will require Architect's approval prior to patching operation.
- 3. Slab Repairs: High and low areas in concrete slabs shall be repaired by removing and replacing defective slab areas unless an alternate method, such as grinding and/or filling with self-leveling underlayment compound or repair mortar is approved by the Architect/Engineer. Repair of slab spalls and other surface defects shall be made using epoxy products as specified above and as determined by the Engineer. The high strength flowing repair mortar may be used for areas greater than 1 inch in depth.

3.14 QUALITY CONTROL TESTING DURING CONSTRUCTION

- A. See Testing Laboratory Services section of these Specifications for concrete materials and cast-in-place concrete inspection and test requirements.

3.15 INVESTIGATION OF LOW CONCRETE STRENGTH TEST RESULTS

- A. Contractor Responsibility for Low Strength Concrete:

1. If the average of any three consecutive strength tests falls below the required f'_c for a class of concrete but no individual strength test is more than 500 psi below f'_c , the Contractor shall immediately notify the Engineer by telephone or e-mail and take immediate steps to increase the average of subsequent strength tests.
2. If any individual strength test falls more than 500 psi below the required f'_c , the Contractor shall immediately notify the Engineer by telephone or e-mail and take immediate steps to assure that the load-carrying capacity of the structure is not jeopardized.

- B. Additional Field Tests to Confirm Low Concrete Strengths:

1. The cost of all investigations of low-strength concrete, as defined by any individual strength test being more than 500 psi below the required f'_c , shall be borne by the Contractor.
2. Code-Prescribed Acceptance: The only accepted field-test methods of determining actual in-situ concrete strength is by the way of core tests as prescribed by ACI 318.
3. Non-Destructive Tests: If any individual strength test falls more than 500 psi below the required f'_c , the Engineer may request that non-destructive field tests be performed on the concrete in question using Swiss Hammer, Windsor Probe, or other appropriate methods as approved by the Engineer. Report the comparative test results of the suspect concrete under consideration with identical tests done on concrete of known strength and of the same class. The Engineer considers these test results as only approximate indicators of strength and may not necessarily, by themselves, resolve the low concrete strength issue. These test results will be considered as additional information by which to make an informed judgment. The Engineer reserves the right to accept the concrete based on the results of these approximate tests or order that core tests be taken as prescribed below. At the Contractor's option, the approximate non-destructive field-tests may be waived and core tests immediately initiated.
4. Core Tests: If, in the opinion of the Engineer, the likelihood of low-strength concrete is confirmed and it has been determined that the load-carrying capacity of the structure is significantly reduced as a result, the Engineer may request that core tests be taken from the area in question as directed by the Engineer. There shall be a minimum of three cores taken for each strength test more than 500 psi below the required f'_c in accordance with ASTM C42. If concrete in the structure will be dry under service conditions, cores shall be air dried (temperature 60° to 80°F, relative humidity less than 60 percent) for 7 days before test and shall be tested dry. If concrete in the structure will be more than superficially wet under service conditions, cores shall be immersed in water for at least 40 hours and tested wet. The Contractor shall fill all holes made by drilling cores with an approved drypack concrete.
5. Acceptance Criteria for Core Test: Concrete in an area represented by core tests shall be considered adequate if the average of three cores is equal to at least 85% of the required f'_c and no single core is less than 75% of the required f'_c . If approved by the Engineer, locations of erratic core strengths may be retested to check testing accuracy.
6. Load Test: If the concrete strength is not considered adequate based on core tests and the structural adequacy remains in doubt, the Engineer may order a load test as specified in ACI 318 be conducted for the questionable portion of the structure.

7. Strengthening or Demolition of the Structure: If the structural adequacy of the affected portion of the structure remains in doubt following the load test, the Engineer may order the structure to be strengthened by an appropriate means or demolished and rebuilt at the Contractor's expense.

END OF SECTION

Concrete Mix Design
Submittal Form (Note 1)

Date: _____

I. Project Information

A. Name of Project: _____ B. City, State: _____
C. General Contractor: _____
D. Concrete Supplier: _____
1. Address: _____
2. Name to Contact: _____ 3. Phone No.: _____ 4. Fax No.: _____

II. Concrete Mix Information

A. Concrete Mix Design Designation (Note 2): _____
B. Minimum Concrete Strength f'_c : _____ psi at _____ days and C. Maximum w/c Ratio: _____
D. Concrete Type (check one) _____ NW _____ LW E. Required Wet Weight: _____ pcf
F. Concrete Use (member type as specified in General Notes): _____
G. Required Air Content: _____ %
H. Method of Concrete Placement for this Mix:
(check one) _____ Bucket _____ Pump _____ Chute _____ Tremie _____ Other (Specify) _____

III. Method of Concrete Mix Design Preparation: (Check One Method Below) (Note 3)

A. _____ Field Experience Method B. _____ Trial Mixture Method

IV. Concrete Production Facility Information

A. Production facility has field strength test records of specified class or within 1 ksi of class: _____ Yes _____ No
Answer B thru C only if answer to IV.A. is "yes". If answer to IV.A. is "no", go to V.B.:
B. Test Record Information: (Check either 1, 2, or 3 below)
1. _____ ≥ 30 consecutive tests 2. _____ Two groups of ≥ 30 tests 3. _____ 15 to 29 tests
C. Standard Deviation S(PSI):
1. Modification Factor (if B.3. checked only. Ref. Table 5.3.1.2 of ACI 318-02.) MF = _____
2. Standard Deviation S = _____ psi 3. MF x S (if B.3. checked only) = _____ psi

Note: Combined aggregate gradation for slabs and other designated concrete shall be 8% -18% for large top size aggregates (1 1/2 in.) or 8%-22% for smaller top size aggregates (1 in. of 3/4 in.) retained on each sieve below the top size and above the No. 100 sieve.

V. Required Average Compressive Strength f'_{cr} (psi)

A. Calculation of f'_{cr} from S (fill out only if IV.A. is "yes") (larger of 1 or 2 below controls)
1. $f'_{cr} = f'_c + 1.34 \times S =$ _____ psi 2. $f'_{cr} = f'_c + 2.33 \times S - 500 =$ _____ psi
B. Calculation of f'_{cr} from ACI 318-02 Table 5.3.2.2: (fill out if IV.A. is "No")
1. $f'_{cr} = f'_c +$ _____ psi = _____ psi

VI. Concrete Mix Design by Field Experience Method: (fill out below only if III.A. is checked)

Note: This method requires one or more mix designs with a 45 day minimum field record of at least ten consecutive test results using similar materials and conditions as the proposed mix design.

A. Available field record is based on how many mix designs? _____ (specify number)
B. Average strength of field record is _____ psi (must be $\geq f'_{cr}$ in V.)

VII. Concrete Mix Design by Trial Mixture Method: (fill out below only if III.B. is checked)

Note: This method requires using at least three different trial mixes with varying W/C ratios or cement contents with a plot of average strength vs. W/C ratio or cement content. Submit scale graph of results.

A. Trial Mixes: (Note: All other ingredients as specified in VIII. below)

	Mix 1	Mix 2	Mix 3	Selected (interpolated) values
Cements (lbs.)	_____	_____	_____	_____
W/C Ratio	_____	_____	_____	_____
Compressive Strength (psi) at Specified Days	_____	_____	_____	_____

VIII. Proposed Mix Design

A. Sources of Materials:

1. Cement: Type: _____ Manufacturer _____ Lo-Alkali? Y N Sp. Gr. _____
2. Fly Ash: Type: _____ Manufacturer _____ Sp. Gr. _____
3. Silica Fume: Manufacturer: _____ Type (check one): _____ Slurry _____ Powder
Slurry: Specific Gravity _____ Water Content by Wt. _____ % Silica by Wt. _____ %
Powder: Specific Gravity _____ Silica by Wt. _____ %
4. Coarse Aggregate: Size: _____ Type: _____ Source: _____ Oven-dry Sp. Gr. _____
(Note 4) Oven-dry Rodded Density: _____ PCF Absorption: _____ % (moist. content at SSD cond.)

5. Lightweight Agg.: _____ Size: _____ Type: _____ Source: _____ Ovendry Sp. Gr. (Note 4) _____ Ovendry Rodded Density: _____ PCF Absorption: _____ % (moist. content at SSD cond.)
6. Fine Aggregate: Type: _____ Source: _____ Fineness Modulus: _____ (Note 4) _____ Ovendry Sp. Gr. _____ Absorption (moisture content at SSD condition): _____ %
7. Air Entraining Agent (AEA): Manufacturer and Name: _____ ASTM No. _____
- Note: Specify below all types and combinations of admixtures anticipated to be used for all anticipated weather conditions. Explain in (12) below.
8. Water Reducers (WR):
- a. (Plain) Manufacturer and Name: _____ ASTM No. _____
- b. (w/Accelerator) Manufacturer and Name: _____ ASTM No. _____
- c. (w/Retarder) Manufacturer and Name: _____ ASTM No. _____
9. Accelerators: Manufacturer and Name: _____ ASTM No. _____
10. Retarders: Manufacturer and Name: _____ ASTM No. _____
11. High Range Water Reducer (HRWR) (Superplasticizers):
- a. (Plain) Manufacturer and Name: _____ ASTM No. _____
- b. (w/Retarder) Manufacturer and Name: _____ ASTM No. _____
12. Comments: _____
- B. Mix Proportions: (Per Cubic Yard)
- | Item | Wt. (lbs.) | Absolute Vol. (Cu. Ft.) |
|--|---|--|
| 1. Cement | _____ | _____ |
| 2. Fly Ash | _____ | _____ |
| 3. Silica Fume | _____ | _____ |
| 4. Coarse Agg. (SSD Wt.) | _____ | _____ |
| 5. Lightweight Agg. (SSD Wt.) | _____ | _____ |
| 6. Fine Agg. (SSD Wt.) | _____ | _____ |
| 7. AEA | _____ oz/100# cement | Added at: _____ Batch Plant _____ Site |
| 8. a. WR (Plain) | _____ oz/100# cement | Added at: _____ Batch Plant _____ Site |
| b. WR (W/Acc.) | _____ oz/100# cement | Added at: _____ Batch Plant _____ Site |
| c. WR (W/Ret.) | _____ oz/100# cement | Added at: _____ Batch Plant _____ Site |
| 9. Accelerator: | _____ oz/100# cement | Added at: _____ Batch Plant _____ Site |
| 10. Retarder: | _____ oz/100# cement | Added at: _____ Batch Plant _____ Site |
| 11. a. HRWR (Plain) | _____ oz/100# cement | Added at: _____ Batch Plant _____ Site |
| b. HRWR (w/Ret.) | _____ oz/100# cement | Added at: _____ Batch Plant _____ Site |
| 12. Other: | _____ | (Specify Units) |
| 13. Water (including free water on aggregates) | _____ (lbs.) _____ (cu. ft.) _____ (gal.) | |
- C. Mix Design Characteristics: (Pozzolan = flyash and/or silica fume)
1. Water (including free water on aggregates)/(Cement + pozzolan): $W/C = \frac{\text{_____ (lbs.)}}{\text{_____ (lbs.)}} = \text{_____}$
(Not applicable for LW concrete)
2. Fine Aggregate/Total Aggregate = $\frac{\text{_____ (lbs.)}}{\text{_____ (lbs.)}} = \text{_____}$ 3. Pozzolan/Pozzolan+Cement = $\frac{\text{_____ (lbs.)}}{\text{_____ (lbs.)}} = \text{_____}$
4. Concrete Density: a. Unit Wet Weight: _____ pcf b. Unit Dry Weight: _____ pcf
5. Air Content: _____ %
6. Slump: a. Initial Slump (before adding WR or HRWR) _____ in.
b. Final Slump (after adding WR or HRWR) _____ in.
- D. Chloride Ion Content: The Concrete Supplier certifies that total chloride ion content of the concrete mix, as tested by ASTM C1218 does not exceed the amounts specified in Table 4.4.1 of ACI 318-02.
- E. Alkali Content: The Concrete Supplier certifies, if required by specification section 3300, that the total alkali content contributed from cementitious materials does not exceed 4.0 lbs./cu. yd. of concrete or certifies that the aggregate contains no deleterious material that react with alkalis in the concrete mix.

Notes:

1. This form is required to be submitted to Engineer and Owner's Testing Laboratory for all concrete mixes on the job. When any mix ingredient changes during the course of the job, this submittal form shall be resubmitted for approval. All information must be filled in for approval of mix design. Submit all backup data for calculations.
2. The mix designation should be that used by the Contractor to order the concrete from the Supplier and as noted on the batch ticket.
3. Refer to ACI 318-02 for requirements of each concrete mix design preparation method.
4. Submit sieve analysis of fine and course aggregates. Include chart indicating combined aggregate retained on each sieve size.

X. Certification by Concrete Supplier

Signature: _____ Representing: _____ Date: _____

SECTION 03 30 01

CAST-IN-PLACE CONCRETE – BURN TOWER ONLY

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This Section specifies cast-in place concrete, including formwork, reinforcing, concrete materials, mix designs, placement procedures, and finishes.
- B. Cast-in-place concrete includes the following:
 - 1. Foundations and footings.
 - 2. Structural slabs and grade beams.
 - 3. Building frame members.

1.03 SUBMITTALS

- A. General: Submit the following according to General Conditions of the Contract and Division 01 Specification Sections.
- B. Product data for proprietary materials and items, including reinforcement, forming accessories, admixtures, joint systems, and each type of product indicated, and others if requested by Engineer.
- C. Shop drawings for reinforcement detailing fabricating, bending, and placing concrete reinforcement. Comply with ACI 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures" showing bar schedules, stirrup spacing, bent bar diagrams, and arrangement of concrete reinforcement. Include special reinforcing required for openings through concrete structures.
- D. Formwork Shop Drawings: Signed and sealed by qualified professional engineer detailing fabrication, assembly, and support of formwork, including shoring.
 - 1. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and reshoring installation and removal.
- E. Laboratory test reports for concrete materials and mix design test. Provide all backup data, as required by ACI 301 and 318, for mix designs. Submit alternate design mixes when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.04 QUALITY ASSURANCE

- A. Codes and Standards: Comply with provisions of the following codes, specifications, and standards, except where more stringent requirements are shown or specified:
 - 1. American Concrete Institute (ACI) 301, "Specifications for Structural Concrete for Buildings."
 - 2. ACI 318, "Building Code Requirements for Reinforced Concrete."
 - 3. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
 - 4. Concrete Reinforcing Steel Institute (CRSI) "Manual of Standard Practice."
- B. Concrete Testing Service: Owner will employ a qualified testing agency to perform material evaluation tests.
- C. Materials and installed work may require testing and retesting at any time during progress of Work. Retesting of rejected materials for installed Work, shall be done at Contractor's expense.

- D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.
- E. Preinstallation Conference: Conduct conference at Project site to comply with requirements of Division 01 Section " Project Management and Coordination " and the following:
 - 1. At least 14 days prior to submitting design mixes, conduct a meeting to review detailed requirements for preparing concrete design mixes and to determine procedures for ensuring satisfactory concrete operations and quality of concrete materials. Review requirements for submittals, status of coordinating work, and availability of materials. Establish preliminary work progress schedule and procedures for materials inspection, testing, and certifications. Require representatives of each entity directly concerned with cast-in-place concrete to attend conference, including, but not limited to, the following:
 - a. Contractor's superintendent.
 - b. Agency responsible for concrete design mixes.
 - c. Agency responsible for field quality control.
 - d. Ready-mix concrete producer.
 - e. Concrete subcontractor.
 - f. Primary admixture manufacturers.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.

PART 2 PRODUCTS

2.01 FORM-FACING MATERIALS

- A. Forms for Exposed Finish Concrete: Plywood, metal, metal-framed plywood faced, or other acceptable panel-type materials to provide continuous, straight, smooth, exposed surfaces. Furnish in largest practicable sizes to minimize number of joints and to conform to joint system shown on drawings.
- B. Forms for Unexposed Finish Concrete: Plywood, lumber, metal, or another acceptable material. Provide lumber dressed on at least two edges and one side for tight fit.
- C. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch minimum, as indicated in drawings.
- D. Form Release Agent: Provide commercial formulation form release agent with a maximum of 350 g/L volatile organic compounds (VOCs) that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
- E. Form Ties: Factory-fabricated, adjustable-length, removable or snap-off metal form ties designed to prevent form deflection and to prevent spalling of concrete upon removal. Provide units that will leave no metal closer than 1-1/2 inches to the plane of the exposed concrete surface.
 - 1. Provide ties that, when removed, will leave holes not larger than 1 inch in diameter in the concrete surface.

2.02 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615 Grade 60, deformed (ASTM A 706 for any rebar that is welded).
- B. Steel Wire: ASTM A 82, plain, cold-drawn steel.
- C. Welded Wire Fabric: ASTM A 185, welded steel wire fabric.
- D. Supports for Reinforcement: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Use wire bar-type supports complying with CRSI specifications.

1. For slabs-on-grade, use supports with sand plates or horizontal runners where base material will not support chair legs.
2. For exposed-to-view concrete surfaces where legs of supports are in contact with forms, provide supports with legs that are protected by plastic (CRSI, Class 1) or stainless steel (CRSI, Class 2).

2.03 CONCRETE MATERIALS

- A. Portland Cement: ASTM C 150, Type I.
 1. Use one type, brand and source of cement throughout Project.
- B. Fly Ash: ASTM C 618, Type F.
- C. Normal-Weight Aggregates: ASTM C 33, Class 4S coarse aggregate or better, graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials.
 1. Maximum coarse aggregate size: 1 inch
 2. For exposed exterior surfaces, do not use fine or coarse aggregates that contain substances that cause spalling.
 3. Provide aggregates free of materials with deleterious reactivity to alkali in cement, to prevent damage due to concrete expansion from alkali silicate and alkali carbonate reactions.
- D. Water: Potable.
- E. Admixtures, General: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
- F. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.
 1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
 - a. Air-Mix or Perma-Air, Euclid Chemical Co.
 - b. Darex AEA or Daravair, W.R. Grace & Co.
 - c. MB-VR or Micro-Air, Master Builders, Inc.
 - d. Sika AER, Sika Corp.
- G. Water-Reducing Admixture: ASTM C 494, Type A.
 1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
 - a. Eucon WR-75, Euclid Chemical Co.
 - b. WRDA, W.R. Grace & Co.
 - c. Pozzolith Normal or Polyheed, Master Builders, Inc.
 - d. Plastocrete 161, Sika Corp.
- H. High-Range Water-Reducing Admixture: ASTM C 494, Type F or Type G.
 1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
 - a. Eucon 37, Euclid Chemical Co.
 - b. WRDA 19 or Daracem, W.R. Grace & Co.
 - c. Rheobuild or Polyheed, Master Builders, Inc.
 - d. Sikament 300, Sika Corp.
- I. Water-Reducing, Accelerating Admixture: ASTM C 494, Type E.
 1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
 - a. Accelguard 80, Euclid Chemical Co.
 - b. Daraset, W.R. Grace & Co.
 - c. Pozzutec 20, Master Builders, Inc.

- J. Water-Reducing, Retarding Admixture: ASTM C 494, Type D.
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
 - a. Eucon Retarder 75, Euclid Chemical Co.
 - b. Daratard-17, W.R. Grace & Co.
 - c. Pozzolith R, Master Builders, Inc.
 - d. Plastiment, Sika Corporation.

2.04 VAPOR RETARDERS

- A. Plastic Vapor Retarder: ASTM E 1745, Class A. Include manufacturer's recommended adhesive or pressure-sensitive tape.
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
 - a. Fortifiber Corporation; Moistop Ultra A.
 - b. Raven Industries Inc.; Vapor Block 15.
 - c. Reef Industries, Inc.; Griffolyn Type-65G.
- B. Granular Fill: Clean mixture of crushed stone or crushed or uncrushed gravel; ASTM D 448, Size 57, with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

2.05 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work, include, but are not limited to, the following:
 - a. Axim Italcementi Group, Inc.; CATExOL CimFilm.
 - b. BASF Construction Chemicals - Building Systems; Confilm.
 - c. ChemMasters; SprayFilm.
 - d. Conspec by Dayton Superior; Aquafilm.
 - e. Dayton Superior Corporation; Sure Film (J-74).
 - f. Edoco by Dayton Superior; BurkeFilm.
 - g. Euclid Chemical Company (The), an RPM company; Eucobar.
 - h. Kaufman Products, Inc.; Vapor-Aid.
 - i. Lambert Corporation; LAMBCO Skin.
 - j. L&M Construction Chemicals, Inc.; E-CON.
 - k. Meadows, W. R., Inc.; EVAPRE.
 - l. Metalcrete Industries; Waterhold.
 - m. Nox-Crete Products Group; MONOFILM.
 - n. Sika Corporation; SikaFilm.
 - o. SpecChem, LLC; Spec Film.
 - p. Symons by Dayton Superior; Finishing Aid.
 - q. TK Products, Division of Sierra Corporation; TK-2120 TRI-FILM.
 - r. Unitex; PRO-FILM.
 - s. Vexcon Chemicals, Inc.; Certi-Vex Envio Set.
- B. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry, complying with AASHTO M 182, Class 2.
- C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- D. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work, include, but are not limited to, the following:
 - a. Anti-Hydro International, Inc.; AH Curing Compound #2 DR WB.
 - b. BASF Construction Chemicals - Building Systems; Kure 200.
 - c. ChemMasters; Safe-Cure Clear.
 - d. Conspec by Dayton Superior; W.B. Resin Cure.

- e. Dayton Superior Corporation; Day-Chem Rez Cure (J-11-W).
- f. Edoco by Dayton Superior; Res X Cure WB.
- g. Euclid Chemical Company (The), an RPM company; Kurez W VOX; TAMMSCURE WB 30C.
- h. Kaufman Products, Inc.; Thinfil 420.
- i. Lambert Corporation; AQUA KURE - CLEAR.
- j. L&M Construction Chemicals, Inc.; L&M Cure R.
- k. Meadows, W. R., Inc.; 1100-CLEAR.
- l. Nox-Crete Products Group; Resin Cure E.
- m. Right Pointe; Clear Water Resin.
- n. SpecChem, LLC; Spec Rez Clear.
- o. Symons by Dayton Superior; Resi-Chem Clear.
- p. TK Products, Division of Sierra Corporation; TK-2519 DC WB.
- q. Vexcon Chemicals, Inc.; Certi-Vex Enviocure 100.

2.06 RELATED MATERIALS

- A. Bonding Agent: Acrylic base.
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
 - a. Acrylic or Styrene Butadiene:
 - 1) SBR Latex, Euclid Chemical Co.
 - 2) Daraweld C, W.R. Grace & Co.
 - 3) Everbond, L&M Construction Chemicals, Inc.
 - 4) Acryl-Set, Master Builders Inc.

2.07 PROPORTIONING AND DESIGNING MIXES

- A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field test data, or both, as specified in ACI 301. For the trial batch method, use an independent testing agency acceptable to Engineer for preparing and reporting proposed mix designs.
 - 1. Do not use the same testing agency for field quality control testing.
 - 2. Limit use of fly ash to not exceed 25 percent of cement content by weight.
- B. Submit written reports to Engineer of each proposed mix for each class of concrete at least 15 days prior to start of Work. Do not begin concrete production until proposed mix designs have been approved by Engineer.
- C. Design mixes to provide normal weight concrete with the following properties as indicated on drawings and schedules:
 - 1. 4,500 psi, 28-day compressive strength; water-cement ratio, 0.45 maximum.
- D. Slump Limits: Proportion and design mixes to result in concrete slump at point of placement as follows:
 - 1. Slabs, and sloping surfaces: Not more than 3 inches.
 - 2. Reinforced foundation systems: Not less than 1 inch and not more than 3 inches.
 - 3. Concrete containing high-range water-reducing admixture (superplasticizer): Not more than 8 inches after adding admixture to verified 2 - 3 inch slump concrete.
 - 4. Other concrete: Not more than 4 inches.
- E. Adjustment to Concrete Mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant, as accepted by Engineer. Laboratory test data for revised mix design and strength results must be submitted to and accepted by Engineer before using in Work.

2.08 ADMIXTURES

- A. Use water-reducing admixture or high-range water-reducing admixture (superplasticizer) in concrete, as required, for placement and workability.
- B. Use accelerating admixture in concrete slabs placed at ambient temperatures below 50 deg F.

- C. Use high-range water-reducing admixture in pumped concrete or concrete with water-cement ratios below 0.50.
- D. Use air-entraining admixture in all concrete unless otherwise indicated. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having total air content of 6.0 percent plus or minus 1-1/2 percent for all concrete except column footings, which shall have a total air content of 3.0 percent plus or minus 1-1/2 percent.
- E. Use admixtures for water reduction and set accelerating or retarding in strict compliance with manufacturer's directions.

2.09 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94, and as specified, and furnish batch ticket information.
 - 1. When air temperature is between 85 deg F and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes, and when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 EXECUTION

3.01 GENERAL

- A. Coordinate the installation of joint materials and other related materials with placement of forms and reinforcing steel.
- B. Tolerances: Tolerances for Concrete Construction and Materials shall conform to all requirements of ACI 117, Standard Specifications for Tolerances for Concrete Construction and Materials.

3.02 FORMS

- A. General: Design, erect, support, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads that might be applied until concrete structure can support such loads. Construct formwork so concrete members and structures are of correct size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117. Maintain formwork construction tolerances and surface irregularities complying with the following ACI 347 limits:
 - 1. Provide Class A tolerances for concrete surfaces exposed to view.
 - 2. Provide Class C tolerances for other concrete surfaces.
- B. Construct forms to sizes, shapes, lines, and dimensions shown and to obtain accurate alignment, location, grades, level, and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, chamfers, blocking, bulkheads, anchorages and inserts, and other features required in the Work. Use selected materials to obtain required finishes. Construct forms tight enough to prevent loss of concrete mortar.
- C. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, recesses, and the like for easy removal.
- D. Provide temporary openings for clean-outs and inspections where interior area of formwork is inaccessible before and during concrete placement. Securely brace temporary openings and set tightly to forms to prevent losing concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- E. Chamfer exposed corners and edges as indicated, using wood, metal, PVC, or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.

- F. Provisions for Other Trades: Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses, and chases from trades providing such items. Accurately place and securely support items built into forms.
- G. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, or other debris just before placing concrete. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- H. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.03 PLACING REINFORCEMENT

- A. General: Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars," for details and methods of reinforcement placement and supports and as specified.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials that reduce or destroy bond with concrete.
- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as approved by the Engineer.
- D. Place reinforcement to maintain minimum coverages as indicated for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.
- E. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

3.04 JOINTS

- A. Construction Joints: Locate and install construction joints so they do not impair strength or appearance of the structure, as acceptable to Engineer.
- B. Provide keyways at least 1-1/2 inches deep in construction joints between stair slabs and supporting slabs. Bulkheads designed and accepted for this purpose may be used for slabs.
- C. Place construction joints perpendicular to main reinforcement. Continue reinforcement across construction joints except as indicated otherwise. Do not continue reinforcement through sides of strip placements.
- D. Use bonding agent on existing concrete surfaces that will be joined with fresh concrete.
- E. Joint fillers: Prepare surfaces and install joint fillers in accordance with the requirements of the manufacturer. Provide non-staining sealants with 1-year warranty and as follows:
 - 1. Isolation Joint between concrete slabs and concrete faces, where indicated on drawings: Fill joint with standard chemically curing elastomeric sealants that comply with ASTM C 920, Grade P, Class 25, Use T, with additional movement capability of 50 percent movement in extension and 50 percent movement in compression for a total of 100 percent movement.
 - 2. Isolation Joint between concrete slabs and masonry faces, where indicated on drawings: Fill joint with standard chemically curing elastomeric sealants that comply with ASTM C 920, Grade NS, Class 25, Use T, with additional movement capability of 50 percent movement in extension and 50 percent movement in compression for a total of 100 percent movement.

3.05 INSTALLING EMBEDDED ITEMS

- A. General: Set and build into formwork anchorage devices and other embedded items required for other work that is attached to or supported by cast-in-place concrete. Use setting drawings, diagrams, instructions, and directions provided by suppliers of items to be attached.
- B. Forms for Slabs: Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and contours in finished surfaces. Provide and secure units to support screed strips using strike-off templates or compacting-type screeds.

3.06 PREPARING FORM SURFACES

- A. General: Coat contact surfaces of forms with an approved, nonresidual, low-VOC, form-coating compound before placing reinforcement.
- B. Do not allow excess form-coating material to accumulate in forms or come into contact with in-place concrete surfaces against which fresh concrete will be placed. Apply according to manufacturer's instructions.

3.07 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed. Notify other trades to permit installation of their work.
- B. General: Comply with ACI 304, "Guide for Measuring, Mixing, Transporting, and Placing Concrete," and as specified.
- C. Provide monolithic slabs without joints, holes, penetrations, or embedded items that pass through the entire thickness, unless shown on the drawings, to prevent moisture from passing through the slab into the thermal lining system below, which could void the thermal lining warranty and cause safety and durability issues. For floor and roof slabs, do not support anything on the bottom forms other than reinforcing chairs and bolsters. Do not have any item pass through the entire slab thickness, including snap-ties or items used to support screeds or forms at tops of slabs, unless shown on the drawings. Support any items used to support screeds or forms at tops of slabs from the reinforcing mats, not the bottom forms.
- D. Deposit concrete continuously or in layers of such thickness that no new concrete will be placed on concrete that has hardened sufficiently to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as specified. Deposit concrete to avoid segregation at its final location.
- E. Placing Concrete in Forms: Deposit concrete in forms in horizontal layers no deeper than 24 inches and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.
 - 1. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping according to ACI 301.
 - 2. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations no farther than the visible effectiveness of the machine. Place vibrators to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mix to segregate.
- F. Placing Concrete Slabs: Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until completing placement of a panel or section.
 - 1. Consolidate concrete during placement operations so that concrete is thoroughly worked around reinforcement, other embedded items and into corners.
 - 2. Bring slab surfaces to correct level with a straightedge and strike off. Use bull floats or darbies to smooth surface free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations.

3. Maintain reinforcing in proper position on chairs during concrete placement.
 4. Slope surfaces uniformly to drainage openings (scuppers) as indicated on the drawings.
 5. When placing concrete on sloping forms at concrete stairs, begin placing concrete at lowest elevation of forms and work up toward the highest elevation.
- G. Cold-Weather Placement: Comply with provisions of ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
 2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise accepted in mix designs.
- H. Hot-Weather Placement: When hot weather conditions exist that would impair quality and strength of concrete, comply with ACI 301 and as follows
1. Cool ingredients before mixing to maintain concrete temperature at time of placement to below 90 deg F. Mixing water may be chilled or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 2. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedding in concrete.
 3. Fog spray forms, reinforcing steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots or dry areas.
 4. Use water-reducing retarding admixture when required by high temperatures, low humidity, or other adverse placing conditions, as acceptable to Engineer.
- I. Do not add water to concrete during delivery, at Project site, or during placement, except as follows. Water withheld at the batch plant may be added at the Project site, provided that the amount withheld is noted on the batch ticket, the water added does not exceed the amount withheld and is documented by the testing agency, and the concrete is properly mixed prior to sampling, testing, and placement.

3.08 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: Provide a rough-formed finish on formed concrete surfaces. This is the concrete surface having texture imparted by form-facing material used, with tie holes and defective areas repaired and patched, and fins and other projections exceeding 1/4 inch in height rubbed down or chipped off.

3.09 MONOLITHIC SLAB FINISHES

- A. Float Finish: Apply float finish to monolithic slab surfaces to receive broom finish, pavement finish and elsewhere as indicated.
1. After screeding, consolidating, and leveling concrete slabs, do not work surface until ready for floating. Begin floating, using float blades or float shoes only, when surface water has disappeared, or when concrete has stiffened sufficiently to permit operation of power-driven floats, or both. Consolidate surface with power-driven floats or by hand-floating if area is small or inaccessible to power units. Finish surfaces to tolerances of F(F) 18 (floor flatness) and F(L) 15 (floor levelness) measured according to ASTM E 1155. Cut down high spots and fill low spots. Uniformly slope surfaces to scuppers and doors. Immediately after leveling, refloat surface to a uniform, smooth, granular texture.
- B. Nonslip Broom Finish: Apply a nonslip broom finish to concrete roofs, elevated slabs, structural ground floor slab, steps, landings, and elsewhere as indicated.

1. Immediately after float finishing, slightly roughen concrete surface by brooming with fiber-bristle broom perpendicular to main traffic route.

3.10 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures for passage of work by other trades, unless otherwise shown or directed, after work of other trades is in place. Mix, place, and cure concrete as specified to blend with in-place construction. Provide other miscellaneous concrete filling shown or required to complete Work.

3.11 CONCRETE CURING AND PROTECTION

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause rapid moisture loss before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.
- D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.
- E. Curing Methods: Cure concrete according to ACI 308.1, by one or a combination of the following methods:
 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
 2. Moisture-retaining Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
 3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.12 SHORES AND RESHORES

- A. General: Comply with ACI 318 and ACI 301 for design, installation and removal of shoring and reshoring in multistory construction, and as specified.
- B. Extend shoring from ground to roof, unless otherwise permitted by Engineer, to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.
- C. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.
- D. Keep reshores in place a minimum of 15 days after placing upper tier, or longer, if required, until all concrete has attained at least 75 percent of its required 28-day strength and heavy loads due to construction operations have been removed.

3.13 REMOVING FORMS

- A. General: Formwork not supporting weight of concrete, such as sides of beams, columns, and similar parts of the work, may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete, provided concrete is sufficiently hard to not be damaged by form-removal operations, and provided curing and protection operations are maintained.
- B. Formwork supporting weight of concrete, such as beam soffits, slabs, and other structural elements, may not be removed until concrete has attained at least 75 percent of the 28-day design minimum compressive strength. Determine potential compressive strength of in-place concrete by testing field-cured specimens representative of concrete location or members.
- C. Form-facing material may be removed 4 days after placement only if shores and other vertical supports have been arranged to permit removal of form-facing material without loosening or disturbing shores and supports.

3.14 REUSING FORMS

- A. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent as specified for new formwork.
- B. When forms are reused for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close joints. Align and secure joint to avoid offsets. Do not use patched forms for exposed concrete surfaces except as acceptable to Engineer.

3.15 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas when approved by Engineer. Remove and replace concrete that cannot be repaired and patched to Engineer's approval.
- B. Patching mortar: Mix dry-pack mortar, consisting of one part portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing.
- C. Repairing Formed Surfaces: Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of Engineer. Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning. Flush out form tie holes and fill with dry-pack mortar or precast cement cone plugs secured in place with bonding agent.
 - 1. Immediately after form removal, cut out honeycombs, rock pockets, voids over 1/4 inch in any dimension, and holes left by tie rods and bolts down to solid concrete but in no case to a depth less than 1 inch. Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water, and brush-coat the area to be patched with bonding agent. Place patching mortar before bonding agent has dried.
 - 2. For surfaces exposed to view, blend white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Provide test areas at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike-off slightly higher than surrounding surface.
 - 3. Repair concealed formed surfaces, where possible, containing defects that affect the concrete's durability and structural performance as determined by Engineer. If defects cannot be repaired, remove and replace the concrete.
- D. Repairing Unformed Surfaces: Test unformed surfaces, such as monolithic slabs, for smoothness and verify surface tolerances specified for each surface and finish. Correct low and high areas as specified. Test unformed surfaces sloped to drain for trueness of slope and smoothness by using a template having the required slope.
 - 1. Repair finished unformed surfaces containing defects that affect the concrete's durability. Surface defects include crazing and cracks in excess of 0.01 inch wide or that penetrate

- to the reinforcement or completely through nonreinforced sections regardless of width, spalling, popouts, honeycombs, rock pockets, and other objectionable conditions.
2. Correct high areas in unformed surfaces by grinding after concrete has cured at least 14 days.
 3. Correct low areas in unformed surfaces during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
 4. Repair defective areas, except random cracks and single holes not exceeding 1 inch in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose reinforcing steel with at least 3/4 inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials to provide concrete of same type or class as original concrete. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
 5. Unless otherwise directed to epoxy inject, repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

3.16 QUALITY CONTROL TESTING DURING CONSTRUCTION

- A. General: The Owner will employ a testing agency to perform tests and inspections and to submit test/inspection reports.
- B. Inspections:
 1. Steel reinforcement placement: visual inspection of all steel reinforcing, prior to all concrete pours, including, but not limited to, the following:
 - a. Reinforcing sizes.
 - b. Reinforcing spacing.
 - c. Lap and splice lengths.
 - d. Bends and hooks.
 - e. Minimum cover.
 - f. Maximum cover.
 - g. Chairs, bolsters, and other support devices.
 - h. Wire ties at all intersections between bars and between bars and supports.
- C. Sampling and testing for quality control during concrete placement includes the following, as directed by the Engineer.
 1. Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94.
 - a. Slump: ASTM C 143; one test at point of discharge for each day's pour of each type of concrete; additional tests when concrete consistency seems to have changed.
 - b. Air Content: ASTM C 173, volumetric method or ASTM C 231, pressure method; one for each day's pour of each type of air-entrained concrete.
 - c. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below, when 80 deg F and above, and one test for each set of compressive-strength specimens.
 - d. Compression Test Specimen: ASTM C 31; sets standard cylinders for each compressive-strength test described below, unless otherwise directed.
 - e. Compressive-Strength Tests: ASTM C 39; one set of four standard cylinders for laboratory-cured testing and one set of four standard cylinders for field-cured testing each day for each mix and for each 50 cubic yards poured. One laboratory-cured specimen tested at 7 days, two laboratory-cured specimens tested at 28 days, and one laboratory-cured specimen held in reserve for later testing if required. One field-cured specimen tested at 7 days, two field-cured

specimens tested at 28 days, and one field-cured specimen tested at a time desired by the Contractor for determining if the concrete has reached sufficient strength to remove formwork and/or shoring.

2. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.
 3. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength and no individual strength test result falls below specified compressive strength by more than 500 psi.
- D. Test and inspection results will be reported in writing to Engineer, ready-mix producer, and Contractor within 24 hours after tests. Reports of compressive strength tests shall contain the Project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-day tests and 28-day tests.
- E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted but shall not be used as the sole basis for acceptance or rejection.
- F. Additional Tests: The testing agency will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by Engineer. Testing agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed.

END OF SECTION

SECTION 03 35 19
COLORED CONCRETE FINISHING

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Concrete floor stain.

1.02 SUBMITTALS

- A. Comply with Section 01 30 00 – Administrative Requirements.
- B. Product Data: Submit manufacturer's product data, including surface preparation and application instructions.
- C. Color Samples: Submit manufacturer's standard color chart.
- D. Installer's Project References: Submit list of successfully completed projects, including project name and location, name of architect, and type and quantity of concrete floor stain applied.
- E. Maintenance Instructions: Submit manufacturer's maintenance and cleaning instructions.

1.03 QUALITY ASSURANCE

- A. Single Source Responsibility: Concrete floor stain materials shall be products of a single manufacturer.
- B. Installer's Qualifications:
 - 1. Successful experience in application of similar concrete floor stains.
 - 2. Employ persons trained for application of concrete floor stains.
- C. Preinstallation Meeting: Convene a preinstallation meeting before start of application of concrete floor stain. Require attendance of parties directly affecting work of this section, including Contractor, Architect, and applicator. Review surface preparation, application, protection, and coordination with other work.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying manufacturer, product name, and concrete floor stain color.
- B. Storage: Store materials in a clean, dry area indoors in accordance with manufacturer's instructions. Keep containers sealed until ready for use.
 - 1. Concrete Floor Sealer: Keep away from ignition sources. Do not allow to freeze.
- C. Handling: Protect materials during handling and application to prevent damage or contamination.

1.05 ENVIRONMENTAL REQUIREMENTS

- A. Do not apply concrete floor stain when air or surface temperature is below 40 degrees F.
- B. Concrete Floor Sealer: Do not apply when air or surface temperature is below 55 degrees.

1.06 SEQUENCING

- A. Prepare surface and apply concrete floor stain after other interior finish work is completed and before baseboards are installed.

PART 2 - PRODUCTS

2.01 MANUFACTURER

- A. Drawings and specifications are based on manufacturer's literature from the manufacturer shown in the Finish Legend. Other manufacturers to comply with the minimum levels of material and detailing indicated on the drawings and in the specifications and in conformance with provisions of Section 01 60 00 – Product Requirements.

2.02 CONCRETE FLOOR STAIN

- A. Concrete Floor Stain:
 - 1. Description: Combination of acid solution, wetting agents, and metallic ions. When mixed with water, chemically combines with portland cement to form permanent colors.
 - 2. Color: Selected by Architect from manufacturer's standard range of colors.

2.03 ACCESSORIES

- A. Concrete Floor Sealer:
 - 1. Acrylic water-based urethane clear sealer.
 - 2. Solids Content: 30 percent.
 - 3. Non-yellowing.
 - 4. Resistant to blush.
 - 5. Satin finish.
 - 6. VOC compliant.
 - 7. Quick drying.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine surfaces to receive concrete floor stain. Notify Architect if surfaces are not acceptable. Do not begin surface preparation or application until unacceptable conditions have been corrected.

3.02 SURFACE PREPARATION

- A. Protection:
 - 1. Protect walls and surrounding surfaces not to receive concrete floor stain.
 - 2. Do not allow stain to come in contact with wood or metal surfaces.
- B. Prepare concrete surface in accordance with manufacturer's instructions.
- C. Ensure concrete surface is clean, dry, structurally sound, and free from dirt, dust, oil, grease, solvents, paint, wax, asphalt, concrete curing compounds, sealing compounds, surface hardeners, bond breakers, adhesive residue, and other surface contaminants.
- D. Do not acid wash or use heavy alkali cleaners.

3.03 APPLICATION

- A. Apply concrete floor stain in accordance with manufacturer's instructions at locations indicated on the drawings.
- B. Control depth of color by adjusting volume of stain applied to floor.
- C. Apply 2 coats of concrete floor stain. Allow floor to completely dry after each coat. Do not scrub clean between coats.

- D. After floor has completely dried, scrub off stain residue in accordance with manufacturer's instructions. Allow floor to completely dry.
- E. Concrete Floor Sealer: Apply concrete floor sealer over concrete floor stain in accordance with manufacturer's instructions.
- F. Keep material containers closed when not in use to avoid contamination.

3.04 PROTECTION

- A. Protect stained concrete floor from damage during construction.
- B. Protect concrete surfaces from foot traffic for a minimum of 24 hours.
- C. Avoid washing concrete surfaces for a minimum of 48 hours.

END OF SECTION

SECTION 04 05 13

MASONRY MORTAR AND GROUT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Mortar for masonry.
- B. Grout for masonry.

1.02 RELATED SECTIONS

- A. Section 04 81 00 - Unit Masonry Assemblies: Installation of mortar.
- B. Section 08 11 13 – Hollow Metal Doors and Frames: Grouting steel door frames installed in masonry.

1.03 REFERENCES

- A. ACI 530/ASCE 5/TMS 402 - Building Code Requirements For Masonry Structures; American Concrete Institute International; 2005.
- B. ACI 530.1/ASCE 6/TMS 602 - Specification for Masonry Structures; American Concrete Institute International; 2005.
- C. ASTM C 94/C 94M - Standard Specification for Ready-Mixed Concrete; 2004a.
- D. ASTM C 144 - Standard Specification for Aggregate for Masonry Mortar; 2004.
- E. ASTM C 150 - Standard Specification for Portland Cement; 2004a.
- F. ASTM C 207 - Standard Specification for Hydrated Lime for Masonry Purposes; 2004.
- G. ASTM C 270 - Standard Specification for Mortar for Unit Masonry; 2004a.
- H. ASTM C 404 - Standard Specification for Aggregates for Masonry Grout; 2004.
- I. ASTM C 476 - Standard Specification for Grout for Masonry; 2002.
- J. ASTM C 780 - Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry; 2002.
- K. ASTM C 1019 - Standard Test Method for Sampling and Testing Grout; 2003.
- L. IMIABC (CW) - Recommended Practices & Guide Specifications for Cold Weather Masonry Construction; International Masonry Industry All-Weather Council; 1993.
- M. IMIABC (HW) - Recommended Practices & Guide Specifications for Hot Weather Masonry Construction; International Masonry Industry All-Weather Council; current edition.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Include design mix and indicate that the Property specification of ASTM C 270 is to be used. Also include required environmental conditions and admixture limitations.
- C. Samples: Submit one sample of each available color of mortar, illustrating mortar color and color range from manufacturer's complete line of available colors. Architect will make an initial selection of mortar color for incorporation into the approval mock-up specified in section 01420.
- D. Reports: Submit reports on mortar indicating conformance of component mortar materials to requirements of ASTM C 270 and test and evaluation reports per ASTM C 780.

- E. Reports: Submit reports on grout indicating conformance of component grout materials to requirements of ASTM C 476 and test and evaluation reports to requirements of ASTM C 1019.
- F. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.05 QUALITY ASSURANCE

- A. Comply with provisions of ACI 530/ASCE 5/TMS 402 and ACI 530.1/ASCE 6/TMS 602, except where exceeded by requirements of the contract documents.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Maintain packaged materials clean, dry, and protected against dampness, freezing, and foreign matter.

1.07 ENVIRONMENTAL REQUIREMENTS

- A. Cold Weather Requirements: Comply with recommendations of IMIABC (CW).
- B. Hot Weather Requirements: Comply with IMIABC (HW).

1.08 MOCK-UP

- A. Include products of this section in required mock-up specified in Section 01420 - Approval Mock-Up.
- B. Scope of mock-up requirements is shown on the drawings.
- C. Final selection of mortar color by Architect will be made based on approval of mock-up

PART 2 PRODUCTS

2.01 MATERIALS

- A. Portland Cement: ASTM C 150, Type I – Normal. Standard gray color and white color are required.
- B. Hydrated Lime: ASTM C 207, Type S.
- C. Mortar Aggregate: ASTM C 144.
- D. Grout Aggregate: ASTM C 404.
- E. Water: Clean and potable.
- F. Accelerating Admixture: Nonchloride type for use in cold weather.
- G. Moisture-Resistant Admixture: Water repellent compound designed to reduce capillarity.
- H. Bonding Agent: Latex type.

2.02 MORTAR MIXES

- A. Mortar for Unit Masonry: ASTM C 270, Property Specification.
 - 1. Engineered masonry: Type S.
 - 2. Masonry below grade and in contact with earth: Type S.
 - 3. Exterior, loadbearing masonry: Type N.
 - 4. Exterior, non-loadbearing masonry: Type N.
 - 5. Interior, loadbearing masonry: Type N.
 - 6. Interior, non-loadbearing masonry: Type N.
 - 7. Pointing mortar: Type N with maximum 2 percent ammonium stearate or calcium stearate per cement weight.

2.03 MORTAR MIXING

- A. Thoroughly mix mortar ingredients using mechanical batch mixer, in accordance with ASTM C 270 and in quantities needed for immediate use.
- B. Maintain sand uniformly damp immediately before the mixing process.
- C. Do not use anti-freeze compounds to lower the freezing point of mortar.
- D. If water is lost by evaporation, re-temper only within two hours of mixing.
- E. Use mortar within two hours after mixing at temperatures of 90 degrees F, or two-and-one-half hours at temperatures under 40 degrees F.

2.04 GROUT MIXES

- A. Bond Beams and Lintels: 3,000 psi strength at 28 days; 8-10 inches slump; provide premixed type in accordance with ASTM C 94/C 94M.
 - 1. Fine grout for spaces with smallest horizontal dimension of 2 inches or less.
 - 2. Coarse grout for spaces with smallest horizontal dimension greater than 2 inches.
- B. Engineered Masonry: 3,000 psi strength at 28 days; 8-10 inches slump; provide premixed type in accordance with ASTM C 94/C 94M.
 - 1. Fine grout for spaces with smallest horizontal dimension of 2 inches or less.
 - 2. Coarse grout for spaces with smallest horizontal dimension greater than 2 inches.

2.05 GROUT MIXING

- A. Mix grout in accordance with ASTM C 94/C 94M.
- B. Thoroughly mix grout ingredients in quantities needed for immediate use in accordance with ASTM C 476 for fine and coarse grout.
- C. Add admixtures in accordance with manufacturer's instructions; mix uniformly.

PART 3 EXECUTION

3.01 PREPARATION

- A. Apply bonding agent to existing concrete surfaces.
- B. Plug clean-out holes for grouted masonry with block masonry units. Brace masonry to resist wet grout pressure.

3.02 INSTALLATION

- A. Install mortar and grout to requirements of section(s) in which masonry is specified.
- B. Work grout into masonry cores and cavities to eliminate voids.
- C. Do not install grout in lifts greater than 16 inches without consolidating grout by rodding.
- D. Do not displace reinforcement while placing grout.
- E. Remove excess mortar from grout spaces.

3.03 GROUTING

- A. Use either high-lift or low-lift grouting techniques, at Contractor's option, subject to other limitations of contract documents.
- B. Low-Lift Grouting:
 - 1. Limit height of pours to 12 inches.
 - 2. Limit height of masonry to 16 inches above each pour.

3. Pour grout only after vertical reinforcing is in place; place horizontal reinforcing as grout is poured. Prevent displacement of bars as grout is poured.
 4. Place grout for each pour continuously and consolidate immediately; do not interrupt pours for more than 1-1/2 hours.
- C. High-Lift Grouting:
1. Verify that horizontal and vertical reinforcement is in proper position and adequately secured before beginning pours.
 2. Hollow Masonry: Limit lifts to maximum 4 feet and pours to maximum height of 24 feet.
 3. Place grout for spanning elements in single, continuous pour.

3.04 FIELD QUALITY CONTROL

- A. Test and evaluate mortar in accordance with ASTM C 780 procedures.
1. Test with same frequency as specified for masonry units.
- B. Test and evaluate grout in accordance with ASTM C 1019 procedures.
1. Test with same frequency as specified for masonry units.

END OF SECTION

SECTION 04 20 00
UNIT MASONRY ASSEMBLIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Concrete Block, including ground face units.
- B. Concrete Brick.
- C. Clay Facing Brick.
- D. Reinforcement and Anchorage.
- E. Flashings.
- F. Lintels.
- G. Accessories.

1.02 RELATED SECTIONS

- A. Section 04 05 13 – Masonry Mortar and Grout.
- B. Section 07 90 00 - Joint Sealers: Backing rod and sealant at control and expansion joints.

1.03 REFERENCES

- A. ACI 530/ASCE 5/TMS 402 - Building Code Requirements for Masonry Structures; American Concrete Institute International; 2005.
- B. ACI 530.1/ASCE 6/TMS 602 - Specification For Masonry Structures; American Concrete Institute International; 2005.
- C. ASTM A 82/A 82M - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement; 2005a.
- D. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2005.
- E. ASTM A 615/A 615M - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement; 2006.
- F. ASTM C 55 - Standard Specification for Concrete Brick; 2003.
- G. ASTM C 67 - Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile; 2005.
- H. ASTM C 90 - Standard Specification for Loadbearing Concrete Masonry Units; 2006.
- I. ASTM C 129 - Standard Specification for Nonloadbearing Concrete Masonry Units; 2005.
- J. ASTM C 140 - Standard Test Methods of Sampling and Testing Concrete Masonry Units and Related Units; 2005a.
- K. ASTM C 216 - Standard Specification for Facing Brick (Solid Masonry Units Made From Clay or Shale); 2005a.
- L. ASTM C 780 - Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry; 2006.
- M. ASTM D 226 - Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing; 2005.

- N. ASTM D 1970 - Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection; 2001.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data for masonry units, fabricated wire reinforcement, and masonry accessories.
- C. Samples: Submit a minimum of four samples of facing brick units and ground face concrete masonry units to illustrate color, texture, and extremes of color range.
- D. Manufacturer's Certificate: Certify that masonry units meet or exceed specified requirements.

1.05 QUALITY ASSURANCE

- A. Comply with provisions of ACI 530/ASCE 5/TMS 402 and ACI 530.1/ASCE 6/TMS 602, except where exceeded by requirements of the contract documents.
 - 1. Maintain one copy of each document on project site.

1.06 MOCK-UP

- A. Construct a masonry wall as a mock-up panel in accordance with Section 01 42 00, which includes mortar and accessories and structural backup.
- B. Locate where directed.
- C. Mock-up may not remain as part of the Work.

1.07 PRE-INSTALLATION MEETING

- A. Convene one week before starting work of this section.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, handle, and store masonry units by means that will prevent mechanical damage and contamination by other materials.

1.09 ENVIRONMENTAL REQUIREMENTS

- A. Cold and Hot Weather Requirements: Comply with requirements of ACI 530.1/ASCE 6/TMS 602 or applicable building code, whichever is more stringent.

1.10 EXTRA MATERIALS

- A. See Section 01 60 00 - Product Requirements, for additional provisions.

PART 2 PRODUCTS

2.01 CONCRETE MASONRY UNITS

- A. Concrete Block: Comply with referenced standards and as follows:
 - 1. Size: Standard units with nominal face dimensions of 16 x 8 inches and nominal depths as indicated on the drawings for specific locations.

2. Special Shapes: Provide non-standard blocks configured for corners, lintels, headers, control joint edges, and other detailed conditions.
3. Load-Bearing Units: ASTM C 90, lightweight.
 - a. Hollow block.
 - b. Exposed faces: Manufacturer's standard color and texture, unless otherwise indicated.
4. Non-Loadbearing Units: ASTM C 129.
 - a. Hollow block.
 - b. Lightweight.
5. Ground Faced Units: Ground face where indicated on drawings.
 - a. Provide ground face on all exposed edges.
 - b. Acceptable Manufacturer: Featherlite Building Products Corporation.
www.featherlitetexas.com
 - c. Color: 707 Burnished Limestone.
 - d. Other Manufacturers: Substitutions will be considered based on the manufacturer's demonstrated ability to match the color and finish of the specified Featherlite product.
6. Split Faced Units: Split face where indicated on drawings.
 - a. Provide split face on all exposed edges.
 - b. Acceptable Manufacturer: Featherlite Building Products Corporation.
 - c. Color: To be selected by Architect.
 - d. Other Manufacturers: Substitutions will be considered based on the manufacturer's demonstrated ability to match the color and finish of the specified product.

2.02 BRICK UNITS

- A. Manufacturers:
 1. Acme Brick Company; www.acme.com
 2. Substitutions: Not permitted.
- B. Facing Brick: ASTM C 216, Type FBS, Grade SW.
 1. Blend Name: Acme Brick Special Blend.
 - a. Product Code: 29-888-01-27.
 - b. 60% - 138-107A07; 40% 136-14307
 2. Nominal size: As indicated on drawings.
 3. Special shapes: Molded units as required by conditions indicated, unless standard units can be sawn to produce equivalent effect. Exposed holes in brick are not acceptable.
 4. Efflorescence: Provide brick that has been tested according to ASTM C 67 and is rated "not effloresced."
 5. Compressive strength: 3,000 psi, measured in accordance with ASTM C 67.

2.03 MORTAR AND GROUT MATERIALS

- A. Mortar and grout: As specified in Section 04 05 13.

2.04 REINFORCEMENT AND ANCHORAGE

- A. Manufacturers of Joint Reinforcement and Anchors:
 1. Dur-O-Wal: www.dur-o-wal.com.
 2. Hohmann & Barnard, Inc: www.h-b.com.
 3. Masonry Reinforcing Corporation of America: www.wirebond.com.
 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Reinforcing Steel: ASTM A 615/A 615M Grade 60 (420) deformed billet bars; galvanized.
- C. Single Wythe Joint Reinforcement: Truss type; ASTM A 82/A 82M steel wire, hot dip galvanized after fabrication to ASTM A 153/A 153M, Class B; 0.1483 inch side rods with 0.1483 inch cross rods; width as required to provide not more than 1 inch and not less than 1/2 inch of mortar coverage on each exposure.

- D. Multiple Wythe Joint Reinforcement: Truss type; fabricated with moisture drip; ASTM A 82/A 82M steel wire, hot dip galvanized after fabrication to ASTM A 153/153M, Class B; 0.1483 inch side rods with 0.1483 inch cross rods; width as required to provide not more than 1 inch and not less than 1/2 inch of mortar coverage on each exposure.
- E. Adjustable Multiple Wythe Joint Reinforcement: Truss type with adjustable ties or tabs spaced at 16 in on center and fabricated with moisture drip; ASTM A 82/A 82M steel wire, hot dip galvanized after fabrication to ASTM A 153/153M, Class B; 0.1875 inch side rods with 0.1483 inch cross rods and adjustable components of 0.1875 inch wire; width of components as required to provide not more than 1 inch and not less than 1/2 inch of mortar coverage from each masonry face.
 - 1. Vertical adjustment: Not less than 2 inches.
- F. Strap Anchors: Bent steel shapes configured as required for specific situations, 1-1/4 in width, 0.105 in thick, lengths as required to provide not more than 1 inch and not less than 1/2 inch of mortar coverage from masonry face, corrugated for embedment in masonry joint, hot dip galvanized to ASTM A 153/A 153M, Class B.
- G. Flexible Anchors: 2-piece anchors that permit differential movement between masonry and building frame, sized to provide not more than 1 inch and not less than 1/2 inch of mortar coverage from masonry face.
 - 1. Concrete frame: Dovetail anchors of bent steel strap, nominal 1 inch width x 0.024 in thick, with trapezoidal wire ties 0.1875 inch thick, hot dip galvanized to ASTM A 153/A 153M, Class B.
 - 2. Steel frame: Crimped wire anchors for welding to frame, 0.25 inch thick, with trapezoidal wire ties 0.1875 inch thick, hot dip galvanized to ASTM A 153/A 153M, Class B.
- H. Two-Piece Wall Ties: Formed steel wire, 0.1875 inch thick, adjustable, eye and pintle type, hot dip galvanized to ASTM A 153/A 153M, Class B, sized to provide not more than 1 inch and not less than 1/2 inch of mortar coverage from masonry face and to allow vertical adjustment of up to 1-1/4 in.
- I. Veneer Anchorage
 - 1. Anchors for attaching veneer to concrete and CMU backup: Provide galvanized DW-10 - Anchors, manufactured by Hohmann and Barnard.
 - 2. Anchors for attaching veneer to steel columns and beams: Provide galvanized No. 362 Grip Stay Channel and No. 363 Flexible Gripstay Anchor manufactured by Hohmann and Barnard.
 - 3. Wall Ties for anchoring veneer to steel studs: Provide galvanized X-Seal Anchors, manufactured by Hohmann and Barnard.
 - 4. Substitutions permitted under provisions of Section 01 60 00.

2.05 FLASHINGS

- A. Rubberized Asphalt Flashing: Self-adhering polymer-modified asphalt sheet complying with ASTM D 1970; minimum 0.030 inch total thickness; with cross-linked polyethylene top and bottom surfaces.
 - 1. Manufacturers:
 - a. Grace Construction Products www.na.graceconstruction.com
 - 1. Product: Perm-A-Barrier Wall Flashing.
 - b. Polyguard Products, Inc. www.polyguardproducts.com
 - 1. Product: Polyguard 400 Air and Moisture Barrier with preformed inside corners and end dams.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Lap Sealant: Butyl type as specified in Section 07 90 00.

2.06 ACCESSORIES

- A. Preformed Control Joints: Rubber material. Provide with corner and tee accessories, fused joints.
 - 1. Manufacturers:
 - a. Dur-O-Wal: www.dur-o-wal.com.
 - b. Hohmann & Barnard, Inc: www.h-b.com.
 - c. Masonry Reinforcing Corporation of America: www.wirebond.com.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Joint Filler: Closed cell rubber; oversized 50 percent to joint width; self expanding x by maximum lengths available.
 - 1. Manufacturers:
 - a. Dur-O-Wal: www.dur-o-wal.com.
 - b. Hohmann & Barnard, Inc: www.h-b.com.
 - c. Masonry Reinforcing Corporation of America: www.wirebond.com.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
- C. Drainage Devices: HDPE drainage device. Provide MORTAR NET, manufactured by Hohmann and Barnard.
 - 1. Substitutions permitted under provisions of Section 01 60 00.
- D. Stainless Steel Drip Plate: Provide "DP" stainless steel drip plate manufactured by Hohmann and Barnard at terminations of flashing.
 - 1. Substitutions permitted under provisions of Section 01 60 00.
- E. Nailing Strips: Softwood, preservative treated for moisture resistance, dovetail shape, sized to masonry joints.
- F. Weeps: Polyethylene tubing. Provide 'Quadro-Vent' manufactured by Hohmann & Barnard.
 - 1. Substitutions: See Section 01 60 00 - Product Requirements.
- G. Cleaning Solution: Non-acidic, not harmful to masonry work or adjacent materials.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive masonry.
- B. Verify that related items provided under other sections are properly sized and located.
- C. Verify that built-in items are in proper location, and ready for roughing into masonry work.

3.02 PREPARATION

- A. Direct and coordinate placement of metal anchors supplied for installation under other sections.
- B. Provide temporary bracing during installation of masonry work. Maintain in place until building structure provides permanent bracing.

3.03 COURSING

- A. Establish lines, levels, and coursing indicated. Protect from displacement.
- B. Maintain masonry courses to uniform dimension. Form vertical and horizontal joints of uniform thickness.

C. Standard Concrete Masonry Units and Ground Face Concrete Masonry Units:

1. Bond: Running.
2. Coursing: One unit and one mortar joint to equal 8 inches.
3. Mortar Joints: Concave.

D. Brick Units:

1. Bond: As indicated for different locations.
2. Coursing: Three units and three mortar joints to equal 8 inches.
3. Mortar Joints: Concave.

3.04 PLACING AND BONDING

- A. Lay solid masonry units in full bed of mortar, with full head joints, uniformly jointed with other work.
- B. Lay hollow masonry units with face shell bedding on head and bed joints.
- C. Buttering corners of joints or excessive furrowing of mortar joints is not permitted.
- D. Remove excess mortar and mortar smears as work progresses.
- E. Interlock intersections and external corners, except for units laid in stack bond.
- F. Do not shift or tap masonry units after mortar has achieved initial set. Where adjustment must be made, remove mortar and replace.
- G. Perform job site cutting of masonry units with proper tools to provide straight, clean, unchipped edges. Prevent broken masonry unit corners or edges.
- H. Cut mortar joints flush where wall tile is scheduled or resilient base is scheduled.
- I. Isolate masonry partitions from vertical structural framing members with a control joint.
- J. Isolate top joint of masonry partitions from horizontal structural framing members and slabs or decks with compressible joint filler.

3.05 WEEPS/CAVITY VENTS

- A. Install weeps in veneer and cavity walls at 24 inches on center horizontally above through-wall flashing, above shelf angles and lintels, and at bottom of walls.

3.06 CAVITY MORTAR CONTROL

- A. Do not permit mortar to drop or accumulate into cavity air space or to plug weep/cavity vents.
- B. For cavity walls, build inner wythe ahead of outer wythe to accommodate accessories.
- C. Install cavity mortar diverter at base of cavity and at other flashing locations as recommended by manufacturer to prevent mortar droppings from blocking weep/cavity vents.

3.07 REINFORCEMENT AND ANCHORAGE - SINGLE WYTHE MASONRY

- A. Install horizontal joint reinforcement 16 inches on center.
- B. Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend minimum 16 inches each side of opening.
- C. Place continuous joint reinforcement in first and second joint below top of walls.
- D. Lap joint reinforcement ends minimum 6 inches.

- E. Reinforce stack bonded unit joint corners and intersections with strap anchors 16 inches on center.

3.08 REINFORCEMENT AND ANCHORAGES - TWO WYTHE CAVITY WALL MASONRY

- A. Install horizontal joint reinforcement 16 inches on center.
- B. Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend minimum 16 inches each side of openings.
- C. Place continuous joint reinforcement in first and second joint below top of walls.
- D. Lap joint reinforcement ends minimum 6 inches.

3.09 REINFORCEMENT AND ANCHORAGES - MULTIPLE WYTHE UNIT MASONRY WITHOUT A CAVITY

- A. Install horizontal joint reinforcement 16 inches on center.
- B. Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend minimum 16 inches each side of opening.
- C. Place continuous joint reinforcement in first and second joint below top of walls.
- D. Lap joint reinforcement ends minimum 6 inches.
- E. Support and secure reinforcing bars from displacement. Maintain position within 1/2 inch of dimensioned position.
- F. Fasten anchors to structural framing and embed in masonry joints as masonry is laid. Space anchors at maximum of 24 inches horizontally and 16 inches vertically.
- G. Reinforce stack bonded unit joint corners and intersections with strap anchors 16 inches on center.

3.10 REINFORCEMENT AND ANCHORAGE - MASONRY VENEER

- A. Masonry Back-Up: Embed anchors to bond veneer at vertical and horizontal locations required by applicable code.
- B. Cast-In-Place Concrete Back-Up: Attach dovetail anchors to bond veneer at vertical and horizontal locations required by applicable code.
- C. Stud Back-Up: Secure veneer anchors to stud framed back-up and embed into masonry veneer at vertical and horizontal locations required by applicable code.

3.11 MASONRY FLASHINGS

- A. Whether or not specifically indicated, install masonry flashing to divert water to exterior at all locations where downward flow of water will be interrupted.
 - 1. Extend flashings full width at such interruptions and at least 4 inches into adjacent masonry or turn up at least 4 inches to form watertight pan at non-masonry construction.
 - 2. Remove or cover protrusions or sharp edges that could puncture flashings.
 - 3. Seal lapped ends and penetrations of flashing before covering with mortar.
- B. Extend plastic and laminated flashings to within 1/4 inch of exterior face of masonry.
- C. Lap end joints of flashings at least 4 inches and seal watertight with mastic or elastic sealant.

3.12 LINTELS

- A. Install lintels as indicated on drawing schedules.
- B. Install reinforced unit masonry lintels over openings where precast concrete lintels are not scheduled.
 - 1. Support and secure reinforcing bars from displacement. Maintain position within 1/2 inch of dimensioned position.
 - 2. Place and consolidate grout fill without displacing reinforcing.
 - 3. Allow masonry lintels to attain specified strength before removing temporary supports.

3.13 GROUTED COMPONENTS

- A. Lap splices minimum 24 bar diameters.
- B. Support and secure reinforcing bars from displacement. Maintain position within 1/2 inch of dimensioned position.
- C. Place and consolidate grout fill without displacing reinforcing.
- D. At bearing locations, fill masonry cores with grout for a minimum 12 inches either side of opening.

3.14 CONTROL AND EXPANSION JOINTS

- A. Do not continue horizontal joint reinforcement through control and expansion joints.
- B. Form control joint with a sheet building paper bond breaker fitted to one side of the hollow contour end of the block unit. Fill the resultant core with grout fill. Rake joint at exposed unit faces for placement of backer rod and sealant.
- C. Install preformed control joint device in continuous lengths. Seal butt and corner joints in accordance with manufacturer's instructions.
- D. Size control joint in accordance with Section 07 90 00 for sealant performance.
- E. Form expansion joint as detailed.

3.15 BUILT-IN WORK

- A. As work progresses, install built-in metal door frames, glazed frames, fabricated metal frames, window frames, wood nailing strips, anchor bolts, and plates and other items to be built into the work and furnished under other sections.
- B. Install built-in items plumb, level, and true to line.
- C. Bed anchors of metal door and glazed frames in adjacent mortar joints. Fill frame voids solid with grout.
 - 1. Fill adjacent masonry cores with grout minimum 12 inches from framed openings.
- D. Do not build into masonry construction organic materials that are subject to deterioration.

3.16 TOLERANCES

- A. Maximum Variation from Alignment of Columns and Pilasters: 1/4 inch.
- B. Maximum Variation From Unit to Adjacent Unit: 1/16 inch.
- C. Maximum Variation from Plane of Wall: 1/4 inch in 10 ft and 1/2 inch in 20 ft or more.

- D. Maximum Variation from Plumb: 1/4 inch per story non-cumulative; 1/2 inch in two stories or more.
- E. Maximum Variation from Level Coursing: 1/8 inch in 3 ft and 1/4 inch in 10 ft; 1/2 inch in 30 ft.
- F. Maximum Variation of Joint Thickness: 1/8 inch in 3 ft.
- G. Maximum Variation from Cross Sectional Thickness of Walls: 1/4 inch.

3.17 CUTTING AND FITTING

- A. Cut and fit for chases, pipes, conduit, sleeves, and grounds. Coordinate with other sections of work to provide correct size, shape, and location.
- B. Obtain approval prior to cutting or fitting masonry work not indicated or where appearance or strength of masonry work may be impaired.

3.18 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control tests, as specified in Section 01 40 00.
- B. Clay Masonry Unit Tests: Test each variety of clay masonry in accordance with ASTM C 67 requirements, sampling 5 randomly chosen units for each 50,000 installed.
- C. Concrete Masonry Unit Tests: Test each variety of concrete unit masonry in accordance with ASTM C 140 for conformance to requirements of this specification.
- D. Mortar Tests: Test each type of mortar in accordance with ASTM C 780, testing with same frequency as masonry samples.

3.19 CLEANING

- A. Remove excess mortar and mortar droppings.
- B. Replace defective mortar. Match adjacent work.
- C. Clean soiled surfaces with cleaning solution.
- D. Use non-metallic tools in cleaning operations.

3.20 PROTECTION OF FINISHED WORK

- A. Without damaging completed work, provide protective boards at exposed external corners which are subject to damage by construction activities.

END OF SECTION

SECTION 04 20 01

UNIT MASONRY ASSEMBLIES – BURN TOWER ONLY

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Concrete unit masonry.
 - 2. Precast concrete lintels.
 - 3. Mortar and grout.
 - 4. Steel reinforcing bars.
 - 5. Masonry joint reinforcement.
 - 6. Ties and anchors.
 - 7. Embedded flashing.
 - 8. Miscellaneous masonry accessories.
 - 9. Cavity-wall insulation.
 - 10. Integral water repellant for masonry units and mortar.
 - 11. Cleaning.
 - 12. Mortar and grout mixes.
 - 13. Masonry sealer.

1.03 PERFORMANCE REQUIREMENTS

- A. Provide unit masonry that develops installed compressive strengths (f'm) at 28 days, based on net area, of 2,000 psi.
 - 1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) according to Tables 1 and 2 in ACI 530.1.

1.04 SUBMITTALS

- A. General: Submit each item in this Article according to the General Conditions of the Contract and Division 01 Specification Sections.
- B. Product data and material certifications for each different masonry unit, accessory, and other manufactured product specified.

1.05 QUALITY ASSURANCE

- A. Pre-installation Conference: Conduct conference at Project site to comply with requirements of Division 01 Section "Project Management and Coordination".
- B. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.
- C. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store masonry units on elevated platforms in a dry location to prevent their deterioration or damage due to moisture, temperature changes, contaminants, corrosion, and other causes. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are in an air-dried condition.

- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- D. Deliver preblended, dry mortar mix in moisture-resistant containers designed for use with dispensing silos. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in covered weatherproof dispensing silos.
- E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.
- F. Store masonry cleaners in unopened original containers, in a cool, dry location away from possible ignition sources and in accordance with the manufacturer's recommendations.

1.07 PROJECT CONDITIONS

- A. Protection of Masonry: During erection, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
- B. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
 - 1. Protect base of walls from rain-splashed mud and mortar splatter by coverings spread on ground and over wall surface.
 - 2. Protect sills, ledges, and projections from mortar droppings.
 - 3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
 - 4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt on completed masonry.
- C. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit masonry damaged by frost or freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1 and as follows:
 - 1. Cold-Weather Construction: When the ambient temperature is within the limits indicated, use the following procedures:
 - a. 40 to 32 deg F: Heat mixing water or sand to produce mortar temperatures between 40 and 120 deg F.
 - b. 32 to 25 deg F: Heat mixing water and sand to produce mortar temperatures between 40 and 120 deg F. Heat grout materials to produce grout temperatures between 40 and 120 deg F. Maintain mortar and grout above freezing until used in masonry.
 - c. 25 to 20 deg F: Heat mixing water and sand to produce mortar temperatures between 40 and 120 deg F. Heat grout materials to produce grout temperatures between 40 and 120 deg F. Maintain mortar and grout above freezing until used in masonry. Heat masonry units to 40 deg F if grouting. Use heat on both sides of walls under construction.
 - d. 20 deg F and Below: Heat mixing water and sand to produce mortar temperatures between 40 and 120 deg F. Heat grout materials to produce grout temperatures between 40 and 120 deg F. Maintain mortar and grout above freezing until used in masonry. Heat masonry units to 40 deg F. Provide enclosures and use heat on both sides of walls under construction to maintain temperatures above 32 deg F within the enclosures.
 - 2. Cold-Weather Protection: When the mean daily temperature is within the limits indicated, provide the following protection:

- a. 40 to 25 deg F: Cover masonry with a weather-resistant membrane for 48 hours after construction.
 - b. 25 to 20 deg F: Cover masonry with insulating blankets or provide enclosure and heat for 48 hours after construction to prevent freezing. Install wind breaks when wind velocity exceeds 15 mi./h.
 - c. 20 deg F and Below: Provide enclosure and heat to maintain temperatures above 32 deg F within the enclosure for 48 hours after construction.
3. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and above and will remain so until masonry has dried out, but not less than 7 days after completion of cleaning.
- D. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1.

PART 2 PRODUCTS

2.01 CONCRETE MASONRY UNITS

- A. General: Provide shapes indicated and as follows for each form of concrete masonry unit required, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.
 1. Provide special shapes for lintels, corners, jambs, control joints, headers, bonding, and other special conditions.
 2. Provide bullnose units for outside corners and where indicated on the drawings.
 3. Provide finished, square-edged units for outside corners, unless otherwise indicated on the drawings.
- B. Integral Water Repellent: Provide units made with integral water repellent for all masonry.
 1. Integral Water Repellent: Liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength. Units made with integral water repellent, when tested according to ASTM E 514 as a wall assembly made with mortar containing integral water-repellent manufacturer's mortar additive, with test period extended to 24 hours, shall show no visible water or leaks on the back of test specimen.
 - a. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include the following:
 - 1) ACM Chemistries; RainBloc.
 - 2) BASF; Rheopel Plus.
 - 3) Grace Construction Products, W. R. Grace & Co. - Conn.; Dry-Block.
 - 4) Acme-Hardesty Company, Inc., Acme Shield.
 2. Add water repellent to units as recommended by water repellent manufacturer.
- C. Concrete Masonry Units: ASTM C 90 and as follows:
 1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2,800 psi.
 2. Density Classification: Normal weight, as indicated on the drawings.
 3. Aggregates: Complying with ASTM C-33 for normal weight aggregate.
 4. Size: Manufactured to the actual dimensions listed below (within tolerances specified in the applicable referenced ASTM specification) for the corresponding nominal sizes indicated on Drawings:
 - a. 4 inch nominal: 3-5/8 inch actual.
 - b. 6 inch nominal: 5-5/8 inch actual.
 - c. 8 inch nominal: 7-5/8 inch actual.
 - d. 12 inch nominal: 11-5/8 inch actual.
 - e. 16 inch nominal: 15-5/8 inch actual.
 5. Manufacturer's standard color (gray) and texture (standard smooth face finish), unless otherwise indicated.

2.02 PRECAST CONCRETE LINTELS

- A. Concrete Lintels: Precast concrete lintels complying with requirements in Division 03 Section "Cast-in-Place Concrete – Burn Tower only" and with reinforcing bars indicated in the Contract Drawings.
- B. Provide precast concrete lintels where shown and where openings of more than 12 inches for brick size units and 24 inches for block size units are shown without other supporting lintels.
- C. Provide minimum bearing of 8 inches at each jamb, unless otherwise indicated.

2.03 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
- B. Hydrated Lime: ASTM C 207, Type S.
- C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.
- D. Masonry Cement: ASTM C 91.
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
 - a. Lafarge North America Inc.; Magnolia Masonry Cement or Lafarge Masonry Cement.
 - b. Lehigh Cement Company; Lehigh Masonry Cement.
 - c. Holcim (US) Inc.; Mortarmix Masonry Cement.
- E. Aggregate for Mortar: ASTM C 144; except for joints less than 1/4 inch, use aggregate graded with 100 percent passing the No. 16 sieve.
- F. Aggregate for Grout: ASTM C 404.
- G. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
 - a. Euclid Chemical Company (The); Accelguard 80.
 - b. Grace Construction Products, W. R. Grace & Co. - Conn.; Morset.
 - c. Sonneborn Products, BASF; Trimix-NCA.
- H. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with CMUs containing integral water repellent by same manufacturer.
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
 - a. ACM Chemistries; RainBloc for Mortar.
 - b. BASF; Rheopel Mortar Admixture.
 - c. Grace Construction Products, W. R. Grace & Co. - Conn.; Dry-Block Mortar Admixture.
 - d. Acme-Hardesty Company, Inc., Acme Shield Mortar Admixture.
 - 2. Add water repellent admixture to mortar mix as recommended by water repellent manufacturer for specific mortar mix used to achieve absorption reduction of at least 80 percent for Type N and S mortar when tested as per ASTM C270.
- I. Water: Potable.

2.04 REINFORCEMENT

- A. Uncoated Steel Reinforcing Bars: ASTM A 615, Grade 60.

2.05 MASONRY JOINT REINFORCEMENT

- A. General: ASTM A 951
- B. Provide joint reinforcement formed from the following:
 - 1. Hot-dip galvanized carbon-steel wire, coating class as follows:
 - a. ASTM A 153, Class B-2, for both interior and exterior walls.
- C. Description: Welded-wire units prefabricated with deformed continuous side rods and plain cross rods into straight lengths of not less than 10 feet, with prefabricated corner and tee units, and complying with requirements indicated below:
 - 1. Wire Diameter for Side Rods: 0.1483 inch.
 - 2. Wire Diameter for Cross Rods: 0.1483 inch.
- D. For single-wythe masonry, provide type as follows with single pair of side rods:
 - 1. Ladder or truss type spaced not more than 16 inches o.c.
- E. For double-wythe cavity wall masonry, provide type as follows spaced not more than 16 inches o.c.:
 - 1. Adjustable (two-piece) ladder type, with one side rod at each face shell of backing wythe and with separate ties that extend into facing wythe. Ties have two hooks that engage eyes or slots in reinforcement and resist movement perpendicular to wall. Ties extend at least halfway through facing wythe but with at least 5/8-inch cover on outside face. Ties have hooks or clips to engage a continuous horizontal wire in the facing wythe.
- F. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and hold reinforcing bars in center of cells. Units are formed from 0.148-inch steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.

2.06 TIES AND ANCHORS, GENERAL

- A. General: Provide ties and anchors specified in subsequent articles that comply with requirements for metal and size of this Article, unless otherwise indicated.
- B. Steel Sheet: As follows:
 - 1. Galvanized Steel Sheet: ASTM A 653, G 60 (commercial quality), steel sheet zinc coated by hot-dip process on continuous lines prior to fabrication, for sheet-metal ties and anchors.
- C. Galvanized Steel Sheet Thickness: For steel sheet hot-dip galvanized by continuous process prior to fabrication:
 - 1. 0.1084 inch.
- D. Thickness of Steel Sheet Galvanized After Fabrication: Uncoated thickness of steel sheet for hot-dip galvanizing after fabrication:
 - 1. 0.1046 inch.

2.07 EMBEDDED FLASHING MATERIALS

- A. Metal Flashing: Provide metal flashing, where flashing is exposed or partly exposed and where indicated, complying with SMACNA's "Architectural Sheet Metal Manual, Division 7 Section "Sheet Metal Flashing and Trim", and as follows:
 - 1. Stainless Steel: ASTM A 240/A 240M, Type 304, 0.016 inch thick.
 - 2. Fabricate continuous flashings in sections 96 inches long minimum, but not exceeding 12 feet. Provide splice plates at joints of formed, smooth metal flashing.
 - 3. Fabricate through-wall metal flashing embedded in masonry from stainless steel, with ribs at 3-inch intervals along length of flashing to provide an integral mortar bond.
 - a. Available Products:
 - 1) Cheney Flashing Company;
 - 2) Keystone Flashing Company, Inc.; Keystone 3-Way Interlocking Thruwall Flashing.
 - 3) Or approved equal.

4. Fabricate through-wall flashing with snaplock receiver on exterior face where indicated to receive counterflashing.
5. Fabricate through-wall flashing with drip edge. Fabricate by extending flashing 1/2 inch out from wall, with outer edge bent down 30 degrees and hemmed.
6. Fabricate metal drip edges and sealant stops for ribbed metal flashing from plain metal flashing of same metal as ribbed flashing and extending at least 3 inches into wall with hemmed inner edge to receive ribbed flashing and form a hooked seam. Form hem on upper surface of metal so that completed seam will shed water.
7. Metal Flashing Terminations: Fabricate from stainless steel. Extend at least 3 inches into wall and out to exterior face of wall. At exterior face of wall, bend metal back on itself for 3/4 inch and down into joint 3/8 inch to form a stop for retaining sealant backer rod.
8. Metal Expansion-Joint Strips: Fabricate from stainless steel to shapes indicated.

2.08 MISCELLANEOUS MASONRY ACCESSORIES

- A. Compressible Filler: Pre-molded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene.
- B. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).
- C. Weep/Vent Products: Use the following, unless otherwise indicated:
 1. Mesh Weep/Vent: Free-draining mesh; made from polyethylene strands, full height and width of head joint and depth 1/8 inch less than depth of outer wythe; in color selected from manufacturer's standard.
 - a. Products:
 - 1) Mortar Net USA, Ltd.; Mortar Net Weep Vents.
 - 2) Or approved equal.

2.09 CAVITY-WALL INSULATION

- A. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV, closed-cell product extruded with an integral skin. Owens Corning Foamular 250 Extruded Polystyrene (XPS) Rigid Foam Insulation or approved equal. Thickness: 1". R-Value: 5.0, minimum per ASTM C518.
- B. Adhesive: Type recommended by insulation board manufacturer for application indicated.

2.10 INTEGRAL WATER REPELLANT FOR MASONRY UNITS AND MORTAR

- A. Concrete masonry units shall be manufactured with an integral water-repelling polymer admixture compatible with the masonry mix, mortar, and grout.

2.11 MASONRY CLEANERS

- A. Manufactured Masonry Detergent: Detergent based solution designed for the cleaning of new masonry structures.
 1. Products:
 - a. EaCo Chem NMD 80.
 - b. Approved equals meeting the specifications.
- B. Manufacture shall provide on-site training for the application and cleaning of the masonry.
- C. Pre-test application on masonry prior to full-scale cleaning.
 1. Allow masonry to fully dry prior to evaluation of test for final appearance and results.
 2. Test all adjacent construction materials (metals, concrete, and other materials) to confirm the cleaning product does not damage finish.
- D. Protect adjacent materials from cleaning solution.
- E. Comply with all manufacturer's instructions and recommendations for the storage and handling of the product, mixing, testing, application, and rinsing of the masonry.

2.12 MORTAR AND GROUT MIXES

- A. General: Other than liquid water-repellent mortar admixture, do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, antifreeze compounds, or other admixtures, unless otherwise indicated.
 - 1. Do not use calcium chloride in mortar or grout.
- B. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification, for types of mortar indicated below:
 - 1. For all masonry, use type S.
- C. Integral water repellant: Mortar shall include an integral water repellant compatible with the integral water repellant in the concrete masonry units.
- D. Grout for Unit Masonry: Comply with ASTM C 476. Minimum compressive strength shall be 2,000 psi. Use grout of consistency (fine or coarse) at time of placement that will completely fill spaces intended to receive grout.
 - 1. Use fine grout in grout spaces less than 2 inches in horizontal dimension, unless otherwise indicated.
 - 2. Use coarse grout in grout spaces 2 inches or more in least horizontal dimension, unless otherwise indicated.
 - 3. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143.

2.13 MASONRY SEALER

- A. Modified silane, "breathable", low volatility, penetrating water repellent providing invisible coating for concrete masonry construction. Water repellent coating shall protect against water and waterborne contaminants.
- B. Water repellent sealer shall be non-solvent based.
- C. Clear, not-glossy finish.
- D. Manufacturer:
 - 1. Prosoco; Sure Klean SL100 Water Repellent.
 - 2. Approve equal meeting the specifications.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of unit masonry. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 INSTALLATION, GENERAL

- A. Thickness: Build cavity and other masonry construction to full thickness shown. Build singlewythe walls to the actual thickness of the masonry units, using units of thickness indicated.
- B. Build chases and recesses to accommodate items specified in this and other Sections of the Specifications.
- C. Leave openings for equipment to be installed before completion of masonry. After installing equipment, complete masonry to match construction immediately adjacent to the opening.
- D. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut masonry units with motor-driven saws to provide clean, sharp, unchipped edges. Allow units cut with water-cooled saws to dry before placing, unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

- E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.
 - 1. Mix units from several pallets or cubes as they are placed.

3.03 CONSTRUCTION TOLERANCES

- A. Variation from Plumb: For vertical lines and surfaces of walls, do not exceed 1/4 inch in 10 feet, nor 3/8 inch in 20 feet, nor 1/2 inch in 40 feet or more. For external corners, expansion joints, control joints, and other conspicuous lines, do not exceed 1/4 inch in 20 feet, nor 1/2 inch in 40 feet or more. For vertical alignment of head joints, do not exceed plus or minus 1/4 inch in 10 feet, nor 1/2 inch maximum.
- B. Variation from Level: For bed joints and lines of exposed lintels, sills, and other conspicuous lines, do not exceed 1/4 inch in 20 feet, nor 1/2 inch in 40 feet or more.
- C. Variation in Cross-Sectional Dimensions: From dimensions shown, do not exceed minus 1/4 inch nor plus 1/2 inch.
- D. Variation in Mortar-Joint Thickness: Do not vary from joint thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch. Do not vary joint thickness from joint thickness of adjacent course by more than 1/8 inch.

3.04 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint widths and for accurate location of openings, movement-type joints, returns, and offsets. Avoid the use of less-than-half-size units at corners, jambs, and where possible at other locations.
- B. Lay walls to comply with specified construction tolerances, with courses accurately spaced and coordinated with other construction.
- C. Bond Pattern: Lay masonry in the following bond pattern; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.
 - 1. One-half running bond with vertical joint in each course centered on units in courses above and below.
- D. Stopping and Resuming Work: In each course, rack back 1/2-unit length; do not tooth. Clean exposed surfaces of set masonry, wet clay masonry units lightly if required, and remove loose masonry units and mortar prior to laying fresh masonry.
- E. Built-in Work: As construction progresses, build-in items specified under this and other Sections of the Specifications. Fill in solidly with masonry around built-in items.
- F. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath in the joint below and rod mortar or grout into core.
- G. Fill cores in hollow concrete masonry units containing vertical reinforcing with grout full height, unless otherwise indicated. Jambs at all door and window openings shall be grouted full height.

3.05 MORTAR BEDDING AND JOINTING

- A. Lay hollow concrete masonry units as follows:
 - 1. With completely filled bed and head joints. Butter ends of units with sufficient mortar to completely fill head joints. Provide full bed joints, including face shells and webs.
 - 2. Maintain joint widths indicated, except for minor variations required to maintain bond alignment. If not indicated, lay walls with 3/8-inch joints.
- B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not furrow bed joints or slush head joints.
- C. Tool joints slightly concave when thumbprint hard, using a jointer larger than joint thickness, unless otherwise indicated.

3.06 CAVITY WALLS

- A. Bond wythes of cavity walls together using the following method and as indicated on the Drawings:
 - 1. Masonry Joint Reinforcement: Installed in horizontal mortar joints.
 - a. Use adjustable (two-piece) ladder type extending across both wythes.
- B. Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Do not attempt to trowel or remove mortar fins protruding into cavity.

3.07 MASONRY JOINT REINFORCEMENT

- A. General: Provide continuous horizontal-joint reinforcement as indicated. Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch. Lap reinforcement a minimum of 6 inches.
 - 1. Space reinforcement not more than 16 inches o.c.
- B. Cut or interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.
- C. Provide continuity at wall intersections by using prefabricated T-shaped units.
- D. Provide continuity at corners by using prefabricated L-shaped units.
- E. Cut and bend reinforcement units as directed by manufacturer for continuity at returns, offsets, pipe enclosures, and other special conditions.

3.08 PLACING REINFORCEMENT

- A. General: Comply with requirements in TMS 402-11 / ACI 30-11 / ASCE5-11.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials that reduce or destroy bond with grout.
- C. Accurately position, support, and secure reinforcement against displacement.

3.09 LINTELS

- A. Provide masonry lintels where shown and where openings of more than 24 inches for block-size units are shown without structural steel or other supporting lintels.
- B. Provide minimum bearing shown on drawings.

3.10 FLASHING, WEEP HOLES, CAVITY DRAINAGE, AND VENTS

- A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, bond beams, bottoms of walls supported on slabs, other obstructions to downward flow of water in wall, and where indicated. Install vents at shelf angles, ledges, bond beams, bottoms of walls supported on slabs, and other obstructions to upward flow of air in cavities, and where indicated.
- B. Install flashing as follows, unless otherwise indicated:
 - 1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
- C. At cavity walls, extend flashing through outer wythe, turned up a minimum of 4 inches, and 1-1/2 inches into the inner wythe. Form 1/4-inch hook in edge of flashing embedded in inner wythe.
 - 1. At lintels and shelf angles, extend flashing a minimum of 6 inches into masonry at each end of lintel and shelf angle. At heads and sills, extend flashing 6 inches at ends and turn up not less than 2 inches to form end dams.
 - 2. Interlock end joints of ribbed sheet metal flashing by overlapping ribs not less than 1-1/2 inches or as recommended by flashing manufacturer, and seal lap with elastomeric sealant complying with requirements in Division 07 Section "Joint Sealants" for application indicated.

3. Install metal drip edges with ribbed sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant complying with requirements in Division 07 Section "Joint Sealants" for application indicated.
4. Install weep holes in head joints in exterior wythes of first course of masonry immediately above embedded flashing and as follows:
 - a. Use open head joints to form weep holes.
 - b. Use wicking material to form weep holes above flashing under brick sills. Turn wicking down at lip of sill to be as inconspicuous as possible.
 - c. Space weep holes 16 inches o.c., unless otherwise indicated.
 - d. Space weep holes formed from wicking material 16 inches o.c.
 - e. Trim wicking material flush with outside face of wall after mortar has set.
5. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in Part 2 "Miscellaneous Masonry Accessories" Article.
6. Install vents in head joints in exterior wythes at spacing indicated. Use open head joints to form vents.
 - a. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.

3.11 GROUTING

- A. Do not place grout until entire height of masonry to be grouted has attained sufficient strength to resist grout pressure.
 1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
 2. Provide cleanout holes at least 3 inches in least dimension for grout pours over 60 inches in height.

3.12 REPAIRING, POINTING, AND CLEANING

- A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or if units do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.
- B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point-up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.
- C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears prior to tooling joints. Remove excess mortar from all vertical expansion joints and remove excess mortar and grout from any horizontal expansion joints at tops of all masonry walls.
- D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
 1. Beginning from the top of the wall, lightly pre-wet or pre-cool the wall;
 2. Begin applying cleaning material from the top to bottom, using even, overlapping passes to ensure full coverage of chemical on the surface;
 - a. Apply cleaning material to the entire drop or section of wall that can be cleaned without allowing the chemical to dry on the surface.
 3. After the first application of cleaning material, scrape the large chunks with a long handled scrapper from the first 8 feet of wall;
 - a. Use a scrapper in accordance to masonry manufacturers' requirements.
 4. Check smears and tags to see if they crumble easily;
 5. If needed, repeat application to melt remaining residue and extend dwell time;
 6. After re-application, scrapping can be done further down the wall;
 7. Once smears and tags crumble easily, begin rinsing from top down. A thorough rinse is necessary to avoid leaving any cleaning material on the surface or in the masonry unit.
 - a. Use long even strokes that overlap each other.

- b. Rinse pressure is determined by the masonry manufacturers' requirements. Color sensitive surfaces should always be rinsed with low pressure..
- E. Protection: Provide final protection and maintain conditions that ensure unit masonry is without damage and deterioration at time of Substantial Completion.

3.13 WATER REPELLENT SEALER

- A. After final cleaning and masonry is thoroughly dry, ensure that surfaces are clean and free of dust, surface dirt, oil, grease and other contaminants.
- B. Test application: Provide test application and allow to fully cure prior to evaluation for appearance and performance. Do not proceed until approval of final appearance.
- C. Protect adjacent construction materials from sealer as recommended by the manufacturer.
- D. Ensure there is adequate ventilation and that there are no potential ignition sources prior to application.
- E. Apply the sealer per manufacturer's recommendations.

3.14 QUALITY CONTROL DURING CONSTRUCTION

- A. General: The Owner will employ a testing agency to perform tests and inspections and to submit testing and inspection reports. Allow inspectors access to scaffolding and work areas, as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.
- B. Perform visual inspections of 75% of masonry placement at each level, checking for reinforcement placement, mortar placement, joint placement, anchorage placement, and grouting.
- C. Testing Frequency: Tests listed in this Article will be performed during construction for each 2,000 sq. ft. of wall area or portion thereof, but no less than three of each test for the Project if there is less than 6,000 square feet of wall surface for the Project.
- D. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C 140 for compressive strength.
- E. Compressive-Strength Tests for Grout: Test grout cylinders or cubes for compressive strength per ASTM C 1019 as follows:
 - 1. Prepare 1 set of laboratory-cured specimens, cylinders or cubes, for testing as follows: one specimen tested at 7 days, two specimens tested at 28 days, and one spare specimen to be held in reserve for later testing if required.
- F. Mortar Aggregate Ratio Test: For each type provided, test mortar for consistency of materials and procedures per ASTM C 780.
- G. Prism Test: For each type of construction provided, according to ASTM C 1314 at 7 days and at 28 days.
- H. Test results shall be reported in writing to Engineer and Contractor within 24 hours after tests. Reports of strength tests shall contain the Project identification name and number, date of masonry placement, name of testing service, masonry type and class, location of masonry in structure, and compressive breaking strength for both 7-day tests and 28-day tests.

END OF SECTION

SECTION 05 12 00
STRUCTURAL STEEL

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.02 STANDARDS

- A. The following Standards are listed in this specification:

ASTM A6	Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, Sheet Piling
ASTM A36	Standard Specification for Carbon Structural Steel
ASTM A53	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A123	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A325	Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A370	Standard Test Methods and Definitions for Mechanical Testing of Steel Products
ASTM A500	Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A563	Standard Specification for Carbon and Alloy Steel Nuts
ASTM A780	Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A992	Standard Specification for Steel for Structural Shapes for Use in Building Framing
ASTM C1107	Standard specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM F436	Standard Specification for Hardened Steel Washers
ASTM F959	Standard Specification for Compressible Washer-Type Direct Tension Indicators for use with Structural Fasteners"
ASTM F1554	Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
ASTM F1852	Standard Specification for "Twist-Off" Type Tension Control Structural Bolt/Nut/Washer Assemblies, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASCE 7-98	Minimum Design Loads for Buildings and Other Structures
OSHA	29 CFR Part 1926, Part R, Safety Standards for Steel Erection

1.03 DESCRIPTION OF WORK

- A. Extent of structural steel work is shown on drawings including schedules, notes and details that show size and location of members, typical connections, and type of steel required. Furnish all labor, materials, services, equipment and appliances required in conjunction with or related to the furnishing, fabrication, delivery, and erection of all structural steel defined below. Include all supplementary parts, members and connections necessary to complete the structural steel work, regardless of whether all such items are specifically shown or specified on the drawings.
- B. Structural steel shall be defined as that work prescribed in Section 2.1 of the AISC Code of Standard Practice and the following items: all steel supports for elevator guide rails.

- C. Miscellaneous metal fabrications, architecturally exposed structural steel, metal stairs and ladders, steel joists and joist girders, cold-formed metal framing, and metal deck are specified elsewhere in these Specifications.

1.04 QUALIFICATIONS

- A. Fabricator: The structural steel fabricator shall have not less than 5 years experience in the successful fabrication of structural steel similar to this project.

The structural steel fabricator must participate in the AISC Quality Certification Program and be designated an AISC Certified Plant in Category Sbd, Conventional Steel Building Structures.

- B. Erector: The structural steel erector shall have not less than 2 years successful experience in the erection of structural steel of a similar nature to this project.
- C. Professional Engineer: A professional engineer who is legally authorized to practice in the jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for projects with structural steel framing that are similar to that indicated for this Project in material, design, and extent.

1.05 QUALITY ASSURANCE

The Contractor is responsible for quality control, including workmanship and materials furnished by his subcontractors and suppliers.

- A. Codes and Standards: Comply with provisions of following, except as otherwise indicated. Certain sections in this specification contain requirements that are more restrictive and/or different than contained in the standards listed. In such cases, the requirements of this specification shall control.
1. All federal (OSHA), state and local laws that govern safety requirements for steel erection and other requirements if more stringent than the codes and standards enumerated below. OSHA requirements include regulation 29 CFR 1926, Part R, "Safety Standard for Steel Erection".
 2. AISC "Code of Standard Practice for Steel Buildings and Bridges," adopted March 7, 2000, except as noted herein.
 - a. Exception is taken to paragraph 1.8.2. In the second sentence, change the word "adequacy" to "design" so that the sentence reads, "The Structural Engineer of Record shall be responsible for the structural design of the structure in the completed project."
 3. AISC "Load and Resistance Factor Design Specification for Structural Steel Buildings," dated December 1, 1993, and supplements thereto as issued.
 4. AISC "Specification for Structural Joints using ASTM A325 or A490 Bolts" approved by the Research Council on Structural Connections, June 23, 2000.
 5. ANSI/AWS D1.1 "Structural Welding Code - Steel".
 6. "Steel Structures Painting Manual", Volumes 1 and 2, Society for Protective Coatings, formerly Steel Structures Painting Council.
- B. Qualifications for Welding Work: Qualify welding processes and welding operators in accordance with AWS "Structural Welding Code - Steel". All welding shall be performed in accordance with a written Welding Procedure Specification (WPS) as required in ANSI/AWS D1.1 that is approved by the Engineer.
- C. Source Quality Control: Materials and fabrication procedures are subject to inspection and tests in the mill, shop, and field by the Owner's testing laboratory. Such inspections and tests will not relieve the Contractor of responsibility for providing materials and fabrication procedures in

compliance with specified requirements. The Contractor shall promptly remove and replace materials or fabricated components that do not comply.

D. Question about Contract Documents: The Contractor shall promptly notify the Architect/Engineer whenever design of members and connections for any portion of the structure are not clearly indicated or when other questions exist about the Contract Documents. Such questions shall be resolved prior to the submission of shop drawings.

E. Testing Laboratory Services: See Testing Laboratory Services section of these Specifications for requirements relating to structural steel.

Inspection or testing by the Owner does not relieve the Contractor of his responsibility to perform the Work in accordance with the Contract Documents.

1.06 SUBMITTALS

A. Product Data: Submit producer's or manufacturer's specifications and installation instructions for following products; include laboratory test reports and other data to show compliance with specifications (including the specified standards):

1. Structural steel (each type), including certified copies of mill reports covering chemical and physical properties.
2. High-strength bolts (each type), including nuts and washers, including certified copies of mill reports covering chemical and physical properties.
3. Shrinkage-resistant grout.
4. Unfinished bolts and nuts.
5. Welding electrodes (each type).
6. Structural steel primer paint.
7. Inorganic or other protective paint.
8. Direct tension indicators.

B. Shop Drawings and Erection Drawings:

1. Definitions:
 - a. Shop Drawings: Drawings of the individual structural steel shipping pieces that are to be produced in the fabrication shop.
 - b. Erection Drawings: Field-installation or member-placement drawings that are prepared by the Fabricator to show the location and attachment of the individual shipping pieces.
 - c. Erection-Bracing Drawings: Drawings that are prepared by the Erector to illustrate the sequence of erection, any requirements for temporary supports and the requirements for raising, bolting, and/or welding. These drawings are in addition to and separate from the Erection Drawings.
2. Shop Drawings: Submit for review and approval shop drawings prepared under the supervision of and sealed by, for connection design only, a professional engineer licensed in the state where the project is located, including complete details and schedules for fabrication and assembly of structural steel components. In lieu of placing a seal on the shop drawings, the licensed professional engineer responsible for the design of the connections may submit a letter that is sealed attesting that the connection design engineer has reviewed the shop drawings and that the connections shown on the shop drawings conform to the design by the engineer. The Engineer reserves the right to reject all shop drawings not complying with the above requirements. Structural steel shop drawings shall include the following minimum information:
 - a. Include details of cuts, connections, camber, holes, and other pertinent data. Indicate welds by standard AWS symbols, and show size, length, and type of each weld. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify the

- type of high-strength bolted connection (slip-critical, direct-tension, or bearing connections).
- b. Provide setting drawings, templates, and directions for installation of anchor bolts and other anchorages to be installed by others.
3. Erection Drawings: Submit for review and approval complete erection drawings showing field-installation and member-placing instructions for locating and attaching the individual shipping pieces.
 4. Erection-Bracing Drawings: Submit for record purposes only complete erection-bracing drawings to illustrate the sequence of erection, any requirements for temporary supports and the requirements for raising, bolting, and/or welding.
 5. All fabricated material and connections shall fit within architectural constraints.
 6. The omission from the shop drawings of any materials required by the Contract Documents shall not relieve the Contractor of the responsibility of furnishing and installing such materials, even though the shop drawings may have been reviewed and approved.
- C. Calculations: The fabricator's engineer shall submit complete design calculations showing all information as specified in Part 2- Connections. The Engineer reserves the right to reject all shop drawings submitted without complete design calculations.
- D. Test Reports: Submit copies of reports of tests conducted on all material and on shop and field bolted and welded connections. Include data on type(s) of tests conducted and test results. See Testing Laboratory Services section of these Specifications for additional requirements.
- E. Qualification Data:
1. Submit qualification data for firms and persons specified in Article 1.03 "Qualifications" to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
 2. Submit Welding Procedure Specifications (WPS) in accordance with ANSI/AWS D1.1 for all welded joints. Submit test reports showing successful passage of qualification tests for all non-prequalified WPSs.
 3. Provide certification that welders to be employed in work have satisfactorily passed AWS qualification tests as specified in section 1.05-B. If recertification of welders is required, retesting will be at Contractor's responsibility.
- F. Substitutions:
1. Substitutions for the member sizes, type(s) of steel connection details or any other modifications proposed by the Contractor will be considered by the Architect/Engineer only under the following conditions:
 - a. That the request has been made and accepted prior to the submission of shop drawings. All substitutions shall be clearly marked and indicated on the shop drawings as a substitute.
 - b. That there is a substantial cost advantage or time advantage to the Owner; or that the proposed revision is necessary to obtain the required materials or methods at the proper times to accomplish the work in the time scheduled.
 - c. That sufficient sketches, engineering calculations, and other data have been submitted to facilitate checking by the Architect/Engineer, including cost reductions or savings in time to complete the work.
 - d. In no case shall such revisions result in additional cost to the Owner.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Store materials to permit easy access for inspection and identification. Keep steel members off ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration. Do not store materials on structure in a manner that might exceed allowable loads on or cause distortion or damage to members or supporting structures. Repair or replace damaged materials or structures as directed by Architect/Engineer.
- B. Furnish all fuel, maintenance, and equipment required for hoisting and placement of materials under this contract.
- C. Process, pay for and maintain all permits and certificates of on-site inspection required for derricks, cranes and hoisting equipment. No derrick, crane or hoisting equipment shall be operated without a certificate of operation and a certificate of on-site inspection, as required by governing authorities.
 - 1. In addition to the above, all hoisting equipment shall be installed, operated and maintained in accordance with all applicable regulations of authorities having jurisdiction.
 - 2. The Contractor shall furnish street storage and sidewalk crossing permits.

1.08 JOB CONDITIONS

- A. The Contractor shall coordinate the fabrication and erection of all structural steel work with the work of other trades.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Structural Steel: All hot rolled steel plates, shapes, sheet piling, and bars shall be new steel conforming to ASTM A6.

Structural steel shall comply with the provisions of the following ASTM Specifications as appropriate for the grades and types, and at the locations as specified on the drawings:

- 1. Structural Steel Wide Flange and WT Shapes - High Strength Steel, ASTM A992.
 - 2. M-Shapes, S-Shapes, and Channels - Carbon Steel, ASTM A36.
 - 3. Angle Shapes – Carbon Steel, ASTM A36.
 - 4. Structural Steel Plates and Bars - Carbon Steel, ASTM A36.
 - 5. Steel Pipe - ASTM A53 (Type E or S) Grade B (Fy = 35 ksi).
 - 6. Square and Rectangular HSS – ASTM A500, Grade B (Fy = 46 ksi).
 - 7. Connection Material: Unless noted otherwise on the drawings, column stiffener plates and doubler plates at moment connections shall be the same grade of steel as the beam connecting the column (highest grade if more than one grade is used). All other connection material except as noted otherwise on the drawings including bearing plates, gusset plates, stiffener plates, filler plates, angles, etc. shall be A36 steel unless a higher or matching grade of steel with the members connected is required by strength or stiffness calculations and provided the resulting sizes are compatible with the members connected.
- B. Structural Bolts and Threaded Fasteners: Structural bolts and threaded fasteners shall comply with the following ASTM Specifications as appropriate for the types and at the locations as specified on the drawings:
 - 1. ASTM A325 Type 1.

2. Alternative Design Fasteners: Fasteners that incorporate a design feature intended to indicate a predetermined tension or torque (load indicator bolts or "twist-off" bolts) shall conform to the requirements of section 2(d) of the RCSC "Specification for Structural Joints Using ASTM A325 or A490 Bolts". Bolts that are manufactured to conform to ASTM A325 shall additionally conform to ASTM F1852.

Subject to conformance with specified requirements, acceptable manufacturers include but are not limited to:

- a. Nucor Fastener, A Division of Nucor Corporation, Conway, AR and St. Joe, IN
- b. Lake Erie Screw Corp., Lakewood, OH.
- c. Vermont Fasteners Manufacturing, Swanton, VT
- d. Lohr Structural Fasteners, Humble, TX

3. Threaded Round Stock: ASTM A36
4. Bolts and Nuts, High Strength Bolts: Bolts and nuts for all high strength bolts shall be heavy hex head conforming to ANSI Standards B18.2.1 and B18.2.2 respectively. Nuts shall conform to ASTM A563.
5. Washers: All washers shall be circular, flat and smooth and shall conform to the requirements of Type A washers in ANSI Standard B23.1. Washers for high strength bolts shall be hardened and conform to ASTM F436.
6. Galvanized Bolts: Provide bolts, nuts and washers that are hot dip galvanized according to ASTM A153, Class C when used to connect steel called for on the drawings or in the specifications as hot dip galvanized after fabrication.
7. Direct Tension Indicators: Compressible washer-type direct-tension indicators conforming to ASTM F959.

Subject to conformance with specified requirements, acceptable manufacturers include but are not limited to:

- a. Applied Bolting Technology, Ludlow, VT.
- b. Turnasure, LLC., Langhorne, PA.

8. Bolt Lubrication: All bolts shall be well lubricated at time of installation. Dry, rusty bolts will not be allowed.
9. New Bolts: All bolts shall be new and shall not be reused.

- C. Electrodes for Welding: Comply with AWS D1.1, "Structural Welding Code - Steel" with a minimum Charpy V-notch toughness of 20 ft-lbs at 0° F. Electrodes for various welding processes shall be as specified below:

1. SMAW: E70XX low hydrogen
2. SAW: F7X-EXXX
3. GMAW: ER70S-X
4. FCAW: E7XT-X

Electrodes shall be compatible with parent metal joined.

- D. Anchor Rods:

1. All anchor rods shall conform to ASTM F1554, Grade 36
2. Anchor rods used with galvanized baseplates shall be galvanized.
3. Nuts: All nuts with anchor rods shall be heavy hex head conforming to ASTM A563.
4. Washers: Washers for all base plates shall be 1/4" thick plates extending minimum 1" from edge of base plate holes on each side with holes 1/16 inch larger than the nominal bolt diameter. Washers shall conform to ASTM A36 steel.

E. Structural Steel Primer Paint:

1. Organic zinc-rich primer utilizing either an epoxy or urethane binder with a minimum volume solids ratio of 50 percent with a minimum zinc content of 80 percent by weight in the dry film. Apply primer at a rate to achieve a dry film thickness of 3.0 to 4.0 mils. The primer shall comply with the AISC class B slip critical requirement. (SSPC-SP6 Commercial Blast Cleaning).
2. Refer to Architect's drawings and specifications for final paint finish requirements of structural steel. Primer paint shall be compatible with final paint requirements.

F. Non-Shrink Grout: Provide grout type(s) as specified on the drawings:

1. Non-Metallic Non-Shrink Grout: Premixed, non-corrosive, non-staining product containing Portland cement, silica sands, shrinkage compensating agents, and fluidity improving compounds. Conform to ASTM C1107. Provide the minimum strength as shown below as determined by grout cube test at 28 days:
 - a. 6,000 PSI for supporting concrete 3000 psi and less.
 - b. 8,000 PSI for supporting concrete greater than 3000 psi and less than or equal to 4000 psi.
 - c. Unless noted otherwise on the drawings, grout strength on supporting concrete greater than 4000 psi shall be 8000 psi.

Subject to conformance with specified requirements, acceptable non-shrink grouts include:

"14k Hy Flow" and "SonogROUT 10k" as manufactured by Sonneborn-ChemRex, Inc.

"Crystex" and "DuragROUT" as manufactured by L&M Construction Chemicals, Inc.

"Sure Grip High Performance Grout," and "1107 Advantage Grout" as manufactured by Dayton-Superior Corporation.

"Masterflow 555", "Masterflow 928" and "Set Grout" as manufactured by ChemRex, Inc., MBT Protection and Repair Division.

"Five Star Grout" as manufactured by U.S. Grout Corp.

"NS Grout" and "Hi-Flow Grout" as manufactured by The Euclid Chemical Company.

G. Hot Dip Galvanizing:

1. Scope: Hot dip galvanize after fabrication all structural steel items and their connections permanently exposed to exterior conditions or that are within areas of unconditioned airspace, whether specified on the drawings or not. Such items include, but are not limited to:
 - a. Shelf angles.
 - b. Parapet wall supporting members.
 - c. Screen wall supporting members.
 - d. Window washing support members.
 - e. Embedded plates in concrete.
 - f. Garage guardrail steel and connections.
 - g. Cooling tower support steel.
 - h. Building skin support steel exposed to moisture outside the exterior waterproofing surface.

Examine the architectural and structural drawings for other items required to be hot dipped galvanized.

Galvanize all nuts, bolts, and washers used in the connection of such steel. Field welded connections shall have welds protected with "Z.R.C. Cold Galvanizing Compound" as manufactured by Z.R.C. Products Company.

2. Surface Preparation: All steel to be hot dip galvanized shall undergo the following surface preparation as specified by the Steel Structures Painting Council (SSPC), Volume 2.
3. Zinc Coating: The zinc coating for steel shapes and plates shall conform to ASTM A123.

H. Galvanizing Repair Paint: Galvanizing repair paint shall be "ZRC Cold Galvanizing Compound" as manufactured by ZRC Chemical Products or a paint complying with SSPC-Paint 20.

2.02 FABRICATION

A. Shop Fabrication and Assembly:

1. Fabricate and assemble structural assemblies in shop to greatest extent possible. Fabricate items of structural steel in accordance with AISC Specification and as indicated on approved final shop drawings.
2. Milled surfaces of built-up sections shall be completely assembled or welded before milling.
3. Fitted stiffeners shall be fabricated neatly between flanges, and the ends of stiffeners shall be milled or ground to secure an even bearing against abutting surfaces. All milled or ground joints shall bear throughout their contact length.

B. Dimensional Tolerances: Dimensional tolerances of fabricated structural steel shall conform to Section 6.4 of the AISC Code of Standard Practice.

C. Camber:

1. Camber of structural steel members is indicated on the drawings.
2. Where indicated on the drawings in a camber diagram, cantilever or double cantilever beams shall be cambered for the main span and cantilever end separately, either by a staged cold bending process or by the application of heat.
3. Cambers indicated on the drawings are intended to be final cambers at time of erection.

D. Splices in Structural Steel: Splicing of structural steel members in the shop or the field is prohibited without prior approval of the Engineer. Any member having a splice not shown and detailed on approved shop drawings will be rejected.

E. Cutting: Manual oxygen cutting shall be done only with a mechanically guided torch. An unguided torch may be used provided the cut is not within 1/8 inch of the finished dimension and final removal is completed by means such as chipping or grinding to produce a smooth surface quality free of notches or jagged edges. All corners shall be smooth and rounded to a minimum 1/2" radius.

F. Holes for Other Work: Provide holes required for securing other work to structural steel framing, and for passage of other work through steel framing members as shown on the contract documents, and/or the final shop drawings.

1. Provide specialty items as indicated to receive other work.
2. Cut, drill, or punch holes perpendicular to metal surfaces. Do not flame cut holes or enlarge holes by burning. Drill holes in bearing plates.

G. Lifting and Erection Devices: The fabricator shall be responsible for designing, detailing and furnishing all lifting devices and erection aids required for erection. Such devices shall be removed after erection if they interfere with architectural finish requirements.

2.03 WELDING

- A. Code: All shop and field welding shall conform to all requirements in the "Structural Welding Code - Steel", ANSI/AWS D1.1, as published by the American Welding Society (AWS).
- B. Welder Certification: All shop and field welders shall be certified according to AWS procedures for the welding process and welding position used.
- C. Welding Procedure Specification: All welding shall be performed in accordance with a Welding Procedure Specification (WPS) as required in AWS D1.1 and approved by the Owner's Testing Laboratory and the Architect/Engineer. The WPS variables shall be within the parameters established by the filler-metal manufacturer.

2.04 BOLTING

- A. Minimum Bolt Diameter: Minimum bolt diameter shall be 3/4 inch.
- B. Connection Type: Unless noted otherwise on the drawings, all bolted connections shall be snug-tightened using high-strength bolts in standard holes (hole diameter nominally 1/16 inch greater than the nominal bolt diameter) with threads included in the shear planes. Notwithstanding, the contractor shall be responsible to adhere to provisions of AISC Specification Section J1.11, which lists circumstances under which certain connections require fully-tightened high strength bolts.
- C. Fastener Tension:
 - 1. High strength bolts in snug-tightened joints shall be tightened to a snug tight condition only. Do not pretension bolts in snug-tightened joints the same as if they were in slip-critical joints. The snug-tightened condition is defined as the tightness that exists when all plies are in firm contact. This may usually be attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench.

Any of the four methods to tighten bolts specified in the AISC "Specification for Structural Joints Using ASTM A325 or A490 Bolts" may be used to achieve the minimum bolt tension. The tightening procedure that uses direct tension indicator washers shall conform to the requirements of ASTM F959.
- D. Minimum Strength of Bolted Connections: Except as specified below in "Connections" or noted otherwise on the drawings, all shop and field bolted connections shall develop the full tensile strength of the member. All members with bolted moment connections, noted on the drawings with "MC", shall be bolted to develop the full flexural capacity of the member, unless noted otherwise on the drawings.

2.05 CONNECTIONS

- A. Typical connection details are indicated on the drawings.
- B. Design Procedure:
 - 1. Unless noted otherwise or specifically detailed on the drawings, end connections of beams, girders, and trusses shall be designed as flexible and the connection shall accommodate end rotations of the unrestrained beams. Restrained end connections, noted on the drawings as "MC", shall be designed for the combined effect of bending moment and shears induced by the rigidity of the connection. Forces to be used in the design are described below.

2. The design of all steel connections that the fabricator is required to design according to the paragraph below shall be performed under the direct supervision of a qualified professional engineer licensed in the state where the project is located, employed by the fabricator.
3. The fabricator's licensed professional engineer shall submit complete design calculations for each connection, including connections completely detailed on the drawings (if any). Such calculations shall show details of the assembled joint with all bolts and welds required. Where predesigned connections are taken directly from the AISC Manual or related publications, calculations need not be submitted provided the project design conditions precisely match those assumed in the referenced publications, all data extracted from the tables is clearly identified with the table number, and such connections are so indicated in the calculations submitted.
4. The fabricator, his detailer and supervising engineer shall coordinate all connection requirements with the erector. The fabricator is responsible to detail connections that contain the adjustability and all other requirements that allow the erector to erect the structural steel in conformance to all specified tolerances.
5. The fabricator's licensed professional engineer shall seal all design calculations.
6. The Engineer reserves the right to reject all shop drawings submitted without complete design calculations. Failure to adhere to the requirements of this section obligates the Contractor to take responsibility for any and all resulting delays in the detailing and fabrication of structural steel.

C. Flexible (Simple) Beam Connections:

1. All typical beam simple connections shall conform to requirements of the AISC specifications. Refer to the drawings for typical connection types.
2. Seated Beam Connections and Stiffened Seated Beam Connections shall not be used unless indicated on the drawings or unless Engineer approval is obtained to verify capacity of supporting member for the resulting eccentricity. The fabricator must verify and bear responsibility that the use of such connections does not interfere with architectural or MEP requirements.
3. Simple Beam Design Capacity: Design the connection to support, at a minimum, the design reaction shown on the plans. Notify the engineer and request a reaction for any beam where no reaction is shown.
 - a. Minimum reaction capacity shall be 10.0 kips service load or 15 kips factored load and each connection shall contain not less than the minimum number of bolts shown in the AISC connection tables for each beam size.

D. Restrained (Moment) Connections:

1. Refer to the drawings for Moment Connection Details.
2. Design Reactions for Moment Connected Beams: Shear connections for moment-connected beams shall be designed for the reaction shown on the drawings.
3. Design and Furnishing of Reinforcement in Moment Connected Joints: As part of the design responsibility outlined above, the fabricator shall design and furnish all additional reinforcement in moment connected joints to resist the specified design forces unless otherwise specifically detailed on the drawings. Column sections shall be investigated for web shear, web yielding, web buckling, and tension. Stiffeners and/or doubler plates shall be furnished as required by the AISC Specification Section K1.

E. Tightening of Bolts in Welded Moment Connections. At moment connections where beams are complete-joint penetration welded directly to columns or girders in the field, welds shall be made after installation of erection bolts to draw the pieces together and before the final shear connection bolts are tightened

F. Column Splices: Bearing and Fit-Up of Column Compression Joints: Compression joints of all columns shall have bearing surfaces finished to a common plane by milling, sawing, or other

suitable means. Lack of contact bearing must not exceed 1/16" or corrective measures as defined by AISC Specification M4.4 shall be required.

G. Base Plates and Bearing Plates:

1. Attachment to Column: Unless shown otherwise on the drawings, all baseplates and bearing plates shall be welded all around to the column with minimum fillet welds as specified in AISC Specification Table J2.4.
2. Setting Base Plates: Baseplates shall be set to the elevation indicated on the drawings and leveled using steel shims (plastic shims will not be allowed) or by three leveling screws with weldments at the plate edges. Plates shall be grouted using specified non-shrink non-metallic grout after all protruding plates have been trimmed. Tighten anchor bolts after supported members have been positioned and plumbed.
3. Anchor Rod Holes in Baseplates: Hole sizes in baseplates for anchor rods shall be made oversized as described in table 14.2 in AISC Manual of Steel Construction, Third Edition.

H. Struts and Braces: Connections for all struts, hangers, and braces shall have connections designed to develop the full allowable tensile strength of the member.

I. Stiffeners: Provide stiffeners finished to bear under all load concentrations on supporting members, on all members framing over columns, at beam column joints (as required by the AISC Specification Section K1) and where shown on the drawings.

J. Steel Shelf Angles: Shelf angles supporting veneer shown on the drawings to be continuous shall be furnished in approximately 8'-0" lengths with at least two supports per section. Provide a 1/4" gap at each joint. The gap shall not be welded. Locate joints halfway between supports. Shelf angles shall be continuous around corners with corner joint complete penetration welded.

2.06 SURFACE PREPARATION AND SHOP PRIME PAINTING

A. Specification: Surface preparation, paint, and painting practices shall conform to the "Steel Structures Painting Manual", Volumes 1 and 2, as published by the Society for Protective Coatings (formerly the Steel Structures Painting Council (SSPC)).

B. Scope: All steel shall remain unpainted, except the following:

1. Shop paint surfaces that are to remain exposed to view in the final construction.
2. Shop paint any steel other than weathering steel that, in the final construction, will not be in a controlled environment and is therefore subject to moisture or high humidity infiltration and that has not been specified to be galvanized.
3. Shop paint any steel that is shown on the drawings to receive a finished paint system as defined in Specification Section 09 90 00.
4. Coordinate all shop painting of structural steel with Architect's painting requirements as specified on the architectural drawings and in the specifications. The Fabricator shall be responsible for determining all painting requirements (which surfaces are to be painted or left unpainted) on the project prior to fabrication.

C. Additional Painting Requirements

1. Extend shop paint to 2" from location of welds on surfaces that are to be field welded.
2. If individual elements (including the mating surfaces) of an assembly that is required to be painted are painted prior to welding into an assembly, then all painted surfaces affected by welding shall be touched-up and repaired (according to manufacturer's instruction, if any) to prevent corrosion bleeding.

3. The Fabricator shall be responsible to ensure that all elements of all assemblies that are to be painted are fabricated so that no exposed surface shall be subject to stains due to corrosion bleeding during the warranty period of the paint.
- D. Surface Preparation - Unpainted Steel: All structural steel that is not specified to receive a shop coat of primer paint shall be prepared in accordance with Society for Protective Coatings specifications as follows:
1. SSPC-SP 2, "Hand Tool Cleaning" or SSPC-SP 3, "Power Tool Cleaning"
- E. Surface Preparation and Primer Paint - Shop Painted Steel:
1. Surface Preparation: Prepare the surface of all structural steel specified to be shop painted as required by the paint manufacturer or the Society for Protective Coatings specifications, but not less than the following:
 - a. SSPC-SP 6, "Commercial Blast Cleaning".
 2. Priming: Immediately after surface preparation, apply primer to all structural steel specified to be shop primed in strict accordance with manufacturers instructions and the Society for Protective Coatings specifications. Apply paint at a rate to conform to the manufacturer's written instructions and to provide a dry film thickness of not less the 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and all exposed surfaces. Apply two coats to surfaces that are inaccessible after assembly or erection. Change the color of the second coat to distinguish it from the first coat.
 3. Finish Coat: Coordinate shop primer paint requirements with architectural drawings and specifications. The primer selected must be compatible with any specified finish coat.
- F. Touch-Up Painting: The General Contractor shall provide for cleaning and touch-up painting of welds, bolted connections, (including nuts, bolts, washers, filler plates, member end supplement plates and welds, if any) and abraded areas. Prior to shipment, apply paint to exposed areas using same materials and surface preparation as used for shop painting. Paint shall be applied by brush or spray with minimum dry film thickness of 1.5 mils.

PART 3 EXECUTION

3.01 ERECTION

- A. The Erection work shall comply with the requirements of AISC Specification Section M4.
- B. Inspection: Erector shall examine areas and conditions under which structural steel work is to be installed and notify the Contractor and the Architect/Engineer in writing of conditions detrimental to proper and timely completion of the work.
- C. Surveys: The General Contractor shall employ a qualified land surveyor to insure accuracy in structural steel erection.
- D. Temporary Shoring and Bracing:
1. The lateral-load resisting system and connecting diaphragms are identified on the drawings. Comply with the provisions of the Code of Standard Practice regarding stability of the structure during the erection process.
 2. Design and provide all required temporary shoring and bracing to hold structural framing securely in position and to safely withstand all loads as specified in the Code of Standard Practice unless larger loads are required by the local building code or specified herein. Provide all bracing, any additional structural members, and increase member sizes and/or

- connections shown on the drawings as required to accommodate the erection loads, methods, sequence of erection, and equipment until the lateral-load resisting or stability-providing system is completely installed. Clearly show all temporary supports and modifications to designed members on the Shop Drawings and the Erection-bracing Drawings.
3. Where architectural or MEP requirements do not allow for any temporary supports, members, erection devices, or connections to be left in place permanently or where such items affect the final structural behavior, they shall be removed by the erector. All costs associated therewith shall be included in the bid price.
- E. Anchor Rods: Furnish anchor rods and other connectors required for securing structural steel to foundations and other in-place work.
- F. Field Modifications to Structural Steel: Errors in shop fabrication or deformation resulting from handling and transportation that prevent the proper assembly and structural fitting of parts shall be reported immediately to the Architect/Engineer, and approval of the method of correction shall be obtained. Approved corrections shall be made at no additional cost to the Owner. Do not use cutting torches, reamers, or other devices in the field for unauthorized correction of fabrication errors.
- G. Miscellaneous Framing: Provide supplemental structural steel support framing for metal deck where normal deck bearing is interrupted by columns, or other framing members or floor openings whether shown or not on the architectural, mechanical, or structural drawings.
- H. Removal of Erection Aids and Devices: The erector shall remove all erection aids and devices that interfere with architectural finish or MEP requirements.
- I. Field Touch-Up Painting:
1. Clean field welds, unpainted areas of bolted connections (including all exposed areas of nuts, bolts, washers, filler plates, member end supplement plates and welds), and any shop-painted areas that are abraded. Apply paint to exposed areas using same material and surface preparation as used for shop painting. Apply by brush or spray to provide minimum dry film thickness of 1.5 mils.
 2. Clean field welds, ungalvanized areas of bolted connections (including all exposed areas of nuts, bolts, washers, filler plates, member end supplement plates and welds) and galvanized areas that are abraded. Prepare surfaces and apply specified galvanizing repair paint in accordance with ASTM A780.
- J. Clean Up: Clean up all debris caused by the Work of this Section, keeping the premises neat and clean at all times.
- K. Tests and Inspections: Refer to Testing Laboratory Services section of this specification for required tests and inspections.

END OF SECTION

SECTION 05 31 23
STEEL ROOF DECK

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 1 - Specification sections, apply to work of this section.

1.02 STANDARDS

- A. The following Standards are listed in this specification:

ASTM A653	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A1008	Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability
ASTM B633	Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel

1.03 SCOPE OF WORK

- A. Supplier: The metal deck supplier shall furnish all metal deck materials and accessories indicated on the Architectural, Structural, and Mechanical Drawings required to produce a complete job including but not necessarily limited to deck units, cover plates, metal deck edge closures, cell closures, cant strips, sump pans, and all related accessories.
- B. Erector: The Subcontractor responsible for erecting the metal deck shall provide all labor and equipment as required to place all metal deck components and accessories as described above.

1.04 QUALIFICATIONS

- A. The metal deck supplier shall be a manufacturer with a minimum of two years successful experience and with a minimum of two successful jobs of a comparable size and scope to this project.

1.05 QUALITY ASSURANCE

The Contractor is responsible for quality control, including workmanship and materials furnished by his subcontractors and suppliers.

- A. Codes and Standards: Comply with provisions of the following codes and standards except as otherwise indicated or specified:
1. "Design Manual for Composite Decks, Form Decks, and Roof Decks", as published by the Steel Deck Institute (SDI).
 2. "Specification for the Design of Cold Formed Steel Structural Members", as published by the American Iron and Steel Institute (AISI).
 3. "Structural Welding Code – Sheet Steel", D1.3 as published by the American Welding Society (AWS).
- B. Qualification of Field Welding: Qualify welding processes and welding operators in accordance with AWS procedures.

- C. Underwriters Label: Provide metal deck units which are listed and conform to Underwriters Laboratories "Fire Resistance Directory", with each deck unit bearing the UL label and marking for specific fire-resistant system detailed. Provide units and construction which are found in UL "Roofing Materials & Systems Directory" and conform to UL Wind Uplift Class 90 construction and with each deck unit bearing the UL label and marking for specific wind-rated system detailed.
- D. Factory Mutual Listing: Provide metal roof deck units which have been evaluated by Factory Mutual Research Corporation and are listed in "Factory Mutual Research Approval Guide 2000-Building Materials" for "Class 1" fire rated construction and 1-90 Windstorm Classification.

1.06 SUBMITTALS

- A. Product Certification: Submit manufacturer's specifications and installation instructions for each type of deck specified. Also submit a certificate of product compliance with SDI Standards as specified.
- B. Shop Drawings: Submit detailed shop drawings showing type of deck, complete layout, attachment details, closures, edge strips, supplementary framing, and all other accessories. The shop drawings shall be sealed by the same registered professional engineer who seals the calculations.
- C. Calculations: The metal deck manufacturer shall submit design calculations sealed by a registered professional engineer in the state where the project is located verifying compliance with the specifications for all load and span conditions shown on the drawings. Calculations that show the deck attachment procedure and pattern meets the specified design criteria shall also be submitted.
- D. Insurance Certification: Assist Architect and Owner in preparation and submittal of roof installation acceptance certification as may be necessary in connection with fire, windstorm, and extended coverage insurance.
- E. Welding Certificates: Submit Copies of certificates for welding procedures and personnel.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. See General Notes on the drawings for the location, depth of deck, design thickness, and type of deck required.

2.02 GRADES OF STEEL

- A. Steel deck shall be manufactured from steel conforming to ASTM A1008 Grades C, D, or E for painted deck or A653, Structural Steel Grade for galvanized deck or Engineer approved equal, having a minimum yield strength of 33,000 PSI.

2.03 FINISH

- A. Galvanizing: Steel deck shall be galvanized with a protective zinc coating conforming to ASTM A653 G90.
- B. Galvanizing Repair Paint: High zinc-dust content paint for repair of damaged galvanized surfaces complying with Department of Defense Specifications DOD-P-21035.

2.04 ROOF DECK ACCESSORIES

- A. Provide minimum 20 gauge ridge and valley plates, minimum 20 gauge cant strips, minimum 14 gauge sump pans, minimum 20 gauge inside or outside closure channels angles or plates, minimum 20 gauge butt strips at change of deck directions, minimum 20 gauge filler sheets, and rubber closures as required to provide a finished surface for the application of insulation and roofing.

2.05 MECHANICAL FASTENERS

- A. Powder-Actuated or Pneumatically Driven Pins: Provide corrosion-resistant, powder-actuated or pneumatically driven fasteners manufactured from steel conforming to AISI 1060 or 1061 steel, austempered to a core hardness of 52 to 58 Rockwell C. Fasteners shall have a knurled shank and shall be zinc-plated in accordance with ASTM B633, Sc. I, Type III.

Subject to compliance with requirements, provide products of one of the following manufacturers:

Hilti, Inc., Tulsa, OK
ITWBuildex, Itasca, IL
Pneutek, Inc., Hudson, NH

- B. Self-Drilling Screw Fasteners: Provide corrosion-resistant, hexagonal head, steel self drilling screws, austempered to a core hardness of Rockwell C 50.

Subject to compliance with requirements, provide products of one of the following manufacturers:

ITWBuildex, Itasca, IL

2.06 SIDE-LAP FASTENERS:

- A. Provide Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 minimum diameter.

2.07 FABRICATION

- A. General: Fabricate deck panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck", in SDI Publication No. 29, and the following.
- B. Metal Deck Spans: Metal deck spans shall not exceed the maximum center to center spans as required by the Factory Mutual Research Corporation Approval Guide 2000 – Building Materials or as recommended by SDI, whichever is less. Where possible, metal decks shall extend over three or more supports. Single span deck is prohibited.
- C. Underwriters Laboratories Wind Uplift Classification: Provide metal deck panels meeting the requirements of Construction No. 157 as listed in the 2000 UL Roofing Materials & Systems Directory under Roof Deck Constructions (TGKX) and rated as a Class 90 assembly.

2.08 ROOF OPENINGS

- A. Provide a 20 gage galvanized flat plate to reinforce openings in roof deck that are greater than 6" and less than 10" in any one direction.

PART 3 EXECUTION

3.01 INSTALLATION

A. General: Install deck units and accessories in accordance with manufacturers recommendations and approved shop drawings, and as specified herein:

1. Place deck units on supporting framework and adjust to final position with accurately aligned side laps and ends bearing 2" minimum on supporting members before being permanently fastened. Do not stretch or contract side lap interlocks. Place the end joint over a chord angle for deck bearing on steel bar joists.
2. Place deck units in straight alignment for entire length of run of cells and with close alignment between cells at ends of abutting units.
3. Place deck units flat and square, secured to adjacent framing without warp or excessive deflection.
4. Do not place deck units on concrete supporting structure until concrete has cured and is dry.
5. Coordinate and cooperate with structural steel erector in locating decking bundles to prevent overloading of structural members.
6. Do not use roof deck units for storage or working platforms until permanently secured.

B. Attachment of Roof Deck:

1. The method of attachment, attachment pattern, and side lap fastener type and spacing, shall be designed to resist the net uplift load and the diaphragm shear as shown on the drawings but not less than the minimum requirements noted below.
2. Method of Attachment: The deck shall be fastened to the structural support members using one of the following methods.
 - a. Welding: Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work. Weld metal shall penetrate all layers of deck material at end laps and side joints and shall have good fusion to the supporting member. Welding washers shall be used only when welding steel deck less than 0.028" thickness. The diameter of the puddle weld on the supporting member shall be, at a minimum, the diameter stated in the specification but no less than 1/2 inch.
 - b. Powder-Actuated or Pneumatically Driven Pins: An operator licensed by the pin manufacturer shall install all pins. Comply with the manufacturer's requirements to install the pins through all layers of the deck material and the manufacturer's required embedment into the supporting member.
 - c. Self-Drilling Fasteners: Comply with the manufacturer's requirements to install the screws through all layers of the deck material and the manufacturer's required embedment into the supporting member.
3. Side Lap Fastening: Unless required otherwise by provisions of this specification, side laps of adjacent units shall be fastened by welding (on 20 gauge or heavier deck only) or #10 (min.) TEK screws so that spacing between supports and fasteners does not exceed the lesser of 1/2 the span or 36 inches. Button Punching is not allowable as a side-lap fastener.
4. End Bearing: Provide a minimum end bearing of 2" over supports.
5. End Joints: End joints of sheets shall be lapped 2" minimum over supports. Decks that slope 1/4 inch or more in 12 inches in the long direction shall be erected beginning at the low side to insure that end laps are shingle fashion.
6. Definition of Perimeter and Corner: Unless shown otherwise on the drawings, the definition of corner and perimeter areas shall be as noted below.
 - a. Definition of Roof Height: Roof height shall be defined as eave height for roofs that slope less than 10% and mean roof height for roofs with a greater slope.
 - b. Buildings with roof heights of 60 feet or less

- (1) Perimeter: The width of the perimeter strip shall be the smaller of one-tenth the least building dimension and four-tenths the roof height but not less than 4 feet. The strip either side of a ridgeline shall be considered as a perimeter strip for the purposes of deck fastening for roofs that slope between 10° and 45°.
 - (2) Corner: On an exterior (not re-entrant) corner, a strip the width of a perimeter strip defined above and extending for a length equal to the dimension of one perimeter strip each direction from the exterior corner.
 - c. Buildings with roof heights greater than 60 feet
 - (1) Perimeter: The width of the perimeter strip shall be one-tenth the least dimension of the building but not less than four feet.
 - (2) Corner: On an exterior (not re-entrant) corner, a strip the width of a perimeter strip defined above and extending for a length equal to the dimension of two perimeter strips each direction from the exterior corner.
7. Underwriters Laboratories Wind Uplift Classification Requirements: Unless a more stringent attachment requirement is specified elsewhere in this specification or on the drawings, roof deck units shall be attached to the supporting structure as required by the Construction Number specified elsewhere in this section.
8. Attachment to Girders: At locations where the deck flutes are parallel to the span of the steel framing and the top of the framing is at the bottom of the deck elevation, the deck shall be attached to the girder using one of the specified fastening methods at 18 inches on center. See the drawings for attachment details when the deck flute does not engage the top of the steel framing.
- C. Cutting and Fitting: Cut and neatly fit deck units and accessories around other work projecting through or adjacent to the decking.
- D. Reinforcement at Openings: Roof openings less than 6" square or diameter require no reinforcement. Openings 6" to 10" inclusive shall be reinforced with a 20 gauge galvanized plate welded to the deck at each corner and 6" maximum centers with a 5/8" diameter puddle weld or sheet metal screws. For openings greater than 10" in diameter or width, refer to the drawings and structural steel specifications for additional framing to support the deck around the opening.
- E. Roof Sump Pans and Sump Plates: Install over openings provided in roof decking and weld flanges to top of deck. Space welds not more than 12 inches apart with at least 1 weld in each corner.
- F. Joint Covers: Provide metal joint covers at changes in direction of deck units, except where taped joints are specified.
- G. Miscellaneous Roof Deck Accessories: Install ridge and valley plates, finish strips, cover plates, and reinforcing channels according to deck manufacturer's written instructions. Weld to substrate to provide a complete deck installation.
- H. Flexible Closure Strips: Install flexible rubber closure strips that seal the flutes of the deck when the deck cantilevers over an exterior beam and the flutes are exposed to weather and over interior partitions where there is no ceiling present and where indicated. Install with adhesive according to manufacturer's written instructions to ensure complete closure.

3.02 TOUCH-UP PAINTING

- A. Touch-up galvanized surfaces with galvanizing repair paint applied in accordance with manufacturer's instructions.

3.03 INSPECTION

- A. Welded decking in place is subject to inspection and testing by designated Testing Laboratory. Expense of removing and replacing portions of decking for testing purposes will be borne by Owner if welds are found to be satisfactory. Remove work found to be defective and replace with new acceptable work. Cost of such removal and replacement shall be borne by the Contractor.
- B. The nail head stand-off distance from the top of the deck for Powder-Actuated or Compressed-Air fasteners shall be in accordance with the manufacturer's requirements and shall be verified with an inspection gauge supplied by the manufacturer. The cost of re-fastening deck that is found to be inadequately fastened shall be borne by the Contractor.

END OF SECTION

SECTION 05 50 01

METAL FABRICATIONS – BURN TOWER ONLY

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This Section includes the following metal fabrications:
 - 1. Rough hardware.
 - 2. Steel pipe handrails attached to walls adjacent to stairs.
 - 3. Steel pipe guardrails.
 - 4. Steel grating.
 - 5. Steel components and hardware for doors and windows.
 - 6. Miscellaneous steel items.

1.03 PERFORMANCE REQUIREMENTS FOR STEEL GUARDRAILS AND HANDRAILS

- A. Structural Performance: Engineer, fabricate, and install guardrails, handrails, and railing systems to withstand the following structural loads without exceeding the allowable design working stress of the materials involved, including anchors and connections. Apply each load to produce the maximum stress in each of the respective components of each metal fabrication.
 - 1. Top Rail of Guardrail and Handrail Systems and Handrails attached to walls: Capable of withstanding the following loads applied as indicated:
 - a. Concentrated load of 200 lbf applied at any point and in any direction.
 - b. Uniform load of 50 lbf per linear foot applied horizontally and concurrently with uniform load of 100 lbf per linear foot applied vertically downward.
 - c. Concentrated and uniform loads above need not be assumed to act concurrently.
 - 2. Guardrails Not Serving as Top Rails: Capable of withstanding the following loads applied as indicated:
 - a. Concentrated load of 200 lbf applied at any point and in any direction.
 - b. Uniform load of 50 lbf per linear foot applied in any direction.
 - c. Concentrated and uniform loads above need not be assumed to act concurrently.

1.04 SUBMITTALS

- A. General: Submit each item in this Article according to the General Conditions of the Contract and Division 01 Specification Sections.
- B. Product data for steel shapes and plates, steel grating and treads, paint products, and grout.
- C. Shop drawings detailing fabrication and erection of each metal fabrication indicated. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide templates for anchors and bolts specified for installation under other Sections.
- D. Welder certificates signed by Contractor certifying that welders comply with requirements specified under the "Quality Assurance" Article.

1.05 QUALITY ASSURANCE

- A. Fabricator Qualifications: Firm experienced in producing metal fabrications similar to those indicated for this Project with a record of successful in-service performance, and with sufficient production capacity to produce required units without delaying the Work.
- B. Installer Qualifications: Engage an experienced Installer who has completed steel work similar in material and extent to that indicated for this Project and with a record of successful in-service performance.

- C. Welding Standards: Comply with applicable provisions of AWS D1.1 "Structural Welding Code--Steel," AWS D1.2 "Structural Welding Code--Aluminum," and AWS D1.3 "Structural Welding Code--Sheet Steel."
 - 1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.
- D. Preinstallation Conference: Conduct conference at Project site to comply with requirements of Division 01 Section "Project Management and Coordination".

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver structural steel to Project site in such quantities and at such times to ensure continuity of installation.
- B. Store materials to permit easy access for inspection and identification. Keep steel members off ground by using pallets, platforms, or other supports. Protect steel members and packaged materials from erosion and deterioration.

PART 2 PRODUCTS

2.01 FERROUS METALS

- A. Metal Surfaces, General: For metal fabrications exposed to view in the completed Work, provide materials selected for their surface flatness, smoothness, and freedom from surface blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
- B. Steel Wide Flange Shapes: ASTM A 992.
 - 1. Galvanized finish unless otherwise indicated.
- C. Steel Channels: ASTM A 572.
 - 1. Galvanized finish unless otherwise indicated.
- D. Steel Angles, Plates, and Bars: ASTM A 36.
 - 1. Galvanized finish unless otherwise indicated.
- E. Steel Tubing: Cold-Formed Steel Tubing: ASTM A 500, Grade B.
 - 1. Galvanized finish unless otherwise indicated.
- F. Steel Pipe: ASTM A 53, standard weight (schedule 40), unless otherwise indicated, or another weight required by structural loads.
 - 1. Galvanized finish unless otherwise indicated.
- G. Steel Grating: 2" deep, 13 gauge, galvanized 'Perf-O Grip' grating by McNichols Co. or an approved equivalent, subject to compliance with requirements, by the following manufacturers:
 - 1. IKG Borden
 - 2. Unistrut Corporation
 - 3. GS Metals Corp.
 - 4. Morton Manufacturing Co.
 - a. Galvanized finish unless otherwise indicated.
- H. Steel Stair Treads: 2" deep, 13 gauge, galvanized 'Perf-O Grip' stair treads by McNichols Co. or an approved equivalent, subject to compliance with requirements, by the following manufacturers:
 - 1. IKG Borden
 - 2. Unistrut Corporation
 - 3. GS Metals Corp.
 - 4. Morton Manufacturing Co.
 - a. Galvanized finish unless otherwise indicated.
- I. Stainless Steel: Grade and type designated below for each form required:
 - 1. Tubing: ASTM A 554, Grade MT 316.

2. Pipe: ASTM A 312, Grade TP 316.
 3. Castings: ASTM A 743, Grade CF 8M.
 4. Plate: ASTM A240, Type 316.
 5. Bolts: ASTM F593, Group 2 with ASTM F594 hex nuts and washers, all type 316.
- J. Cor-ten Steel: USS Cor-ten A
1. Plates & Shapes: ASTM A-242
- K. Gray-Iron Castings: ASTM A 48, Class 30.
- L. Malleable-Iron Castings: ASTM A 47, Grade 32510.
- M. Welding Rods and Bare Electrodes: Select according to AWS specifications for the metal alloy to be welded.

2.02 PAINT

- A. Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with performance requirements of FS TT-P-664, selected for good resistance to normal atmospheric corrosion, compatibility with finish paint systems indicated, and capability to provide a sound foundation for field-applied topcoats despite prolonged exposure.
- B. Finish Paint: Exterior quality, rust-inhibiting enamel paint. Consult Owner for color.
- C. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in galvanized steel, with dry film containing not less than 94 percent zinc dust by weight, and complying with MIL-P-21035 or SSPC-Paint 20.

2.03 FASTENERS

- A. General: Provide plated fasteners complying with ASTM B 633, Class Fe/Zn 25 for electrodeposited zinc coating. Select fasteners for the type, grade, and class required.
- B. Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A, with hex nuts, ASTM A 563, and, where indicated, flat washers.
- C. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy hex steel structural bolts, heavy hex carbon-steel nuts, and hardened carbon-steel washers.
1. Finish: Hot-dip zinc-coating, ASTM A 153, Class C.
- D. Anchor Bolts: ASTM F 1554, Grade 36.
1. Provide threaded carbon-steel hooked bolts and carbon-steel nuts; and flat hardened-steel washers zinc-coated by hot-dip process according to ASTM A 153, Class C or mechanically deposited according to ASTM B 695, Class 50 where item being fastened is indicated to be galvanized.
- E. Machine Screws: ASME B18.6.3.
- F. Lag Bolts: ASME B18.2.1.
- G. Wood Screws: Flat head, carbon steel, ANSI B18.6.1.
- H. Plain Washers: Round, carbon steel, ANSI B18.21.1.
- I. Lock Washers: Helical, spring type, carbon steel, ANSI B18.21.1.
- J. Expansion Anchors: Stud type with a single piece three section wedge. The anchors shall meet the description in Federal Specification A-A-1923A, Type 4. Anchors shall be Hilti Kwik Bolt III, manufactured by Hilti Fastening Systems, or an approved equivalent by ITW Ramset/Redhead or Powers Fasteners, Inc.
1. Material: Carbon steel components zinc plated to comply with ASTM B633, service condition SC 1, Type III.
 2. Material: Where indicated as stainless steel, Group 1 alloy 304 or Group 2 alloy 316 stainless-steel bolts and nuts complying with ASTM F 593 and ASTM F 594.

- K. Sleeve anchors shall be HLC-HX SS 304, manufactured by Hilti Fastening Systems, or an approved equivalent by ITW Ramset/Redhead or Powers Fasteners, Inc.
 - 1. Material: Where indicated as stainless steel, Group 1 alloy 304 or Group 2 alloy 316 stainless-steel bolts and nuts complying with ASTM F 593 and ASTM F 594.
- L. Adhesive Anchors: Where installed in hollow CMU, adhesive anchors shall consist of a threaded anchor rod, nut, and washer, a cylindrical wire mesh screen tube, and an injectable adhesive material specifically designed for fastening into material containing voids and holes such as hollow block. Adhesive anchors shall be Hilti HIT HY20, manufactured by Hilti Fastening Systems, or an approved equivalent by ITW Ramset/Redhead or Powers Fasteners, Inc. Where installed in grouted CMU, adhesive anchors shall consist of a threaded anchor rod and an injectable adhesive material specifically designed for fastening into grouted masonry cells. Adhesive anchors shall be Hilti HIT HY150, manufactured by Hilti Fastening Systems, or an approved equivalent by ITW Ramset/Redhead or Powers Fasteners, Inc.
 - 1. Material: Group 1 alloy 304 or Group 2 alloy 316 stainless-steel bolts and nuts complying with ASTM F 593 and ASTM F 594.

2.04 GROUT

- A. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for exterior applications.
- B. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include the following:
 - 1. Nonshrink, Nonmetallic Grouts:
 - a. Euco N-S Grout; Euclid Chemical Co.
 - b. Five Star Grout; Five Star Products.
 - c. Masterflow 928 and 713; Master Builders Technologies, Inc.

2.05 FABRICATION, GENERAL

- A. Form metal fabrications from materials of size, thickness, and shapes indicated but not less than that needed to comply with performance requirements indicated. Work to dimensions indicated or accepted on shop drawings, using proven details of fabrication and support. Use type of materials indicated or specified for various components of each metal fabrication.
- B. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges.
- C. Shear and punch metals cleanly and accurately. Remove burrs.
- D. Ease exposed edges to a radius of approximately 1/32 inch, unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- E. Remove sharp or rough areas on exposed traffic surfaces.
- F. Weld corners and seams continuously to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shows after finishing, and contour of welded surface matches those adjacent.
- G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners wherever possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flat-head (countersunk) screws or bolts. Locate joints where least conspicuous.

- H. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
- I. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- J. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- K. Fabricate joints that will be exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate.

2.06 FABRICATION OF STEEL PIPE GUARDRAILS, HANDRAILS, AND RAILING SYSTEMS

- A. General: Fabricate pipe guardrails, handrails, and railing systems to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of pipe, post spacings, and anchorage, but not less than that required to support structural loads.
- B. Interconnect railing and guardrail and handrail members by butt-welding or welding with internal connectors, at fabricator's option, unless otherwise indicated.
 - 1. At tee and cross intersections, cope ends of intersecting members to fit contour of pipe to which end is joined, and weld all around.
- C. Form changes in direction of guardrails, handrails, and rails as follows:
 - 1. By welding in prefabricated flush elbow fittings.
 - 2. By radius bends of radius indicated.
 - 3. By flush radius bends.
 - 4. By bending and mitering elbow bends.
 - 5. By any method indicated above, applicable to change of direction involved.
- D. Form simple and compound curves by bending pipe in jigs to produce uniform curvature for each repetitive configuration required; maintain cylindrical cross section of pipe throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of pipe.
- E. Welded Connections: Fabricate guardrails, handrails, and railing systems for connection of members by welding. For connections made during fabrication, weld corners and seams continuously to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At tee and cross intersections, cope ends of intersecting members to fit contour of pipe or tube to which end is joined, and weld all around.
 - 5. At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shows after finishing and welded surface matches contours of adjoining surfaces.
- F. Provide wall returns at ends of wall-mounted handrails, unless otherwise indicated.
- G. Close exposed ends of pipe by welding steel plate in place.
- H. Brackets, Flanges, and Fittings: Provide manufacturer's heavy duty wall brackets, end closures, flanges, and miscellaneous fittings for interconnections of pipe and attachment of guardrails, handrails, and railing systems to other work..
- I. Connect railing posts to steel platform framing by direct welding, unless otherwise indicated.
- J. For galvanized guardrails, handrails, and railing systems, provide galvanized fittings, brackets, fasteners, sleeves, and other ferrous components unless otherwise indicated.

2.07 STEEL AND IRON FINISHES

- A. Galvanizing: For those items indicated for galvanizing, apply zinc coating by the hot-dip process complying with the following requirements:
 - 1. ASTM A 153 for galvanizing iron and steel hardware.
 - 2. ASTM A 123 for galvanizing both fabricated and unfabricated iron and steel products made of uncoated rolled, pressed, and forged shapes, plates, bars, and strip 0.0299 inch thick or thicker.
- B. Galvanizing Vent Hole Plugs: At galvanizing vent holes in pipes and tubes at railings and steel stairs, rope frames and other noted items, plug all holes after galvanizing and installation are complete. Provide a black nylon bumper panel retainer by Au-ve-co Products (Part number 10831) and supplied by Fastenal (Fastenal part number 0162595 at www.fastenal.com), or an approved equivalent. Provide a different size plug if galvanizing vent hole is different size than the specified plug. An acceptable alternative is to plug weld the vent holes after galvanizing, grind the welds smooth, and touch up with galvanizing repair paint.
- C. Preparation for Shop Priming: Prepare uncoated ferrous metal surfaces to comply with minimum requirements for SSPC-SP6, "Commercial Blast Cleaning" for surface preparation specifications and environmental exposure conditions of installed metal fabrications.
- D. Apply shop primer to uncoated surfaces of metal fabrications indicated to be painted. Comply with requirements of SSPC-PA 1 "Paint Application Specification No. 1" for shop painting.

PART 3 EXECUTION

3.01 PREPARATION

- A. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installing anchorages, including concrete inserts, sleeves, anchor bolts, and miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.02 INSTALLATION, GENERAL

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing miscellaneous metal fabrications to in-place construction. Include expansion anchors, sleeve anchors, adhesive anchors, through-bolts, and other connectors as required.
- B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing miscellaneous metal fabrications. Set metal fabrication accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete masonry or similar construction.
- D. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop-welded because of shipping size limitations. Do not weld, cut, or abrade the surfaces of exterior units that have been hot-dip galvanized after fabrication and are intended for bolted or screwed field connections.
- E. Field Welding: Comply with the following requirements:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shows after finishing, and contour of welded surface matches those adjacent.

3.03 INSTALLATION OF STEEL PIPE GUARDRAILS, HANDRAILS, AND RAILINGS

- A. Fit exposed connections accurately together to form tight, hairline joints.
- B. Adjust guardrails, handrails, and railing systems prior to anchoring to ensure matching alignment at abutting joints. Space posts at spacing indicated. Plumb posts in each direction.
 - 1. Set posts plumb within a tolerance of 1/4 inch in 12 feet.
 - 2. Align rails so that variations from level for horizontal members and from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.
- C. Use fully welded joints for permanently connecting railing components by welding. Cope or butt components to provide 100 percent contact, or use fittings designed for this purpose.
- D. Secure handrails to wall with wall brackets and end fittings. Provide bracket with indicated clearance from inside face of handrail and finished wall surface. Locate brackets at spacing required to support structural loads, but at no greater spacing than that indicated. Secure wall brackets and wall return fittings to building construction using type of bracket with predrilled hole for exposed bolt anchorage.
- E. Anchor handrails to masonry walls with through bolts, as shown on the drawings.
- F. Anchor railing posts to concrete with expansion anchors, as shown on the drawings.
- G. Connect railing posts to steel platform framing by direct welding, unless otherwise indicated.

3.04 SETTING BASE PLATES

- A. Clean concrete bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of base plates.
- B. Set base plates on wedges or other adjustable devices. After the bearing members have been positioned and plumbed, tighten the anchor bolts. Do not remove wedges or shims, but if protruding, cut off flush with the edge of the base plate before packing with grout.
 - 1. Use nonshrink, nonmetallic grout, unless otherwise indicated.
 - 2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.05 PLUGGING GALVANIZING VENT HOLES AFTER INSTALLATION

- A. After installation, plug galvanizing vent holes in pipes and tubes at railings, rope frames and other noted items as indicated in Part 2 of this specification section.

3.06 FIELD QUALITY CONTROL

- A. Owner will engage an independent testing and inspecting agency to perform field inspections and tests and to prepare test reports.
 - 1. Testing agency will conduct and interpret tests and state in each report whether tested Work complies with or deviates from requirements.
- B. Correct deficiencies in or remove and replace structural steel that inspections and test reports indicate do not comply with specified requirements.
- C. Additional testing, at Contractor's expense, will be performed to determine compliance of corrected Work with specified requirements.
- D. Field-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- E. All welds shall be visually inspected. If required as a result of visual inspection, welded connections shall be inspected and tested according to AWS D1.1 and the inspection procedures listed below, at testing agency's option.
 - 1. Liquid Penetrant Inspection: ASTM E 165.
 - 2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
 - 3. Radiographic Inspection: ASTM E 94 and ASTM E 142; minimum quality level "2-2T."

4. Ultrasonic Inspection: ASTM E 164.

3.07 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop and finish paint, and paint exposed areas with one coat of same material as used for shop painting to comply and two coats of finish paint.
- B. For galvanized surfaces, clean welds, bolted connections, and abraded areas, and apply galvanizing repair paint to comply with ASTM A 780.

END OF SECTION

SECTION 06 10 00
ROUGH CARPENTRY

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Miscellaneous framing and sheathing, including exterior gypsum sheathing.
- B. Telephone and electrical panel boards.
- C. Wood nailers and curbs for roofing and items installed on roof.
- D. Concealed wood blocking for support of toilet and bath accessories, wall cabinets, and wood trim.
- E. Miscellaneous wood nailers and furring strips.
- F. Preservative treatment of wood.
- G. Fire retardant treatment of wood.

1.02 RELATED SECTIONS

- A. Section 05 50 00 - Metal Fabrications: Miscellaneous steel connectors and support angles for wood framing.

1.03 REFERENCES

- A. AFPA T10 - Wood Frame Construction Manual; American Forest and Paper Association; 2001.
- B. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2004.
- C. ASTM C 1177/C 1177M - Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing; 2004.
- D. ASTM D 2898 - Standard Test Methods for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing; 1994 (Reapproved 2004).
- E. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2005.
- F. AWPA C2 - Lumber, Timber, Bridge Ties and Mine Ties -- Preservative Treatment by Pressure Processes; American Wood-Preservers' Association; 2002.
- G. AWPA C9 - Plywood -- Preservative Treatment by Pressure Processes; American Wood-Preservers' Association; 2003.
- H. AWPA C20 - Structural Lumber -- Fire Retardant Treatment by Pressure Processes; American Wood-Preservers' Association; 2002.
- I. AWPA C27 - Plywood -- Fire-Retardant Treatment by Pressure Processes; American Wood-Preservers' Association; 2003.
- J. AWPA U1 - Use Category System: User Specification for Treated Wood; American Wood-Preservers' Association; 2004.
- K. PS 1 - Construction and Industrial Plywood; National Institute of Standards and Technology (Department of Commerce); 1995.
- L. PS 20 - American Softwood Lumber Standard; National Institute of Standards and Technology (Department of Commerce); 1999.

- M. RIS (GR) - Standard Specifications for Grades of California Redwood Lumber; Redwood Inspection Service; 2000.
- N. SPIB (GR) - Grading Rules; Southern Pine Inspection Bureau, Inc.; 2002.
- O. WCLB (GR) - Standard Grading Rules for West Coast Lumber No. 17; West Coast Lumber Inspection Bureau; 1996, Suppl. VII (1996) & VIII (1997).
- P. WWPA G-5 - Western Lumber Grading Rules; Western Wood Products Association; 2005.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide technical data on wood preservative materials, application instructions, and gypsum sheathing.
- C. Manufacturer's Certificate: Certify that wood products supplied for rough carpentry meet or exceed specified requirements.

1.05 QUALITY ASSURANCE

- A. Lumber: Comply with PS 20 and approved grading rules and inspection agencies.
 - 1. Acceptable Lumber Inspection Agencies: RIS, SPIB, WCLB, and WWPA.
 - 2. Lumber of other species or grades, or graded by other agencies, is acceptable provided structural and appearance characteristics are equivalent to or better than products specified.
- B. Fire-Retardant Treated Wood: Mark each piece of wood with producer's stamp indicating compliance with specified requirements.
- C. Preservative-Treated Wood: Provide lumber and plywood marked or stamped by an ALSC-accredited testing agency, certifying level and type of treatment in accordance with AWWA standards.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. General: Cover wood products to protect against moisture. Support stacked products to prevent deformation and to allow air circulation.
- B. Fire Retardant Treated Wood: Prevent exposure to precipitation during shipping, storage, or installation.

PART 2 PRODUCTS

2.01 SUSTAINABLY HARVESTED WOOD

- A. Provide sustainably harvested wood in accordance with LEED requirements.

2.02 DIMENSION LUMBER

- A. Sizes: Nominal sizes as indicated on drawings, S4S.
- B. Moisture Content: S-dry or MC19.
- C. Miscellaneous Blocking, Furring, and Nailers:
 - 1. Lumber: S4S, No. 2.
 - 2. Boards: Standard or No. 3.

2.03 CONSTRUCTION PANELS

- A. Sheathing: Glass Mat Faced Gypsum, ASTM C 1177/C 1177M, water-resistant core, square long edges, 1/2 inch thick.
 - 1. Acceptable Product: Dens-Glas Gold as manufactured by Georgia Pacific.
 - 2. Substitutions permitted under provisions of Section 01 60 00.
- B. Concealed Plywood: PS 1, C-C Plugged, exterior grade.
- C. Exposed Plywood: PS 1, A-D, interior grade.
- D. Electrical Component Mounting: APA rated sheathing, fire retardant treated.

2.04 ACCESSORIES

- A. Fasteners and Anchors:
 - 1. Metal and Finish: Hot-dipped galvanized steel per ASTM A 153/A 153M for high humidity and preservative-treated wood locations, unfinished steel elsewhere.
 - 2. Drywall Screws: Bugle head, hardened steel, power driven type, length to achieve full penetration of sheathing substrate.
 - 3. Anchors: Expansion shield and lag bolt type for anchorage to solid masonry or concrete.

2.05 FACTORY WOOD TREATMENT

- A. Treated Lumber and Plywood: Comply with requirements of AWP A U1 - Use Category System for wood treatments determined by use categories, expected service conditions, and specific applications.
- B. Fire Retardant Treatment:
 - 1. Manufacturers:
 - a. Arch Wood Protection, Inc: www.wolmanizedwood.com.
 - b. Hoover Treated Wood Products, Inc: www.frtw.com.
 - c. Osmose, Inc: www.osmose.com.
 - 2. Interior Type A: AWP A Use Category UCFA, Commodity Specification H (Treatment C20 for lumber and C27 for plywood), low temperature (low hygroscopic) type, chemically treated and pressure impregnated; capable of providing a maximum flame spread rating of 25 when tested in accordance with ASTM E 84, with no evidence of significant combustion when test is extended for an additional 20 minutes.
 - a. Kiln dry wood after treatment to a maximum moisture content of 19 percent for lumber and 15 percent for plywood.
 - b. Treat rough carpentry items as indicated .
 - c. Do not use treated wood in applications exposed to weather or where the wood may become wet.
- C. Preservative Treatment:
 - 1. Manufacturers:
 - a. Arch Wood Protection, Inc: www.wolmanizedwood.com.
 - b. Chemical Specialties, Inc: www.treatedwood.com.
 - c. Osmose, Inc: www.osmose.com.
- D. Preservative Pressure Treatment of Lumber Above Grade: AWP A Use Category UC3B, Commodity Specification A (Treatment C2) using waterborne preservative to 0.25 lb/cu ft retention.
 - 1. Kiln dry lumber after treatment to maximum moisture content of 19 percent.
 - 2. Treat lumber in contact with roofing, flashing, or waterproofing.
 - 3. Treat lumber in contact with masonry or concrete.
 - 4. Treat lumber less than 18 inches above grade.

5. Preservative Pressure Treatment of Plywood Above Grade: AWPAC Use Category UC2 and UC3B, Commodity Specification F (Treatment C9) using waterborne preservative to 0.25 lb/cu ft retention.
 - a. Kiln dry plywood after treatment to maximum moisture content of 19 percent.
 - b. Treat plywood in contact with roofing, flashing, or waterproofing.
 - c. Treat plywood in contact with masonry or concrete.
 - d. Treat plywood less than 18 inches above grade.

PART 3 EXECUTION

3.01 FRAMING INSTALLATION

- A. Set structural members level, plumb, and true to line. Discard pieces with defects that would lower required strength or result in unacceptable appearance of exposed members.
- B. Make provisions for temporary construction loads, and provide temporary bracing sufficient to maintain structure in true alignment and safe condition until completion of erection and installation of permanent bracing.
- C. Install structural members full length without splices unless otherwise specifically detailed.
- D. Comply with member sizes, spacing, and configurations indicated, and fastener size and spacing indicated, but not less than required by applicable codes and AFPA Wood Frame Construction Manual.
- E. Provide miscellaneous members as indicated or as required to support finishes, fixtures, specialty items, and trim.
- F. Where treated wood is used on interior, provide temporary ventilation during and immediately after installation sufficient to remove indoor air contaminants.

3.02 INSTALLATION OF ACCESSORIES AND MISCELLANEOUS WOOD

- A. Curb roof openings except where prefabricated curbs are provided. Form corners by alternating lapping side members.
- B. Coordinate curb installation with installation of decking and support of deck openings.

3.03 INSTALLATION OF CONSTRUCTION PANELS

- A. Secure with long dimension perpendicular to wall studs, with ends over firm bearing and staggered, using screws.

3.04 SITE APPLIED WOOD TREATMENT

- A. Apply preservative treatment compatible with factory applied treatment at site-sawn cuts, complying with manufacturer's instructions.
- B. Allow preservative to dry prior to erecting members.

3.05 TOLERANCES

- A. Framing Members: 1/4 inch from true position, maximum.
- B. Variation from Plane (Other than Floors): 1/4 inch in 10 feet maximum, and 1/4 inch in 30 feet maximum.

3.06 CLEANING

- A. Waste Disposal:
 1. Comply with applicable regulations.

2. Do not burn scrap on project site.
 3. Do not burn scraps that have been pressure treated.
 4. Do not send materials treated with pentachlorophenol, CCA, or ACA to co-generation facilities or "waste-to-energy" facilities.
- B. Do not leave any wood, shavings, sawdust, etc. on the ground or buried in fill.

END OF SECTION

SECTION 07 20 00

THERMAL LINING SYSTEM – BURN TOWER ONLY

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This Section includes requirements for the thermal lining system.

1.03 COMPONENT REQUIREMENTS FOR THERMAL LINING SYSTEM

- A. Provide thermal lining system that includes the following minimum components:
 - 1. A 1-inch thick layer of calcium silicate insulation with a maximum density of 18 pounds per cubic foot and a continuous service temperature rating of a minimum of 1,800° F. Provide material with a minimum compressive strength of 450 psi and minimum flexural strength of 260 psi. Provide material with maximum shrinkage of 1% in length and width when subjected to continuous temperature of minimum 1,700° F for 24 hours. Provide material with maximum "k" value of .73 at 800° F. Provide materials that are free of asbestos or any other toxic substances.
 - 2. Fully cover the insulation with thermo-ceramic-refractory-concrete fire castings. Provide castings that each measure 12" x 12" x 1-1/2" thick. Provide castings that interlock with one another in a fashion that ensures shedding of water from fire hose streams and preventing water from reaching the insulation barrier. Design castings to allow the installed system to immediately expand and contract with extreme fluctuations in temperature as a result of the thermal shock generated by fire extinguishment. Provide special shapes of castings to adapt the thermal lining system to different conditions, such as corner conditions at beams, columns, and wall openings. Provide bullnose corner castings where the corners are subject to abuse from equipment, as indicated in the Contract Documents. Provide a completed system in which every casting interlocks with adjacent castings, providing an impenetrable, floating barrier of thermo-ceramic-refractory-concrete that fully covers and protects the insulation barrier, including ceiling panels, wall panels, and corners. Provide special castings to accommodate temperature monitoring devices, conduit, and wiring as indicated in the Contract Documents. Provide casting material with a density of 140 to 160 pounds per cubic foot and cold crushing strength of 10,000 psi after exposure to 2,000° F. Provide casting material that expels any absorbed water without cracking or spalling when exposed to temperatures up to 2,000° F.
 - 3. Anchor each casting to the structure with one stainless steel anchor. At ceiling locations, provide expansion anchors that are a minimum 3/8" diameter, Grade 304 stainless steel, with 2" minimum embedment into concrete (or per the anchor manufacturer's recommendations, whichever is greater). Provide ceiling anchors that have a minimum pullout rating of 600 pounds. At wall locations, provide masonry sleeve anchors that are a minimum 3/8" diameter, Grade 304 stainless steel, with minimum 1-1/2" embedment into concrete or masonry (or per the anchor manufacturer's recommendations, whichever is greater). Provide wall anchors with a minimum pullout rating of 470 pounds in hollow CMU.
 - 4. Provide a base course of mortared-in-place fire brick for all wall locations that receive the thermal lining system. Provide fire brick that is a minimum of 4-1/2" x 9" x 2-1/2" thick medium duty fire brick per ASTM C-27, set in type N Portland cement mortar.
 - 5. Provide stainless steel and aluminum flashings as indicated in the Contract Documents. For stainless steel flashings, provide Grade 304 stainless steel with a minimum thickness of .018". For aluminum flashings, provide a minimum thickness of .032".

6. Provide refractory packings as indicated in the Contract Documents. Provide a general purpose castable packing mix for use to temperatures to 2,000°F. Provide packing mix that has good resistance to abrasion, a low iron content, no more than 0.5% shrinkage when exposed to 2,000° F, and minimum cold crushing strength of 1,400 psi after exposure to 2,000° F.

1.04 PERFORMANCE REQUIREMENTS FOR THERMAL LINING SYSTEM

- A. Provide thermal lining system that is specifically designed for use within live fire training structures (burn buildings) exposed to frequent training with Class B fuels. Provide a thermal lining system that is designed to withstand repetitive live fire training for 20 years without significant panel/tile replacement and without degradation of the thermal protection.
- B. Thermal lining system shall provide thermal protection for the structural components from temperatures attained during fire training.
 1. Provide thermal lining system that withstands temperatures at the exposed face of thermal lining during a live fire training evolution of up to 1,500° F continuous and 1,700° F short duration spike.
 2. Provide thermal lining system that keeps temperature behind the system during live fire training, at the face of the protected structure, below 350° F when the room temperature at the exposed face of the thermal lining is 1,500° F continuous and 1,700° F short duration spike.
 3. During a live fire training day, multiple live fire training evolutions may occur. After each evolution, the fire may be left smoldering, but not completely extinguished. At the beginning of the next evolution, the fire is reignited. This cycle typically repeats all day during a training day. As a result, significant residual heat builds up in the training structure by the last training evolution. Provide thermal lining system that withstands, without damage, residual heat buildup created by a minimum of 20 consecutive live fire training evolutions.
- C. Provide thermal lining system that withstands, without damage, repetitive thermal shock created by rapid cooling of heated surfaces with cool water from water mains. Provide thermal lining system that allows for expansion and contraction caused by rapid heating and cooling.
- D. Provide thermal lining system that withstands, without damage, impact loads and other associated stresses induced by pressurized water sprayed from hoses (300 gallons per minute, 100 pounds per square inch of pressure) and thermally pressurized steam.
 1. Provide thermal lining system that prevents water and steam penetration to the protected structure.
 2. Provide thermal lining system that allows for the fact that almost all cementitious materials will absorb water through direct water application or through condensation caused by large fluctuations in temperature, such as those commonly experienced during winter months. Once this absorbed water is abruptly heated during a fire, it will convert to pressurized steam which could act to degrade the lining material. Provide thermal lining system that expels water and vapor that could penetrate the system. Provide thermal lining system that is functional in all seasons of the year.
 3. For multi-component thermal lining systems consisting of an insulation layer protected by another layer of durable materials, provide insulation layer that does not sag or move behind the protective layer.
- E. Provide thermal lining system that withstands, without damage, routine physical abuse during typical live fire training evolutions, including, but not limited to:
 1. impact of fire fighters' protective clothing, self-contained breathing apparatuses, or hand tools
- F. Provide thermal lining system that is functional year-round, withstanding the effects of seasonal weather considerations, including seasonal temperature changes, freeze/thaw cycles, humidity, and precipitation.

- G. Provide thermal lining system that withstands, without damage, the effects of oxygen deficient atmosphere.
- H. Provide thermal lining system that allows for the use of surface and subsurface mounted thermocouples that penetrate the lining.
- I. Provide thermal lining system that is free from asbestos or other harmful ingredients, and shall not produce toxic byproducts during live fire training.
- J. Provide thermal lining system that has properties that do not degrade under repeated use.

1.05 QUALIFICATION PROCEDURE

- A. For any prospective thermal lining manufacturer/supplier/product that is not listed under Part 2, submit a written request for qualification to the Engineer. For all requests for qualification, include the information defined in the following sections and deliver to the Engineer 14 calendar days before the stated date of bid opening as identified in the solicitation documents. Lack of adequate information is sufficient cause for rejection. References to catalogs or other descriptive documents not included with the application for qualification to the Engineer are not acceptable.
- B. Company and Product Capabilities: Provide the following information:
 - 1. Corporate qualifications and capabilities that fully describe the ability to provide the required thermal lining system and support to the Owner.
 - 2. A history of corporate experience with thermal linings in live fire training props ("burn buildings").
 - 3. A list of ten (10) completed projects, at least five (5) of which shall be more than five (5) years old, illustrating thermal lining performance equal or greater to the performance criteria listed in this specification. Include the award date, the completion date, the contract value, and the name and telephone number of a person employed by the Owner who has personal knowledge of the thermal lining system supplier's contractual and technical performance. Provide descriptions of any testing that has been performed on the product to indicate that it will have performance equal or greater to the performance criteria listed in this specification
 - 4. Material and installation data.

1.06 SUBMITTALS

- A. General: Submit each item in this Article according to the General Conditions of the Contract and Division 01 Specification Sections.
- B. Evidence of installer qualifications, including certification by thermal lining system manufacturer.
- C. Certificate of Conformance: Manufacturer's certification that materials and equipment are physically and chemically compatible with each other, that materials are in compliance with performance requirements of this specification, and that each material and/or equipment is suitable for the intended purpose. Materials and equipment not listed in the certificate will not be permitted in the work area. Submit Material Safety Data Sheets (MSDS) for the thermal lining system.
- D. Materials Certification: Letter from the manufacturer certifying that materials shipped meet manufacturer's specification data.
- E. Samples of materials to be used, including thermal tile, insulation, flashing, anchoring system, and fire clay.
- F. Shop drawings detailing fabrication and erection of thermal lining system. Include plans, elevations, sections, and details of thermal lining system and connections to substrates. Show anchorage and accessory items.
- G. Minutes of preinstallation conference.

- H. Operations and Maintenance manual describing all required maintenance and operational requirements. If required maintenance requires training, provide one on-site training session for Owner's representatives at a date and time agreeable to Owner.

1.07 QUALITY ASSURANCE

- A. All thermal lining systems shall be provided by one manufacturer.
- B. Installer Qualifications: Install thermal lining system by manufacturer or by a contractor approved by the manufacturer and under the supervision of the manufacturer.
- C. Warranties:
 - 1. The manufacturer shall furnish a one year warranty for the thermal lining system, starting from the date of Owner's acceptance of the Work, to cover replacement of all defective materials found within the warranty period.
 - 2. The installer shall furnish a one year warranty for the thermal lining system, starting from the date of Owner's acceptance of the Work, to cover replacement of all materials found to be defective due to workmanship found within the warranty period.
 - 3. Warranties can be limited to replacement of defective materials, including labor, due to thermal lining system or performance. Warranties can exclude repairs, replacement, and corrective work to the substrate, structure, and/or property. Warranties can exclude mechanical damage due to abuse or neglect, structural failure, or forces of nature greater than normal weather conditions.
 - 4. Substrate shall be monolithic, without joints, holes, penetrations, or embedded items that pass through the entire thickness that could cause moisture to pass through the substrate into the thermal lining system, except for joints and items shown on the drawings. Warranty can exclude damage to the lining system and substrate caused by moisture penetration through the joints, holes, penetrations, and embedded items in the substrate that are not shown on the drawings.
- D. Pre-installation conference: Conduct conference at Project site to comply with requirements of Division 01 Section "Project Management and Coordination".

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Deliver thermal lining system materials in manufacturer's original unopened containers or wrapped with labels intact and legible.
- B. Store and protect materials from damage and weather in accordance with the manufacturer's instructions. Keep materials clean and dry at all times.
- C. Handle materials in accordance with manufacturer's recommendations.

PART 2 PRODUCTS

2.01 THERMAL LINING SYSTEM

- A. At noted locations in plans, HTL System 203 Lite, by High Temperature Linings, of Whitestone, Virginia (800) 411-6313, including all components, or an approved equal.

PART 3 EXECUTION

3.01 PREPARATION

- A. Clean all surfaces to receive thermal lining system of oils, dust, and other deleterious matter. Install thermal lining system over dry surfaces.

3.02 INSTALLATION

- A. Install thermal lining system and all accessories in accordance with the manufacturer's requirements.

3.03 CLEAN UP

- A. Remove all debris, scraps, containers, and any other trash resulting from the installation of the thermal lining system.

END OF SECTION

SECTION 07 61 00

STANDING SEAM METAL ROOFING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Preformed and prefinished metal roofing and flashings.
- B. Miscellaneous trim, flashing, closures, drip flashing, and accessories.
- C. Sealant
- D. Fastening devices.

1.02 RELATED SECTIONS

- A. Section 05 12 00: Structural Steel Framing.
- B. Section 05 50 00: Miscellaneous metal fabrication.
- C. Section 06 10 00: Rough Carpentry.
- D. Section 07 62 00: Sheet Metal Flashing and Trim.
- E. Section 07 90 00: Sealants.

1.03 REFERENCES

- A. American Iron & Steel Institute (AISI) Specification for the Design of Coldformed Steel Structural Members.
- B. ASTM A-653 & ASTM A924 Steel Sheet, Zinc-Coated (Galvanized)
- C. ASTM E-1680-95 (Air Infiltration Test)
- D. ASTM E-1646-95 (Water Penetration Test)
- E. ASTM E-1592
- F. Spec Data Sheet - Galvalume Sheet Metal by Bethlehem Corp.
- G. SMACNA - Architectural Sheet Metal Manual.
- H. Building Materials Directory - Underwriter's Laboratories, Test Procedure 580.

1.04 ASSEMBLY DESCRIPTION

- A. The roofing assembly includes preformed sheet metal panels, related accessories, valleys, hips, ridges, eaves, corners, rakes, miscellaneous flashing and attaching devices.

1.05 SUBMITTALS

- A. Submit detailed drawings in accordance with Section 01 30 00 showing layout of panels, anchoring details, joint details, trim, flashing, and accessories. Show details of weatherproofing, terminations, and penetrations of metal work. Show details of snow guards.
- B. Submit a sample of each type of roof panel, complete with factory finish.
- C. Submit a sample of snow guards, complete with factory finish.
- D. Submit results indicating compliance with minimum requirements of the following performance tests:
 - 1. Air Infiltration ASTM E-1680-95
 - 2. Water Infiltration ASTM E-1646-95

3. Wind Uplift - U.L.90

- E. Submit calculations with registered engineer seal, verifying roof panel and attachment method resists wind pressures imposed on it pursuant to applicable building codes.

1.06 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in Architectural Sheet Metal Products with ten (10) years minimum experience.
- B. No product substitutions shall be permitted without meeting specifications.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Upon receipt of panels and other materials, installer shall examine the shipment for damage and completeness.
- B. Panels should be stored in a clean, dry place. One end should be elevated to allow moisture to run off.
- C. Panels with strippable film must not be stored in the open, exposed to the sun.
- D. Stack all materials to prevent damage and to allow for adequate ventilation.

1.08 WARRANTY

- A. Paint finish shall have a twenty year guarantee against cracking, peeling and fade, not to exceed 5 N.B.S. units.
- B. Galvalume material shall have a twenty year guarantee against failure due to corrosion, rupture or perforation.
- C. Applicator shall furnish guarantee covering watertightness of the roofing system for the period of two (2) years from the date of substantial completion.

PART 2 PRODUCT

2.01 ACCEPTABLE MANUFACTURERS - STANDING SEAM ROOFING

- A. Products and systems indicated in this section are manufactured by Berridge Manufacturing Company and establish a standard of quality for products of this section. Substitutions permitted under provisions of Section 01 60 00. www.berridge.com
- B. Substitutions shall fully comply with provisions of Section 01 60 00.

2.02 ACCEPTABLE PRODUCT: BERRIDGE ZEE-LOCK STANDING SEAM PANEL

- A. 2" high vertical legs shall be spaced at 16" on-center.
- B. Panels shall be site-formed with the Berridge Model SP-21 Portable Roll Former in continuous lengths from ridge to eave or factory-formed to 40' max.
- C. Continuous Zee Rib shall be 1-3/8" wide and 2-1/8" in height. Rib shall be connected to purlin with two #12-14 x 1" self-drilling/tapping fasteners..
- D. Optional Vinyl Weatherseal (U.S. Patent 5134825) to be factory-installed over Continuous Zee Rib.
- E. Sidelap to be mechanically seamed with a powered seamer.
- F. When required, panel assembly to bear Underwriters Laboratories Label UL90, pursuant to Construction Number 312 for open framing conditions, either uninsulated or with blanket insulation; 335 or 335 (mod.) with rigid board insulation or 403 over solid substrate and applicable Fire Ratings.

- G. Certification shall be submitted, based on independent testing laboratory, indicating no measurable water penetration or air leakage through the system when tested in accordance with ASTM E-1680-95 and ASTM E-1646-95.

2.03 SHEET MATERIALS

- A. Prefinished Metal shall be Hot-Dipped Galvanized - ASTM A446-85 Grade C G90 Coating A525-86 24 Gauge core steel or prefinished Galvalume - ASTM 792-86 AZ-55.
- B. Unfinished Metal shall be Grade C Galvalume ASTM 792-86, AZ 55, "Satin Finish".
- C. Finish shall be full strength Kynar 500 Fluoropolymer coating, applied by the manufacturer on a continuous coil coating line, with a top side dry film thickness of 0.70 to 0.90 mil over 0.25 to 0.35 mil prime coat, to provide a total dry film thickness of 0.95 to 1.25 mil. Bottom side shall be coated with primer with a dry film thickness of 0.25 mil. Finish shall conform to all tests for adhesion, flexibility, and longevity as specified by the Kynar 500 finish supplier.
- D. Strippable film shall be applied to the top side of the painted coil to protect the finish during fabrication, shipping and field handling. This strippable film must be removed before installation.

2.04 ACCESSORY MATERIALS

- A. Fasteners: Cadmium Plated Steel with washers where required.
- B. Sealant: As specified in Section 07900.
- C. Vinyl Weatherseal Insert.

2.05 FABRICATION

- A. All exposed adjacent flashing shall be of the same material and finish as the roof panels.
- B. Hem all exposed edges of flashing on underside, 1/2 inch.

PART 3 EXECUTION

3.01 STANDING SEAM ROOFING INSTALLATION

- A. Substrate Examination:
 - 1. Examine plywood or metal deck to ensure proper attachment to framing.
 - 2. Inspect roof deck to verify deck is clean and smooth, free of depressions, waves or projections, level to +/- 1/4" in 20', and properly sloped to valleys or eaves.
 - 3. Verify roof openings, curbs, pipes, sleeves, ducts or vents through roof are solidly set, cant strips and reglets in place, and nailing strips located.
 - 4. Verify deck is dry and free of snow or ice. Flutes in steel deck to be clean and dry or joints in wood deck to be solidly supported and nailed.
- B. Underlayment:
 - 1. Verify #30 unperforated asphalt saturated roofing felt underlayment has been installed over solid sheathing and fastened in place.
 - 2. One (1) layer of #30 asphalt roofing felt paper for roof slopes of 3:12 and up, two (2) layers for roof slopes of 1:12 - 3:12.
 - 3. Grace Ice & Water Shield underlayment to be used on all curved applications and on low (less than 1:12) slope or complex roofs per manufacturers recommendation.
 - 4. Ensure felt installed horizontally, starting at eave to ridge with a 6" minimum overlap and 18" endlaps.

5. Ensure that all nail heads are totally flush with the substrate. Nails shall be galvanized roofing nails with Berridge Coated Felt Caps.

C. Installation

1. Comply with manufacturers standard instructions and conform to standards set forth in the Architectural Sheet Metal Manual published by SMACNA, in order to achieve a watertight installation.
2. Install panels in such a manner that horizontal lines are true and level and vertical lines are plumb.
3. Install starter and edge trim before installing roof panels.
4. Remove protective strippable film prior to installation of roof panels.
5. Attach panels using manufacturer's standard clips and fasteners, spaced in accordance with approved shop drawings.
6. Install sealants for preformed roofing panels as approved on shop drawings.
7. Do not allow panels or trim to come into contact with dissimilar materials.
8. Do not allow traffic on completed roof. If required, provide cushioned walk boards.
9. Protect installed roof panels and trim from damage caused by adjacent construction until completion of installation.
10. Remove and replace any panels or components which are damaged beyond successful repair.

3.02 CLEANING

- A. Clean any grease, finger marks or stains from the panels per manufacturer's recommendations.
- B. Remove all scrap and construction debris from the site.

END OF SECTION

SECTION 07 71 23

GUTTERS AND DOWNSPOUTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Pre-finished steel gutters and downspouts.

1.02 DESIGN REQUIREMENTS

- A. Conform to SMACNA Architectural Sheet Metal Manual for sizing components for rainfall intensity determined by a storm occurrence of 1 in 10 years.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Pre-Finished Galvanized Steel Sheet: ASTM A 653/A 653M, with G90/Z275 zinc coating; minimum 0.02 inch thick base metal.
 - 1. Finish: Shop pre-coated with PVDF (polyvinylidene fluoride) coating.
 - 2. Color: As scheduled.

2.02 FABRICATION

- A. Form gutters and downspouts of profiles and size indicated.
- B. Fabricate with required connection pieces.
- C. Form sections square, true, and accurate in size, in maximum possible lengths, free of distortion or defects detrimental to appearance or performance. Allow for expansion at joints.
- D. Hem exposed edges of metal.
- E. Fabricate gutter and downspout accessories; seal watertight.

2.03 FACTORY FINISHING

- A. Fluoropolymer Coating: High Performance Organic Finish, AAMA 2604; multiple coat, thermally cured fluoropolymer finish system; color as scheduled.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install gutters, downspouts, and accessories in accordance with manufacturer's instructions and as detailed on the drawings.
- B. Sheet Metal: Join lengths with formed seams sealed watertight. Flash and seal gutters to downspouts and accessories.

END OF SECTION

SECTION 07 72 00

ROOF ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Manufactured curbs, equipment rails, and pedestals.
- B. Roof hatches, manual and automatic operation, including smoke vents.
- C. Ice guards.

1.02 RELATED SECTIONS

- A. Section 07 54 00 - Thermoplastic Membrane Roofing.
- B. Section 07 61 00 - Standing Seam Metal Roofing: Custom ice guards in association with custom sheet metal roofing.

1.03 REFERENCES

- A. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2005a.
- B. UL (BMD) - Building Materials Directory; current edition.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
 - 4. Maintenance requirements.
 - 5. For smoke hatches, submit evidence of approval by evaluation agency specified.
- C. Certificate: For smoke hatches, provide certificate of approval from authority having jurisdiction.

1.05 DELIVERY, STORAGE, AND PROTECTION

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Store products under cover and elevated above grade.

PART 2 PRODUCTS

2.01 MANUFACTURED CURBS

- A. Manufactured Curbs, Equipment Rails, and Other Roof Mounting Assemblies:
 - 1. AES Manufacturing Inc.: www.aescurb.com.
 - 2. The Pate Company: www.patecurbs.com.
 - 3. RPS Accessories: www.rpscurbs.com.
- B. Manufactured Curbs, Equipment Rails, and Other Roof Mounting Assemblies: Factory-assembled hollow sheet metal construction with fully mitered and welded corners, integral counterflashing, internal reinforcing, and top side and edges formed to shed water.
 - 1. Sheet Metal: Hot-dip zinc coated steel sheet complying with ASTM A 653/A 653M, SS Grade 33 ; G60 coating designation; 18 gage, 0.048 inch thick.
 - 2. Manufacture curb bottom and mounting flanges for installation directly on roof deck, not on insulation; match slope and configuration of roof deck.

3. Provide the layouts and configurations shown on the drawings.
- C. Curbs Adjacent to Roof Openings: Provide curb on all sides of opening, with top of curb horizontal for equipment mounting.
 1. Provide preservative treated wood nailers along top of curb.
 2. Insulate inside curbs with 1-1/2 inch thick fiberglass insulation.
 3. Height Above Finished Roof Surface: 8 inches, minimum.
- D. Equipment Rails: Two-sided curbs in straight lengths, with top horizontal for equipment mounting.
 1. Provide preservative treated wood nailers along top of rails.
 2. Height Above Finished Roof Surface: 8 inches, minimum.
- E. Pipe, Duct, and Conduit Mounting Pedestals: Vertical posts, minimum 8 inches square unless otherwise indicated.
 1. Provide sliding channel welded along top edge with adjustable height steel bracket, manufactured to fit item supported.
 2. Height Above Finished Roof Surface: 8 inches, minimum.

2.02 ROOF HATCHES, MANUAL AND AUTOMATIC OPERATION

- A. Manufacturers - Roof Hatches:
 1. Bilco Co: www.bilco.com.
 2. Dur-Red Products: www.dur-red.com.
 3. Milcor Inc: www.milcorinc.com.
 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Roof Hatches: Factory-assembled aluminum frame and cover, complete with operating and release hardware.
 1. Style: Provide flat metal covers unless otherwise indicated.
 2. Mounting: Provide frames and curbs suitable for mounting conditions indicated on the drawings.
 3. Smoke Hatches: Where "smoke" or "smoke/heat" operation is indicated, provide the following additional features:
 - a. Smoke Release Mechanism: Automatic opening on melting of replaceable UL-listed fusible link at 165 deg F.
 - b. UL-listed as automatically operated smoke and heat vent.
 - c. Fire Alarm Connection: Provide separate resettable electrical link release mechanism and connection point for fire alarm system.
 4. Size(s): As indicated on drawings; single-leaf style unless indicated as double-leaf.
- C. Frames/Curbs: One-piece curb and frame with integral cap flashing to receive roof flashings; extended bottom flange to suit mounting.
 1. Material: Mill finished aluminum, 11 gage, 0.125 inch thick.
 2. Insulation: 1 inch rigid glass fiber, located on outside face of curb.
 3. Curb Height: 12 inches from finished surface of roof, minimum.
- D. Metal Covers: Flush, insulated, hollow metal construction.
 1. Capable of supporting 40 psf live load.
 2. Material: Mill finished aluminum; outer cover 0.125 inch thick, liner 0.04 inch thick.
 3. Insulation: 1 inch rigid glass fiber.
 4. Gasket: Neoprene, continuous around cover perimeter.
- E. Hardware: Steel, zinc coated and chromate sealed, unless otherwise indicated or required by manufacturer.
 1. Lifting Mechanisms: Compression or torsion spring operator with shock absorbers that automatically opens upon release of latch; capable of lifting covers despite 10 psf load.
 2. Hinges: Heavy duty pintle type.
 3. Hold open arm with vinyl-coated handle for manual release.
 4. Latch: Upon closing, engage latch automatically and reset manual release.

5. Manual Release: Pull handle on interior.
6. Smoke Hatches: Manual release operation not to disturb automatic release mechanisms; easy resetting by Owner's maintenance personnel; provide latch designed to prevent relatching unless the automatic release mechanism has been properly reset for automatic operation.
7. Locking: Padlock hasp on interior.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions, in manner that maintains roofing weather integrity.

3.04 CLEANING AND PROTECTION

- A. Clean installed work to like-new condition.
- B. Protect installed products until completion of project.
- C. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

SECTION 07 84 00
FIRESTOPPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Firestopping materials.
- B. Firestopping of all penetrations and interruptions to fire rated assemblies, whether indicated on drawings or not, and other openings indicated.

1.02 RELATED SECTIONS

- A. Section 01 70 00 - Execution Requirements: Cutting and patching.

1.03 REFERENCES

- A. ASTM E 814 - Standard Test Method for Fire Tests of Through-Penetration Fire Stops; 2002.
- B. ITS (DIR) - Directory of Listed Products; Intertek Testing Services NA, Inc.; current edition.
- C. FM P7825 - Approval Guide; Factory Mutual Research Corporation; current edition.
- D. UL (FRD) - Fire Resistance Directory; Underwriters Laboratories Inc.; current edition.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Schedule of Firestopping: List each type of penetration and proposed product.
- C. Product Data: Provide data on product characteristics.
- D. Manufacturer's Installation Instructions: Indicate preparation and installation instructions.
- E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- F. Certificate from authority having jurisdiction indicating approval of materials used.

1.05 QUALITY ASSURANCE

- A. Fire Testing: Provide firestopping assemblies of designs which provide the specified fire ratings required by local applicable code when tested in accordance with methods indicated.appllicable codes.
 - 1. Listing in the current classification or certification books of UL, FM, or ITS (Warnock Hersey) will be considered as constituting an acceptable test report.
 - 2. Current evaluation reports published by CABO, ICBO, or BOCA will be considered as constituting an acceptable test report.
 - 3. Submission of actual test reports is required for assemblies for which none of the above substantiation exists.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum five years documented experience.
- C. Installer Qualifications: Company specializing in performing the work of this section and:
 - 1. With minimum five years documented experience installing work of this type.
 - 2. Approved by firestopping manufacturer.

1.06 ENVIRONMENTAL REQUIREMENTS

- A. Comply with firestopping manufacturer's recommendations for temperature and conditions during and after installation. Maintain minimum temperature before, during, and for 3 days after installation of materials.
- B. Provide ventilation in areas where solvent-cured materials are being installed.

PART 2 PRODUCTS

2.01 FIRESTOPPING ASSEMBLIES

- A. Firestopping: Any material meeting requirements.
 - 1. Fire Ratings: Use any system listed by UL or tested in accordance with ASTM E 814 that has F Rating equal to fire rating of penetrated assembly and T Rating Equal to F Rating and that meets all other specified requirements.

2.02 MATERIALS

- A. Elastomeric Silicone Firestopping: Single component silicone elastomeric compound and compatible silicone sealant.
 - 1. Manufacturers:
 - a. A/D Fire Protection Systems Inc: www.adfire.com.
 - b. 3M Fire Protection Products: www.mmm.com/US/arch_construct.
 - c. Specified Technologies, Inc: www.stifirestop.com.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Foam Firestoppping: Single component foam compound.
 - 1. Manufacturers:
 - a. 3M Fire Protection Products: www.mmm.com/US/arch_construct.
 - b. Specified Technologies, Inc: www.stifirestop.com.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.
- C. Fibered Compound Firestopping: Formulated compound mixed with incombustible non-asbestos fibers.
 - 1. Manufacturers:
 - a. A/D Fire Protection Systems Inc: www.adfire.com.
 - b. USG Corporation: www.usg.com.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.
- D. Fiber Packing Material: Mineral fiber packing insulation.
 - 1. Manufacturers:
 - a. A/D Fire Protection Systems Inc: www.adfire.com.
 - b. Pecora Corporation: www.pecora.com.
 - c. USG Corporation: www.usg.com.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
- E. Firestop Devices: Mechanical device with silicone elastomer filler and sheet stainless steel jacket, collar, and flanged stops.
 - 1. Manufacturers:
 - a. Grace Construction Products: www.na.graceconstruction.com.
 - b. 3M Fire Protection Products: www.mmm.com/US/arch_construct.
 - c. Specified Technologies, Inc: www.stifirestop.com.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.

- F. Intumescent Putty: Compound which expands on exposure to surface heat gain.
 - 1. Manufacturers:
 - a. Grace Construction Products: www.na.graceconstruction.com.
 - b. 3M Fire Protection Products: www.mmm.com/US/arch_construct.
 - c. Specified Technologies, Inc: www.stifirestop.com.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
- G. Firestop Pillows: Formed mineral fiber pillows.
 - 1. Manufacturers:
 - a. Grace Construction Products: www.na.graceconstruction.com.
 - b. Nelson Firestop Products: www.nelsonfirestop.com.
 - c. Specified Technologies, Inc: www.stifirestop.com.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
- H. Cableways: Galvanized steel gang mounting plates
 - 1. Acceptable Product: EZ-Path, four and seven gang mounting plates, manufactured by Specified Technologies, Inc.
 - a. Substitutions: See Section 01 60 00 - Product Requirements.
- I. Primers, Sleeves, Forms, and Accessories: Type required for tested assembly design.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify openings are ready to receive the work of this section.

3.02 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter which may affect bond of firestopping material.
- B. Remove incompatible materials which may affect bond.
- C. Install backing materials to arrest liquid material leakage.

3.03 INSTALLATION

- A. Install materials in manner described in fire test report and in accordance with manufacturer's instructions, completely closing openings.
- B. Do not cover installed firestopping until inspected by authority having jurisdiction.
- C. Install labeling required by code.

3.04 CLEANING AND PROTECTION

- A. Clean adjacent surfaces of firestopping materials.
- B. Protect adjacent surfaces from damage by material installation.

END OF SECTION

SECTION 07 90 00

JOINT SEALERS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Sealants and joint backing with low or no VOC emissions.
- B. Precompressed foam sealers.
- C. Hollow gaskets.

1.02 REFERENCES

- A. ASTM C 834 - Standard Specification for Latex Sealants; 2005.
- B. ASTM C 919 - Standard Practice for Use of Sealants in Acoustical Applications; 2002.
- C. ASTM C 920 - Standard Specification for Elastomeric Joint Sealants; 2005.
- D. ASTM C 1193 - Standard Guide for Use of Joint Sealants; 2005a.
- E. ASTM D 1056 - Standard Specification for Flexible Cellular Materials--Sponge or Expanded Rubber; 2000.
- F. SCAQMD 1168 - South Coast Air Quality Management District Rule No.1168; current edition; www.aqmd.gov.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data indicating sealant chemical characteristics.
- C. Manufacturer's Installation Instructions: Indicate special procedures.

1.04 QUALITY ASSURANCE

- A. Maintain one copy of each referenced document covering installation requirements on site.
- B. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience.
- C. Applicator Qualifications: Company specializing in performing the work of this section with minimum five years experience.

1.05 MOCK-UP

- A. Construct mock-up with specified sealant types and with other components noted.

1.06 ENVIRONMENTAL REQUIREMENTS

- A. Maintain temperature and humidity recommended by the sealant manufacturer during and after installation.

1.07 COORDINATION

- A. Coordinate the work with all sections referencing this section.

1.08 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Correct defective work within a five year period after Date of Substantial Completion.
- C. Warranty: Include coverage for installed sealants and accessories which fail to achieve airtight seal, exhibit loss of adhesion or cohesion, or do not cure.

1.09 VOC EMISSIONS

- A. Provide sealants with low or no VOC emissions.

PART 2 PRODUCTS

2.01 SEALANTS

- A. General Purpose Exterior Sealant: Silicone Sealant: ASTM C 920, Grade NS, Class 25, Uses NT, A, G, M, O; single component, neutral curing, non-sagging, non-staining, fungus resistant, non-bleeding.
 - 1. Color: Standard colors matching finished surfaces.
 - 2. Applications: Use for:
 - a. Control, expansion, and soft joints in masonry.
 - b. Joints between concrete and other materials.
 - c. Joints between metal frames and other materials.
 - d. Other exterior joints for which no other sealant is indicated.
 - 3. Available Manufacturers:
 - a. Spectrum 1, manufactured by Traco.
 - b. 864, manufactured by Pecora Corporation.
- B. Exterior Expansion Joint Sealer: Precompressed foam sealer; urethane with water-repellent;
 - 1. Color: Black.
 - 2. Size as required to provide weathertight seal when installed.
 - 3. Applications: Use for:
 - a. Exterior wall expansion joints.
- C. Exterior Metal Lap Joint Sealant: Butyl or polyisobutylene, nondrying, nonskinning, noncuring.
 - 1. Applications: Use for:
 - a. Concealed sealant bead in sheet metal work.
 - b. Concealed sealant bead in siding overlaps.
- D. General Purpose Interior Sealant: Acrylic emulsion latex; ASTM C 834, Type OP, Grade NF single component, paintable.
 - 1. Color: Standard colors matching finished surfaces.
 - 2. Applications: Use for:
 - a. Interior wall and ceiling control joints.
 - b. Joints between door and window frames and wall surfaces.
 - c. Other interior joints for which no other type of sealant is indicated.
- E. Bathtub/Tile Sealant: White silicone; ASTM C 920, Uses I, M and A; single component, mildew resistant.
 - 1. Applications: Use for:
 - a. Joints between plumbing fixtures and floor and wall surfaces.
 - b. Joints between kitchen and bath countertops and wall surfaces.

- F. Acoustical Sealant: Butyl or acrylic sealant; ASTM C 920, Grade NS, Class 12-1/2, Uses M and A; single component, solvent release curing, non-skinning.
 - 1. Applications: Use for locations indicated on the drawings.
- G. Interior Floor Joint Sealant: Polyurethane, self-leveling; ASTM C 920, Grade P, Class 25, Uses T, M and A; single component.
 - 1. Approved by manufacturer for wide joints up to 1-1/2 inches.
 - 2. Color: Standard colors matching finished surfaces.
 - 3. Applications: Use for:
 - a. Expansion joints in floors.
- H. Concrete Paving Joint Sealant: Polyurethane, self-leveling; ASTM C 920, Class 25, Uses T, I, M and A; single component.
 - 1. Color: Gray.
 - 2. Applications: Use for:
 - a. Joints in sidewalks and vehicular paving.

2.02 ACCESSORIES

- A. Primer: Non-staining type, recommended by sealant manufacturer to suit application.
- B. Joint Cleaner: Non-corrosive and non-staining type, recommended by sealant manufacturer; compatible with joint forming materials.
- C. Joint Backing: Round foam rod compatible with sealant; ASTM D 1056, sponge or expanded rubber; oversized 30 to 50 percent larger than joint width.
- D. Bond Breaker: Pressure sensitive tape recommended by sealant manufacturer to suit application.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that substrate surfaces are ready to receive work.
- B. Verify that joint backing and release tapes are compatible with sealant.

3.02 PREPARATION

- A. Remove loose materials and foreign matter which might impair adhesion of sealant.
- B. Clean and prime joints in accordance with manufacturer's instructions.
- C. Perform preparation in accordance with manufacturer's instructions and ASTM C 1193.
- D. Protect elements surrounding the work of this section from damage or disfigurement.

3.03 INSTALLATION

- A. Perform work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.
- B. Perform installation in accordance with ASTM C 1193.
- C. Perform acoustical sealant application work in accordance with ASTM C 919.
- D. Measure joint dimensions and size joint backers to achieve the following, unless otherwise indicated:
 - 1. Width/depth ratio of 2:1.

2. Neck dimension no greater than 1/3 of the joint width.
 3. Surface bond area on each side not less than 75 percent of joint width.
- E. Install bond breaker where joint backing is not used.
- F. Install sealant free of air pockets, foreign embedded matter, ridges, and sags.
- G. Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.
- H. Tool joints concave.
- I. Precompressed Foam Sealant: Do not stretch; avoid joints except at corners, ends, and intersections; install with face 1/8 to 1/4 inch below adjoining surface.
- J. Compression Gaskets: Avoid joints except at ends, corners, and intersections; seal all joints with adhesive; install with face 1/8 to 1/4 inch below adjoining surface.

3.04 CLEANING

- A. Clean adjacent soiled surfaces.

3.05 PROTECTION OF FINISHED WORK

- A. Protect sealants until cured.

END OF SECTION

SECTION 08 06 10

DOOR HARDWARE

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Hardware for wood, hollow steel, and aluminum doors.
- B. Hardware for fire-rated doors.
- C. Electrically operated and controlled hardware.
- D. Lock cylinders for doors for which hardware is specified in other sections.
- E. Thresholds.
- F. Weatherstripping, seals and door gaskets.

1.02 SUBMITTALS

- A. General: Submit in accordance with Section 01300.
- B. Submit six (6) complete typewritten copies of proposed finish hardware schedule for approval. This schedule shall be prepared using the "Sequence and Format for the Hardware Schedule" as approved and recommended by the Door and Hardware Institute (DHI).
- C. Product Data: Submit two (2) copies of catalog data sheets for each type of hardware scheduled.
- D. Finish Hardware Schedule: Indicate hardware required for each opening.
- E. Use same reference numbers for opening as drawings.
- F. Include glossary of abbreviations, symbols and codes contained in schedule.
- G. Coordinate schedule with submittal requirements of related door and frame Sections.
- H. Include product name, catalog number, and manufacturer of each item.
- I. Include type, style, model number, function, size, fastenings, finish and other pertinent data for each item. Indicate degree of opening for closers, overhead stops, overhead holders, and other similar hardware items.
- J. Keying Schedule: Submit separate detailed schedule for Owner's review after Hardware Schedule has been received with Architect's approval.
- K. Templates: Furnish templates and approved Hardware Schedule to door and frame fabricators. Where fabricator cannot work to paper templates, furnish physical hardware.
- L. Ship templates and physical hardware to factories of respective manufactures: prepay costs for shipping and delivery.
- M. Informational Submittals: Submit following packaged separately from other submittals:
- N. Certifications specified in Quality Assurance article.
- O. Closeout submittals: Submit following in accordance with Section 01700
 - 1. Operation and maintenance data.
 - 2. Warranty.

1.03 QUALITY ASSURANCE

- A. General Requirement: Hardware has been specified by manufacturer's name, brand and catalog numbers for purpose of establishing basis for quality, design and operational function.
- B. Provide designated product, or where more than one product or manufacturer is listed, provide equivalent product of from one of the other listed manufacturers.
- C. Obtain each type of hardware from single manufacturer.
- D. Hardware Sets within this Section are not complete with respect to thickness of doors, hand, backset, method of fastening, and other detail requirements.

- E. Review Drawings and Door Schedules thoroughly and provide required hardware for openings, including openings, which may have been inadvertently omitted from Door Schedules.
- F. Should opening be omitted or opening not indicated with hardware set, provide hardware of same quality, design and function as specified for similar openings.
- G. Furnish hardware complete with brackets, plates, fittings, fastenings and other accessories required for installation.
- H. Provide screws, nuts, bolts, through-bolts, washers, grommets and other fastening devices necessary for proper installation of hardware; match finish of hardware being attached. Non-ferrous or corrosion resistant type required where exposed to exterior atmosphere.
- I. Provide concealed fastening wherever possible. Where exposed, use countersunk Phillips oval-head type screws, except flat head for hinges.
- J. Do not attach hardware to metal frames and metal doors with self-tapping or sheet metal screws.
 - 1. Wood Screws: Full thread.
 - 2. Machine Screws: Undercut head and full thread.
 - 3. Hardware Items Affixed to Concrete, Masonry, or Stone: Machine screws and threaded expansion shields.
- K. Provide door closers at fire-rated openings.
- L. Through-bolts: Anchor overhead door closers to fire-rated wood doors with through-bolts or with screws fastened to blocking in door.
- M. Regulatory Requirements:

Comply with following accessibility standard to accommodate barrier free design.

 - 1. Americans with Disabilities Act (ADA) including ADA Accessibility Guidelines ANSI A117.1
 - 2. Uniform Federal Accessibility Standards
 - 3. Article 9102, Texas Civil Statutes, Elimination of Architectural Barriers Act of Texas.
 - 4. Comply with NFPA 80 Standard for Fire Doors & Windows.
 - 5. Comply with NFPA-101 Life Safety Code.
- N. Provide hardware, which has been tested and listed, by UL, FM or WHI for fire-rated assemblies of types, which comply, with requirements of door and frame labels.
 - 1. FM – Factory Mutual
 - 2. UL – Underwriter's Laboratories
 - 3. WHI – Warnock Hersey International
- O. Hardware Supplier Qualifications: Builders hardware supplier who has been furnishing hardware in Project's vicinity for period of not less than five 5 years, and who is, or who employs Architectural Hardware Consultant (AHC) who will be available at reasonable times during course of Work for consultation about Project's hardware requirements.
- P. Certification: After completion of hardware installation, submit written certification attesting that hardware has been installed in accordance with manufacturer's templates and instructions.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Comply with Section 01600.
- B. Pack each hardware item separately. Include manufacturer's printed installation instructions, trim, fasteners, accessories, and special tools necessary for installation.
- C. Legibly mark and adequately label each package indicating opening for which intended. Provide markings corresponding with approved Hardware Schedule.

1.05 WARRANTY

- A. See Section 01700 – Contract Closeout, for additional warranty requirements.
- B. All the finish hardware shall carry a limited warranty against defects in workmanship and operation for a period of one (1) year from the date of acceptance. Exceptions:
 - 1. Hinges shall carry a lifetime warranty.
 - 2. Door closers shall carry a warranty of ten (10) years.
 - 3. Exit devices shall carry a warranty of five (5) years.
 - 4. No liability is to be assumed where damage or faulty operation is due to abuse, improper usage, improper installation or failure to exercise normal maintenance.

1.06 EXTRA MATERIALS

- A. Comply with Section 01700
- B. Maintenance Materials: Furnish not less than three sets of special tools necessary for adjustment and installation of hardware.
- C. At Contract closeout, deliver special tools to Architect for presentation to Owner.

PART 2 - PRODUCTS

2.01 HINGES

- A. Acceptable Manufacturers:
 - 1. McKinney, ASSA ABLOY, Scranton, PA.
 - 2. Hager Hinge Co., St. Louis, MO.
 - 3. Stanley Hardware Division of Stanley Works, New Britain, CT.
- B. Butt Hinges: ANSI A156.1 and A156.7.
- C. Five knuckle with square corners. Type and model as specified.
- D. Full mortise type, except where indicated as half mortise, half surface, or full surface in Hardware Sets.
- E. Flat button tip and matching plug, except where indicated as hospital tip in Hardware Sets.
- F. Non-removable pins for out-swinging exterior doors and for interior reverse bevel doors equipped with locking device; safety stud also acceptable. Non-rising pin for other doors.
- G. Non-ferrous construction at locations exposed to exterior atmosphere.
- H. Anti-friction type for doors equipped with closers.
- I. Anti-friction type for doors 3 feet width and over which are not equipped with closers.
- J. Plain bearing type for doors less than 3 feet width, which are not equipped with closers.
- K. Minimum Number Hinges:
 - 1. Doors 5 feet or less in Height: Two (2) each.
 - 2. Doors over 5 feet and not over 90 inches: Three (3) each.
 - 3. Doors over 90 inches: One (1) for each additional 30 inches height or fraction thereof.
 - 4. Dutch Doors: Four (4) each.
- L. Minimum Size and Gauge:
 - 1. Doors 3 feet width or less: 4-1/2x4-1/2 inches, 0.134 gauge.
 - 2. Doors over 3 feet up to 40 inches: 5x4-1/2 inches, 0.146 gauge.
 - 3. Doors over 40 inches: 5x4-1/2 inches, 0.190 gauge.
 - 4. Fire rated Doors over 8 feet height: Sized as indicated above, except not less than 0.180 gauge
- M. Acceptable Products:

1. Standard duty full mortise steel hinge.
McKinney TA2714
Hager BB1279
Stanley FBB179
2. Heavy Duty Continuous Hinges:
McKinney MCK-25HD
Hager 780-112HD

2.02 KEYS AND KEYING

- A. Consult with Owner's authorized representative and prepare detailed keying schedule accordingly.
- B. Keying:
 1. Provide Best interchangeable core cylinders designed so that cores can quickly and easily be changed by non-technical personnel by using a special control key.
- C. Construction Keying:
 1. Furnish exterior door lock sets with keyed alike removable construction core cylinders for use during construction.
 2. Restrict distribution of construction keys. Maintain record of persons who have received keys and deliver copies of record to Contracting Officer upon request.
 3. Provide permanent cores to owner prior to substantial completion.
 4. Owner shall store them securely until needed. At substantial completion and at Contracting Officer direction, remove construction cores and replace with permanent cores in presence of Owner.
 5. Provide keys to Owner and return construction cores to manufacturer.
- D. Permanent Keying: Master locks and cylinders are to match the Best Key System as instructed by owner.
- E. Provide keys of Nickel Silver Material in Following Quantities:
 1. Grandmaster-keys (MGK): Six (6)
 2. Masterkeys (MK - each set): Six (6)
 3. Change-keys (per lock): Two (2)
 4. Removable Core Control Keys: Six (6)
 5. Construction Masterkeys: Ten (10)
 6. Construction Control Keys Two (2)
- F. Identification and Control:
 1. Stamp all keys with do not duplicate, or as otherwise instructed by owner.
- G. Furnish visual control system; coordinate provisions with Owner. Stamp or emboss keys with identification code.
- H. Deliver construction masterkeys to Project site. Forward other keys directly from manufacturer to Owner. Ship masterkeys, and grandmaster-keys via prepaid registered mail. Ship change keys via prepaid freight.

2.03 CYLINDERS AND PERMANENT CORES

- A. Furnish permanent cores keyed to factory-registered extension of existing Best series interchangeable core cylinder system.
- B. Cores shall be Solid brass construction to provide high quality and long cylinder life.
- C. Removable Core: 7 pin tumbler interchangeable core design removable by a control key.

1. Brass cylinder body having a head cap of brass, bronze or stainless steel finished to match locking trim.
 2. Equip cylinders with appropriate rings.
 3. Equip with proper tail piece for mortise and or rim cylinders.
- D. Acceptable Manufacturers:
1. Best Access Systems.

No Substitutions

2.04 KEY CONTROL SYSTEM

- A. Acceptable Manufacturers:
1. Key Control Systems, Inc., Bechtelsville, PA.
 2. Lund Equipment Co., Inc., Bath, OH.
 3. Telkee, Inc., Glen Riddle, PA.
- B. Cabinet: Surface mounted hinged panel type cabinet manufactured from cold-rolled furniture steel, electro-welded construction, with manufacturer's standard baked enamel finish. Equip with pin tumbler locking mechanism. Sized to contain indexed keys for Project, plus 50 percent expansion.
- C. Key Control System: Dual tag indexed system complete with numbered labels and numbered tags, permanent key tags, working key tags, key loan and receipt system, three way cross index system, key gathering envelopes, and instruction manual.

2.05 LOCKING AND LATCHING DEVICES

- A. Acceptable Manufacturers:
1. Yale Security, ASSA ABLOY, Lenoir City, TN.
 2. Corbin Russwin, ASSA ABLOY, Berlin, CT.
 3. Sargent, ASSA ABLOY, New Haven, CT.
 4. Schlage, Ingersol-Rand, Indianapolis, IN.
 5. Best Access Systems, Indianapolis, IN.

Products specified are manufactured by Best Access Systems, Indianapolis, Indiana, to establish standard of quality, function, and design.

- B. Mortise Locksets and Latchsets: ANSI A156.13, Grade 1.
- C. Acceptable Products for cast or forged Lever with Rose Trim:
1. Yale 8800FL Series x PBR Lever.
 2. Corbin Russwin ML2000 Series x PSA Lever.
 3. Sargent 8200 Series x LNP Lever.
 4. Schlage L9000 Series x 17A Lever.
 5. Best 40H Series x 14H Lever.
- E. Backset: 2-3/4 inches.
- F. Faceplate: 8 by 1-1/4 inches, adjustable from flat to bevel of 1/8 inch in 2 inches, finished to match trim on hinge side of door.
- G. Latch Bolt: Two piece anti-friction, 3/4 inch throw.
- H. Strike: ANSI standard 4-7/8 inch height, 1-1/4 inch curved lip.
- I. Provide strikes with proper lip length to protect trim of the frame, but not to project more than 1/8 inch (3.2) beyond frame trim or the inactive leaf of a pair of doors.
- J. Equip with wrought or plastic box.
- K. Finish to match trim on hinge side of door
- F. Removable Mullions: Equip with strikes mated to exit device.

2.08 SURFACE MOUNTED CLOSERS

- A. Acceptable Manufacturers:
 - 1. Norton, ASSA ABLOY, Monroe, NC.
 - 2. Sargent, ASSA ABLOY, New Haven, CT.
 - 3. Corbin Russwin, ASSA ABLOY, Berlin, CT.
 - 4. LCN, Ingersol-Rand, Princeton, IL.
- B. Acceptable Products: full featured door closers.
 - 1. Norton 7500 / 8500 Series.
 - 2. Sargent 351 / 1431 Series.
 - 3. Corbin Russwin DC6000 / DC3000 Series.
 - 4. LCN 4041 / 1461-72FC Series.
- C. Standard: ANSI A156.4, Grade 1.
- D. Required Features: Manufacturer's standard cast aluminum or cast iron construction.
- E. Regular or parallel arm mounting where indicated in Hardware sets.
- F. Rack and pinion construction with compression spring, fully hydraulic.
- G. Closing speed and latching speed controlled by independently operated valves.
- H. Adjustable spring power allowing adjustment up to 50 percent in field to suit individual door conditions.
- I. Maximum operating force of 8.5 pounds (3.86 kg) exterior doors, 5 pounds (2.27 kg) for interior doors, and 15 pounds (6.80 kg) for label doors.
- J. Size as recommended by manufacturer for door size and weight.
- K. Hold open, deadstop, or spring shock-absorbing arm features where indicated in Hardware Sets.
- L. Adjustable hydraulic delayed action feature where indicated in Hardware Sets.
- M. Accessories: Manufacturer's full size cover, non-metallic or metal construction for painted finish.
- N. Furnish with necessary arms, tracks, brackets, plates, shoes, and other accessories to suit door and frame conditions.
- O. Finish accessories to match cover.
- P. Mounting: Refer to hardware locations.

2.09 DOOR STOPS

- A. Acceptable Manufacturers:
 - 1. McKinney, ASSA ABLOY, Scranton, PA.
 - 2. Rockwood Manufacturing Co., Rockwood, PA.
 - 3. Trimco, Los Angeles, CA.
- B. Description: Provide door stops at each door leaf, except not required at doors equipped with overhead stops/holders, or doors equipped with closers having deadstop or spring shock-absorbing feature.
 - 1. Door stops consist of roller bumpers, wall stop/holders, floor stop/holders, floor stops or wall stops to prevent doors from striking building components or equipment.
 - 2. Wall Bumper: Use at all locations, except where roller bumpers, wall stop/holders, floor stop/holders, and floor stops are indicated or permitted.
 - 3. Equivalent to McKinney WS01 as applicable equipped with expandable anchor for use at gypsum board/stud walls.
 - 4. Use where indicated in Hardware Sets.
 - 5. Dome Floor Stops: Equivalent to McKinney FS01 with machine screw and expansion shield.

2.12 FLUSH BOLTS

- A. Acceptable Manufacturers:
 - 1. McKinney, ASSA ABLOY, Scranton, PA.
 - 2. Rockwood Manufacturing Co., Rockwood, PA.
 - 3. Trimco, Los Angeles, CA.
- B. Flush Bolts:

Manual design equivalent to McKinney FB01M at non-labeled metal or wood doors.

Equip with extension bolts of lengths to locate operating mechanism at 12 inches (305 mm) above floor for bottom unit and not over 72 inches (1829 mm) above floor for top unit.
- C. Dust Proof Strike: Equip bottom bolts with dust proof strike equivalent to McKinney DPS1.

2.13 MISCELLANEOUS HARDWARE

- A. Acceptable Manufacturers
 - 1. McKinney, ASSA ABLOY, Scranton, PA.
 - 2. Rockwood Manufacturing Co., Rockwood, PA.
 - 3. Trimco, Los Angeles, CA.
- B. Silencers: Preformed neoprene or rubber.

Location and Quantities:

Pairs of Doors: Two at header.

Single Doors: Three at strike jamb.

Acceptable Products: McKinney S1M for hollow metal frames and McKinney S2W for wood frames.

2.14 WEATHERSTRIPPING, SEALS AND THRESHOLDS

- A. Acceptable Manufacturers:
 - 1. McKinney, ASSA ABLOY, Scranton, PA.
 - 2. Zero, Bronx, NY.
 - 3. Pemko, ASSA ABLOY, Ventura, CA.
- B. Thresholds:
 - 1. Thresholds: Extruded aluminum of types detailed and at locations where indicated on Hardware Sets.
 - 2. Weatherstripping: Extruded aluminum with silicon seal bulb.
- C. Seals:
 - 1. Meeting Stile Seals: Extruded aluminum with neoprene seals.
 - 2. Color: Black.
 - 3. Sweep Strips: Extruded aluminum with neoprene seals.
 - 4. Rain Drips: Extruded aluminum.
 - 5. Equivalent to product models as specified in Hardware Sets.

2.15 FINISHES

- A. Except where indicated otherwise in Hardware Sets, comply with following:
- B. Typically: 626 Brushed Chrome, 630 stainless steel.
- C. Surface Mounted Closers: Spray-painted to match other hardware.
- D. Special care is to be taken to make uniform the finish of all various manufactured items.
- E. Extruded aluminum products, except for thresholds and specified gasketing, are not acceptable.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install hardware plumb, level, and true to line in accordance with manufacturer's templates, Section 01600, and Project conditions.
- B. Install fire rated hardware in accordance with NFPA 80.
- C. Where cutting and fitting is required on substrates to be field painted or similarly finished, install, fit, remove and store hardware prior to finishing. Reinstall hardware after finishing operations are completed.
- D. Do not install surface mounted items until finishes have been completed on substrate.
- E. Reinforce attachment substrates as necessary for installation and operation for substrates which are not factory prepared for hardware:
- F. Mortise work to correct size and location without gouging, splintering or causing irregularities in exposed finish work.
- G. Fit faces of mortised components snug and flush without excessive clearance.
- H. Set thresholds at exterior doors in bed of sealant. Remove excess sealant.

3.02 ADJUSTING

- A. Check and adjust each operating hardware item to ensure correct operation and function.
- B. Ensure weatherstripping and seals do not inhibit closing and positive latching of door.
- C. Lubricate moving or operating components as recommended by hardware manufacturer. Use graphite type lubrication if none other is recommended.
- D. Replace defective materials or units, which cannot be adjusted to operate as intended. Reinstall items found improperly installed.
- E. Prior to date of Substantial Completion, readjust and re-lubricate hardware items as necessary.

3.03 DEMONSTRATION

- A. Demonstration and Instruction of Owner's Personnel: Provide in accordance with Section 01700.
- B. Instruct Owner's designated personnel in proper adjustment and maintenance of hardware.

3.04 HARDWARE LOCATIONS

- A. Mount hardware units at heights indicated in following applicable publications, except as specifically indicated or required to comply with governing regulations and except as otherwise directed by Architect.

- 1. "Recommended Locations for Builders Hardware for Standard Steel Doors and Frames" by the Door and Hardware Institute.
- 2. "Recommended Locations for Builders Hardware for Custom Steel Doors and Frames" by the Door and Hardware Institute.
- 3. NWWDA Industry Standard I.S.1.7, "Hardware Locations for Wood Flush Doors."

- B. Install each hardware item in compliance with the manufacturer's instructions and recommendations. Where cutting and fitting is required to install hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation or application of surface protection with finishing work specified in the Division 9 Sections. Do not install surface-mounted items until finishes have been completed on the substrates involved.

- C. Set units level, plumb, and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.

- D. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.

- E. Set thresholds for exterior doors in full bed of butyl-rubber or polyisobutylene mastic sealant complying with requirements specified in Division 7 Section "Joint Sealers."
- F. Weatherstripping and Seals: Comply with manufacturer's instructions and recommendations to the extent installation requirements are not otherwise indicated.
- G. Adjusting, Cleaning and Demonstrating:
 - 1. Adjust and check each operating item of hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate freely and smoothly or as intended for the application made.
 - 2. Where door hardware is installed more than one month prior to acceptance or occupancy of a space or area, return to the installation during the week prior to acceptance or occupancy and make final check and adjustment of all hardware items in such space or area. Clean operating items as necessary to restore proper function and finish of hardware and doors. Adjust door control devices to compensate for final operation of heating and ventilating equipment.
 - 3. Clean adjacent surfaces soiled by hardware installation.
- H. Instruct Owner's personnel in the proper adjustment and maintenance of door hardware and hardware finishes.
- I. Six-Month Adjustment: Approximately six months after the date of Substantial Completion, the Installer, accompanied by representatives of the manufacturers of latchsets and locksets and of door control devices, and of other major hardware suppliers, shall return to the Project to perform the following work:
- J. Examine and re-adjust each item of door hardware as necessary to restore function of doors and hardware to comply with specified requirements.
- K. Consult with and instruct Owner's personnel in recommended additions to the maintenance procedures.
- L. Replace hardware items that have deteriorated or failed due to faulty design, materials, or installation of hardware units.
- M. Prepare a written report of current and predictable problems (of substantial nature) in the performance of the hardware.

3.05 HARDWARE SETS

- A. General: Provide hardware for each door to comply with requirements of Section "Door Hardware," hardware set numbers indicated in door schedule, and in the following schedule of hardware sets.
- B. Hardware sets indicate quantity, item, manufacturer and product designation, size, and finish or color, as applicable.

Abbreviations / Manufacturers Listed in Hardware Sets

ARM	Adams Rite	http://www.adamsrite.com/
BAS	Best Access	http://www.bestaccess.com/
KNO	Knox Box	http://www.knoxbox.com/
NOR	Norton	http://www.nortondoорcontrols.com/
MCK	McKinney	http://www.mckinneyhinge.com/
RIX	Rixson	http://www.rixson.com/
SEC	Securitron	http://www.securitron.com/
SGT	Sargent	http://www.sargentlock.com/
YAL	Yale	http://www.yalecommercial.com/

Set 04.4 Single HMF/HMD

Outdoor Classroom Restroom

3	ea	Hinge	TA2714 4.5 x 4.5	652	MCK
1	ea	Classroom Lockset	45H-7J14H	626	BAS
1	ea	Closer	8501 SN	689	NOR
1	ea	Kick Plate	KP50 8" x DW-2" B4E CSK	630	MCK
1	ea	Floor Stop	FS01	626	MCK
1	ea	Rain Drip	MCK346C x DW + 4"	628	MCK
1	ea	Weatherstrip	MCK303AV x (head & jambs)	719	MCK
1	ea	Door Bottom	MCK307AV	719	MCK
1	ea	Threshold	MCK171A	719	MCK

END OF SECTION 08710

SECTION 08 11 13

HOLLOW METAL DOORS AND FRAMES – BURN TOWER ONLY

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section includes hollow metal work. The work includes all hollow metal doors in the Burn Tower.
- B. Related Requirements:
 - 1. Section 08 71 00 "Door Hardware – Burn Tower only" for door hardware for hollow-metal doors.

1.03 DEFINITIONS

- A. Minimum Thickness: Minimum thickness of base metal without coatings 14 gauge according to NAAMM-HMMA 803 or SDI A250.8.

1.04 COORDINATION

- A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Include the following:
 - 1. Elevations of each door type.
 - 2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
 - 3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
 - 4. Locations of reinforcement and preparations for hardware.
 - 5. Details of each different wall opening condition.
 - 6. Details of anchorages, joints, field splices, and connections.
 - 7. Details of accessories.
 - 8. Details of moldings, removable stops, and glazing.
 - 9. Details of conduit and preparations for power, signal, and control systems.
- C. Mock-Up:
 - 1. Provide one full-size operational mock-up.
 - 2. Mock-up to be installed in temporary, wood-framed wall or in final wall.
 - 3. Owner to confirm hardware and shutter operation. Make any necessary adjustments to hardware and installation to provide approved operation and function.
- D. Samples for Verification:
 - 1. For each type of exposed finish required, prepared on Samples of not less than 3 by 5 inches.
- E. Schedule: Provide a schedule of hollow-metal work prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final Door Hardware Schedule.

1.06 INFORMATIONAL SUBMITTALS

- A. Oversize Construction Certification: For assemblies required to be fire rated and exceeding limitations of labeled assemblies.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver hollow-metal work palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use non-vented plastic.
- B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
- C. Store hollow-metal work vertically under cover at Project site with head up. Place on minimum 4-inch high wood blocking. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Ceco Door Products; an Assa Abloy Group company. Medallion Series.
- B. Source Limitations: Obtain hollow-metal work from single source from single manufacturer.

2.02 EXTERIOR HOLLOW-METAL DOORS AND FRAMES

- A. Construct exterior doors and frames to comply with the standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
- B. Hollow-Metal Doors and Frames: NAAMM-HMMA 860. Typical.
 - 1. Physical Performance: Level A according to SDI A250.4.
 - 2. Doors:
 - a. Type: As indicated in the Door and Frame Schedule.
 - b. Thickness: 1-3/4 inches
 - c. Face: Metallic-coated steel sheet, minimum thickness of 0.042 inch, with minimum G90 coating.
 - d. Edge Construction: Continuously welded with no visible seam.
 - e. Core: Steel stiffened.
 - 3. Frames:
 - a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch, with minimum G60A60 coating.
 - b. Construction: Full profile welded.
 - 4. Exposed Finish: Hot dipped galvanized G90.

2.03 FRAME ANCHORS

- A. Jamb Anchors:
 - 1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.042 inch thick, with corrugated or perforated straps not less than 2 inches wide by 10 inches long; or wire anchors not less than 0.177 inch thick.
- B. Floor Anchors: Formed from same material as frames, minimum thickness of 0.042 inch, and as follows:
 - 1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.

2.04 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

- C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B.
- D. Frame Anchors: ASTM A 879/A 879M, Commercial Steel (CS), 04Z coating designation; mill phosphatized.
 - 1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.
- E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.
- F. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.
- G. Grout: ASTM C 476, except with a maximum slump of 4 inches, as measured according to ASTM C 143/C 143M.
- H. Bituminous Coating: Cold-applied asphalt mastic, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.05 FABRICATION

- A. Fabricate hollow-metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for metal thickness. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.
- B. Hollow-Metal Doors:
 - 1. Steel-Stiffened Door Cores: Provide minimum thickness 0.026 inch, steel vertical stiffeners of same material as face sheets extending full-door height, with vertical webs spaced not more than 6 inches apart. Spot weld to face sheets no more than 5 inches o.c. Fill spaces between stiffeners with glass- or mineral-fiber insulation.
 - 2. Vertical Edges for Single-Acting Doors: Provide beveled or square edges at manufacturer's discretion.
 - 3. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets.
 - 4. Bottom Edge Closures: Close bottom edges of doors where required for attachment of weather stripping with end closures or channels of same material as face sheets.
 - 5. Exterior Doors: Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.
- C. Hollow-Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
 - 1. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners, unless otherwise indicated.
 - 2. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
 - 3. Floor Anchors: Weld anchors to bottoms of jambs with at least four spot welds per anchor.
 - 4. Jamb Anchors: Provide number and spacing of anchors as follows:
 - a. Masonry Type: Locate anchors not more than 16 inches from top and bottom of frame. Space anchors not more than 32 inches o.c., to match coursing, and as follows:
 - 1) Two anchors per jamb up to 60 inches high.
 - 2) Three anchors per jamb from 60 to 90 inches high.
 - 5. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.
 - a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.

- D. Fabricate concealed stiffeners and edge channels from either cold- or hot-rolled steel sheet.
- E. Hardware Preparation: Factory prepare hollow-metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to SDI A250.6, the Door Hardware Schedule, and templates.
 - 1. Reinforce doors and frames to receive non-templated, mortised, and surface-mounted door hardware.
 - 2. Comply with applicable requirements in SDI A250.6 and BHMA A156.115 for preparation of hollow-metal work for hardware.
- F. Stops and Moldings: Provide stops and moldings around glazed lites and louvers where indicated. Form corners of stops and moldings with mitered hairline joints.
 - 1. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.
 - 2. Provide loose stops and moldings on inside of hollow-metal work.
 - 3. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.

2.06 STEEL FINISHES

- A. Finish: Hot dipped galvanized, G90.

2.07 ACCESSORIES

- A. Grout Guards: Formed from same material as frames, not less than 0.016 inch thick.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for embedded and built-in anchors to verify actual locations before frame installation.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.
- B. Drill and tap doors and frames to receive non-templated, mortised, and surface-mounted door hardware.

3.03 INSTALLATION

- A. General: Install hollow-metal work plumb, rigid, properly aligned, and securely fastened in place. Comply with Drawings and manufacturer's written instructions.
- B. Hollow-Metal Frames: Install hollow-metal frames of size and profile indicated. Comply with SDI A250.11 or NAAMM-HMMA 840 as required by standards specified.
 - 1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
 - a. Install door silencers in frames before grouting.
 - b. Remove temporary braces necessary for installation only after frames have been properly set and secured.

- c. Check plumb, square, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
 - d. Field apply bituminous coating to backs of frames that will be filled with grout containing anti-freezing agents.
- 2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with post-installed expansion anchors.
 - a. Floor anchors must be set with post-installed expansion anchors.
- 3. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.
- 4. Installation Tolerances: Adjust hollow-metal door frames for squareness, alignment, twist, and plumb to the following tolerances:
 - a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
 - c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.
- C. Hollow-Metal Doors: Fit hollow-metal doors accurately in frames, within clearances specified below. Shim as necessary.
 - 1. Non-Fire-Rated Steel Doors:
 - a. Between Door and Frame Jambs and Head: 1/8 inch plus or minus 1/32 inch.
 - b. At Bottom of Door: 5/8 inch plus or minus 1/32 inch.
 - c. Between Door Face and Stop: 1/16 inch to 1/8 inch plus or minus 1/32 inch.

3.04 ADJUSTING AND CLEANING

- A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow-metal work that is warped, bowed, or otherwise unacceptable.
- B. Remove grout and other bonding material from hollow-metal work immediately after installation.
- C. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

END OF SECTION

SECTION 08 11 13
HOLLOW METAL DOORS AND FRAMES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Non-fire-rated steel doors and frames.
- B. Accessories, including glazing.

1.02 RELATED SECTIONS

- A. Section 08 70 00 - Door Hardware.
- B. Section 08 80 00 - Glazing: Glass for doors and borrowed lites.
- C. Section 09 90 00 - Paints and Coatings: Field painting.

1.03 REFERENCES

- A. ANSI/ICC A117.1 - American National Standard for Accessible and Usable Buildings and Facilities; International Code Council; 1998.
- B. ANSI A250.8 - SDI-100 Recommended Specifications for Standard Steel Doors and Frames; 1998.
- C. ANSI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames; 1998.
- D. Americans with Disabilities Act, Title III.
- E. TEXAS ACCESSIBILITY STANDARDS (TAS) of the Architectural Barriers Act Article 9102, Texas Civil Statutes
- E. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2002a.
- F. DHI A115 Series - Specifications for Steel Doors and Frame Preparation for Hardware; Door and Hardware Institute; current edition (ANSI/DHI A115 Series).
- G. NAAMM HMMA 840 - Installation and Storage of Hollow Metal Doors and Frames; The National Association of Architectural Metal Manufacturers; 1999.
- H. NAAMM HMMA 860 - Guide Specifications for Hollow Metal Doors and Frames; The National Association of Architectural Metal Manufacturers; 1992.
- I. NAAMM HMMA 861 - Guide Specifications for Commercial Hollow Metal Doors and Frames; The National Association of Architectural Metal Manufacturers; 2000.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Materials and details of design and construction, hardware locations, reinforcement type and locations, anchorage and fastening methods, and finishes.
- C. Label Compliance: Doors requiring fire labeling or sound transmission labeling, list fire and sound resistance ratings of doors provided.
- D. Shop Drawings: Details of each opening, showing elevations, glazing, frame profiles, and identifying location of different finishes, if any.

- E. Installation Instructions: Manufacturer's published instructions, including any special installation instructions relating to this project.
- F. Manufacturer's Certificate: Certification that products meet or exceed specified requirements.

1.05 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum five years documented experience.
- B. Maintain at the project site a copy of all reference standards dealing with installation.

1.06 DELIVERY, STORAGE, AND PROTECTION

- A. Store in accordance with NAAMM HMMA 840.
- B. Protect with resilient packaging; avoid humidity build-up under coverings; prevent corrosion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Steel Doors and Frames:
 - 1. Ceco Door Products: www.cecodoor.com.
 - 2. Curries: www.curries.com
 - 3. Republic Builders Products: www.republicdoor.com.
 - 4. Steelcraft: www.steelcraft.com.
 - 5. Substitutions: See Section 01 60 00 – Products Options.

2.02 DOORS AND FRAMES

- A. Requirements for All Doors and Frames:
 - 1. Accessibility: Comply with ANSI/ICC A117.1, Americans with Disabilities Act and Texas Accessibility Standards.
 - 2. Door Top Closures: Flush with top of faces and edges.
 - 3. Door Edge Profile: Beveled on both edges.
 - 4. Door Texture: Smooth faces.
 - 5. Glazed Lights: Non-removable stops on non-secure side; sizes and configurations as indicated on drawings.
 - 6. Hardware Preparation: In accordance with DHI A115 Series, with reinforcement welded in place, in addition to other requirements specified in door grade standard.
 - 7. Finish: Factory primed, for field finishing.
- B. Combined Requirements: If a particular door and frame unit is indicated to comply with more than one type of requirement, comply with all the specified requirements for each type; for instance, an exterior door that is also indicated as being sound-rated must comply with the requirements specified for exterior doors and for sound-rated doors; where two requirements conflict, comply with the most stringent.

2.03 STEEL DOORS

- A. Interior Doors, Non-Fire-Rated:
 - 1. Grade: NAAMM HMMA 860, physical performance Level A, 20 gage.
 - 2. Core: Vertical steel stiffeners.
 - 3. Thickness: 1-3/4 inches.

2.04 STEEL FRAMES

- A. General:
 - 1. Comply with the requirements of grade specified for corresponding door.
 - 2. Finish: Same as for door.
 - 3. Provide mortar guard boxes for hardware cut-outs in frames to be installed in masonry or to be grouted.
 - 4. Frames in Masonry Walls: Size to suit masonry coursing as indicated on drawings.
 - 5. Frames Wider than 48 Inches: Reinforce with steel channel fitted tightly into frame head, flush with top.
- B. Interior Door Frames, Non-Fire-Rated: Fully welded type.
 - 1. Terminated Stops: Provide at all interior doors; closed end stop terminated at floor line at 90 degree angle.
- C. Frames for Interior Glazing or Borrowed Lights: Construction and face dimensions to match door frames, and as indicated on drawings.

2.05 ACCESSORY MATERIALS

- A. Glazing: As specified in Section 08 80 00, factory installed.
- B. Grout for Frames: Portland cement grout of maximum 4-inch slump for hand troweling; thinner pumpable grout is prohibited.
- C. Silencers: Resilient rubber, fitted into drilled hole; 3 on strike side of single door, 3 on center mullion of pairs, and 2 on head of pairs without center mullions.
- D. Temporary Frame Spreaders: Provide for all factory- or shop-assembled frames.

2.06 FINISH MATERIALS

- A. Primer: Rust-inhibiting, complying with ANSI A250.10, door manufacturer's standard.
- B. Bituminous Coating: Asphalt emulsion or other high-build, water-resistant, resilient coating.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that opening sizes and tolerances are acceptable.

3.02 PREPARATION

- A. Coat inside of frames to be installed in masonry or to be grouted, with bituminous coating, prior to installation.

3.03 INSTALLATION

- A. Install in accordance with the requirements of the specified door grade standard and NAAMM HMMA 840.
- B. Coordinate frame anchor placement with wall construction. Provide minimum 3 anchors per jamb.
- C. Grout frames in masonry and concrete construction, using hand trowel methods; brace frames so that pressure of grout before setting will not deform frames.

- D. Coordinate installation of hardware.
- E. Coordinate installation of glazing.

3.04 ERECTION TOLERANCES

- A. Clearances between door and frame: As specified in ANSI A250.8.
- B. Maximum Diagonal Distortion: 1/16 in measured with straight edge, corner to corner.

3.05 ADJUSTING

- A. Adjust for smooth and balanced door movement.

END OF SECTION

SECTION 08 33 23

OVERHEAD ROLLING FIRE DOORS

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. The work of this Section includes rolling fire doors.
- B. Related Sections: Other specification sections which directly relate to the work of this Section include, but are not limited to, the following:
 - 1. Section 08 71 00 - Finish Hardware; key cylinders for locks.
 - 2. Division 26 - Electrical; wiring.

1.02 SUBMITTALS

- A. Product Data: Submit manufacturer's product data and installation instructions for each type of rolling fire door. Include both published data and any specific data prepared for this project.
- B. Shop Drawings: Submit shop drawings for approval prior to fabrication. Include detailed plans, elevations and details of framing members, required clearances, anchors, and accessories. Include relationship with adjacent materials.

1.03 QUALITY ASSURANCE

- A. Manufacturer: Rolling fire doors shall be manufactured by a firm with a minimum of five years experience in the fabrication and installation of rolling fire doors. Manufacturers proposed for use, which are not named in these specifications, shall submit evidence of ability to meet performance and fabrication requirements specified, and include a list of five projects of similar design and complexity completed within the past five years.
- B. Installer: Installation of rolling fire doors shall be performed by an authorized representative of the manufacturer.
- C. Single-Source Responsibility: Provide doors, guides, motors, and related primary components from one manufacturer for each type of door. Provide secondary components from source acceptable to manufacturer of primary components.
- D. Pre-Installation Conference: Schedule and convene a pre-installation conference just prior to commencement of field operations, to establish procedures to maintain optimum working conditions and to coordinate this work with related and adjacent work.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials and products in labeled protective packages. Store and handle in strict compliance with manufacturer's instructions and recommendations. Protect from damage from weather, excessive temperatures and construction operations.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURER

- A. Drawings and specifications are based on manufacturer's literature from Overhead Door Corporation unless otherwise indicated. Other manufacturers to comply with the minimum levels of material and detailing indicated on the drawings and in the specifications and in conformance with provisions of Section 01 60 00 – Product Requirements.

2.02 ROLLING FIRE DOORS

- A. Trade Reference: Series 630 Fire Doors by Overhead Door Corporation.

- B. Label: Provide fire doors certified with the following listing.
 - 1. Rolling fire doors up to 144 sq. ft. and 12' in width or height shall bear the (UL and FM 3-Hour Class A Label.)(ULC 3-Hour Label.)(UL and FM 1-1/2 Hour Class B Label for non-masonry fire walls.)
 - 2. Rolling fire doors over 144 sq. ft. shall receive the UL Oversize Fire Door Label.
 - 3. Rolling fire doors over 144 sq. ft. and not exceeding 18' in height or width shall receive the Factory Mutual Label for Oversize Fire Doors.
- C. Curtain: Interlocking roll-formed slats as specified following. Endlocks shall be attached to each end of alternate slats to prevent lateral movement.
 - 1. Curved profile type C-187 for doors thru 14'0" wide by 12'0" high, fabricated of 22 gauge galvanized steel.
 - 2. Curved profile type C-187 for doors over 14'0" thru 20'0" wide, fabricated of 20 gauge galvanized steel.
 - 3. Curved profile type C-275 for doors thru 14'0" wide by 12'0" high, fabricated of 22 gauge galvanized steel.
 - 4. Curved profile type C-275 for doors over 14'0" thru 20'0" wide, fabricated of 20 gauge galvanized steel.
 - 5. Curved profile type C-275 for doors over 20'0" thru 24'0" wide, fabricated of 18 gauge galvanized steel.
 - 6. Flat profile type F-265 for doors thru 14'0" wide by 12'0" high, fabricated of 22 gauge galvanized steel.
 - 7. Flat profile type F-265 for doors over 14'0" thru 20'0" wide, fabricated of 20 gauge galvanized steel.
 - 8. Flat profile type F-265 for doors over 20'0" thru 24'0" wide, fabricated of 18 gauge galvanized steel.
- D. Glazing: Fire-rated vision panels, four glazing panels 3" by 5/8"; FireLite glazing as manufactured by Nippon Electric Glass Co. and distributed by Technical Glass Products.)
- E. Finish:
 - 1. Galvanized Steel: Slats and hood shall be galvanized steel in accordance with ASTM A 525 and receive rust-inhibitive, roll coating process, including bonderizing, 0.2 mils thick baked-on prime paint, and 0.6 mils thick baked-on polyester (powder coated) top coat. Non-galvanized exposed ferrous surfaces shall receive one coat of rust-inhibitive primer.
 - 2. Stainless Steel: Slats shall be stainless steel with 2B mill finish.
- F. Color: Gray polyester top coat. Powder coating finish in color as selected by Architect from manufacturer's standard colors.
- G. Bottom Bar: Two galvanized structural steel angles 1-1/2" by 1-1/2" by 1/8" minimum.
- H. Guides: Roll-formed steel shapes attached to continuous steel wall angle for doors thru 12' wide. Three structural steel angles with minimum thickness of 3/16" for doors over 12' wide. Guides for between jamb doors shall be structural angles.
 - 1. Fastening Guides to Masonry Fire Walls: UL listed expansion anchors, or by through-bolts on soft brick or hollow block walls, or by bolts on steel jambs, or welded in accordance with manufacturer's listing.
 - 2. Fastening Guides to Non-Masonry Fire Walls: Comply with the manufacturer's listing.
- I. Brackets: Steel plate to support counterbalance, curtain and hood.
- J. Counterbalance: Helical torsion spring type. Counterbalance shall be housed in a steel tube or pipe barrel, supporting the curtain with deflection limited to 0.03" per foot of span. Counterbalance shall be adjustable by means of an adjusting tension wheel.

- K. Hood: 24 gauge galvanized primed steel minimum for wall openings thru 19' wide. 22 gauge galvanized primed steel for wall openings over 19' wide. Hood shall be equipped with thermally controlled, internal, galvanized steel flame baffle as required. Provide one intermediate support bracket for wall openings over 13'6" wide and two support brackets for wall openings over 19'0" wide.
- L. Electric Motor Operation: Provide UL listed electric operator, size as recommended by manufacturer to move door in either direction at not less than 2/3 foot nor more than 1 foot per second.
 - 1. Sensing Edge Protection: Electric sensing edge.
 - 2. Operator Controls: Push-button and key operated control stations with open, close, and stop buttons for surface, for interior location.
 - 3. Special Operation: Vehicle detector operation.
- M. Automatic Closure: Provide automatic closing in fire conditions to meet applicable code.
- N. Locking: Cylinder locking bottom bar with mortise cylinders.

PART 3 EXECUTION

3.01 PREPARATION

- A. Take field dimensions and examine conditions of substrates, supports, and other conditions under which this work is to be performed. Do not proceed with work until unsatisfactory conditions are corrected.

3.02 INSTALLATION

- A. Strictly comply with manufacturer's installation instructions and recommendations. Coordinate installation with adjacent work to ensure proper clearances and allow for maintenance.
- B. Install rolling fire doors in compliance with requirements of NFPA 80. Test fire-release system and reset components after testing.
- C. Instruct Owner's personnel in proper operating procedures and maintenance schedule.

3.03 ADJUSTING AND CLEANING

- A. Test rolling fire doors for proper operation and adjust as necessary to provide proper operation without binding or distortion.
- B. Touch-up damaged coatings and finishes and repair minor damage. Clean exposed surfaces using non-abrasive materials and methods recommended by manufacturer of material or product being cleaned.

END OF SECTION

SECTION 08 71 00

DOOR HARDWARE – BURN TOWER ONLY

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section includes:
 - 1. Mechanical door hardware for the following:
 - a. Swinging doors.
 - 2. Cylinders for door hardware specified in other Sections.
- B. Related Sections:
 - 1. Section 08 11 13 "Hollow Metal Doors and Frames – Burn Tower only".

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction and installation details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Provide one full set of hardware for Set 1 for installation on mock-up listed in Section 08 11 13. If approved, hardware set may be used in final application.

1.04 INFORMATIONAL SUBMITTALS

- A. Warranty: Special warranty specified in this Section.

1.05 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of door hardware to include in maintenance manuals. Include final hardware schedule.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: Supplier of products and an employer of workers trained and approved by product manufacturers and an Architectural Hardware Consultant who is available during the course of the Work to consult with Contractor, Architect, and Owner about door hardware and keying.
 - 1. Warehousing Facilities: In Project's vicinity.
 - 2. Scheduling Responsibility: Preparation of door hardware and keying schedules.
- B. Source Limitations: Obtain each type of door hardware from a single manufacturer.
- C. Means of Egress Doors: Latches do not require more than 15 lbf to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.
- D. Accessibility Requirements: For door hardware on doors in an accessible route, comply with the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.
 - 1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf.
 - 2. Comply with the following maximum opening-force requirements:
 - a. Interior, Non-Fire-Rated Hinged Doors: 5 lbf applied perpendicular to door.
 - 3. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than 1/2 inch high.
 - 4. Adjust door closer sweep periods so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches from the latch, measured to the

leading edge of the door.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.
- B. Tag each item or package separately with identification coordinated with the final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.
- C. Deliver keys to manufacturer of key control system for subsequent delivery to Owner.

1.08 COORDINATION

- A. Installation Templates: Distribute for doors, frames, and other work specified to be factory prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
- B. Security: Coordinate installation of door hardware, keying, and access control with Owner's security consultant.

1.09 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including excessive deflection, cracking, or breakage.
 - b. Faulty operation of doors and door hardware.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
 - 2. Warranty Period: Three years from date of Final Completion, unless otherwise indicated.
 - a. Exit Devices: Two years from date of Final Completion.

PART 2 PRODUCTS

2.01 SCHEDULED DOOR HARDWARE

- A. Provide door hardware for each door as scheduled on Sheet BT4.05 to comply with requirements in this Section.
 - 1. Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and named manufacturers' products.
 - 2. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.
- B. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of door hardware are indicated in Part 3 "Door Hardware Schedule" Article. Products are identified by using door hardware designations, as follows:
 - 1. Named Manufacturers' Products: Manufacturer and product designation are listed for each door hardware type required for the purpose of establishing minimum requirements. Manufacturers' names are abbreviated in Part 3 "Door Hardware Schedule" Article.

2.02 HINGES

- A. Hinges: BHMA A156.1. Provide template-produced hinges for hinges installed on hollow-metal doors and hollow-metal frames. Provide stainless steel hinges for ALL doors.

2.03 MECHANICAL LOCKS AND LATCHES

- A. Lock Functions: As indicated in door hardware schedule.

- B. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:
 - 1. Mortise Locks: Minimum 3/4-inch latchbolt throw.
 - 2. Deadbolts: Minimum 1-inchbolt throw.
- C. Lock Backset: 2-3/4 inches, unless otherwise indicated.
- D. Strikes: Provide manufacturer's standard strike for each lock bolt or latchbolt complying with requirements indicated for applicable lock or latch and with strike box and curved lip extended to protect frame; finished to match lock or latch.

2.04 SURFACE BOLTS

- A. Surface Bolts: BHMA A156.16.

2.05 MANUAL FLUSH BOLTS

- A. Manual Flush Bolts: BHMA A156.16; minimum 3/4-inch throw; designed for mortising into door edge.

2.06 LOCK CYLINDERS

- A. Lock Cylinders: Tumbler type, constructed from brass or bronze, stainless steel, or nickel silver.
 - 1. Manufacturer: Same manufacturer as for locking devices.
- B. Construction Master Keys: Provide cylinders with feature that permits voiding of construction keys without cylinder removal. Provide 10 construction master keys.

2.07 KEYING

- A. Keying System: Factory registered, complying with guidelines in BHMA A156.28, Appendix A. Incorporate decisions made in keying conference.
 - 1. Existing System:
 - a. Master key or grand master key locks to Owner's existing system.
 - 2. Keyed Alike: Key all cylinders to same change key.
- B. Keys: Brass.
 - 1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:
 - a. Notation: "DO NOT DUPLICATE." and/or other information to be furnished by Owner.

2.08 DOOR GASKETING

- A. Door Gasketing: BHMA A156.22; air leakage not to exceed 0.50 cfm per foot of crack length for gasketing other than for smoke control, as tested according to ASTM E 283; with resilient or flexible seal strips that are easily replaceable and readily available from stocks maintained by manufacturer.

2.09 AUXILIARY DOOR HARDWARE

- A. Auxiliary Hardware: BHMA A156.16.

2.10 FABRICATION

- A. Manufacturer's Nameplate: Do not provide products that have manufacturer's name or trade name displayed in a visible location except in conjunction with required fire-rated labels and as otherwise approved by Architect.
 - 1. Manufacturer's identification is permitted on rim of lock cylinders only.
- B. Base Metals: Produce door hardware units of base metal indicated, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware

units and BHMA A156.18.

- C. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine, wood, and sheet metal screws. Provide screws that comply with commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated.
 - 1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.
 - 2. Spacers or Sex Bolts: For through bolting of hollow-metal doors.
 - 3. Gasketing Fasteners: Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

2.11 FINISHES

- A. Provide finishes complying with BHMA A156.18 as indicated in door hardware schedule.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved samples and are assembled or installed to minimize contrast.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Steel Doors and Frames: For surface applied door hardware, drill and tap doors and frames according to ANSI/SDI A250.6.

3.03 INSTALLATION

- A. Mounting Heights: Mount door hardware units at heights to comply with the following unless otherwise indicated or required to comply with governing regulations.
 - 1. Standard Steel Doors and Frames: ANSI/SDI A250.8.
- B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing. Do not install surface-mounted items until finishes have been completed on substrates involved.
 - 1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
 - 2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
- C. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than

the number recommended by manufacturer for application indicated or one hinge for every 30 inches of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.

- D. Lock Cylinders: Install construction cores to secure building and areas during construction period.
 - 1. Replace construction cores with permanent cores as directed by Owner.
 - 2. Furnish permanent cores to Owner for installation.
- E. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
- F. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.

3.04 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3.05 CLEANING AND PROTECTION

- A. Clean adjacent surfaces soiled by door hardware installation.
- B. Clean operating items as necessary to restore proper function and finish.
- C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Final Completion.

END OF SECTION

SECTION 09 72 16
DRY ERASE WALLCOVERING

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. Dry Erase Wallcovering
- B. Accessories

1.02 RELATED SECTIONS

- A. Section 09 26 00 – Gypsum Board Assemblies: Wall substrates
- B. Section 09 90 00 – Painting: Preparation and priming of substrate surfaces.
- C. Section 09 72 00 – Wallcovering

1.03 REFERENCES

- A. American Society for Testing and Materials (ASTM)
 - 1. E 84-01 Test method for surface burning characteristics of building materials.
- B. Gypsum Association
 - 1. GA-14-M-97 Recommended levels of gypsum board.

1.04 SUBMITTALS

- A. Manufacturer's product data and installation instructions for dry erase wallcovering, adhesive, and accessories required.
- B. Manufacturer's written product data indicating compliance with specified materials required.
- C. Manufacturer's written installation instructions.
- D. Manufacturer's written instructions for recommended maintenance of dry erase wallcovering required.

1.05 QUALITY ASSURANCE

- A. Applicator: Installation by skilled commercial wallcovering applicators with no less than five years of documented experience installing dry erase wallcovering required.
- B. Composition: Provide woven, fabric backed, pigmented vinyl laminated with a dry erase clear film.
- C. Fire Hazard Classification: Provide materials that comply with Class A fire rating when tested in accordance with ASTM E84-01. Identify components with markings from testing and inspection organization.

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver dry erase wallcovering to the project site in unbroken and undamaged original factory wrappings and clearly labeled with the manufacturer's identification label and lot number.
- B. Store materials in a clean, dry storage area with temperature maintained above 55 degrees F with normal humidity.
- C. Store material in a flat position to prevent damage to roll ends. Do not cross stock material. Support material off the floor in a manner to prevent sagging, warping and creasing.

1.07 PROJECT CONDITIONS

- A. Do not apply dry erase wallcoverings when surface and ambient temperatures are outside the temperature ranges required by the wallcovering manufacturer.
- B. Provide continuous ventilation and heating facilities to maintain substrate surface and ambient temperatures above 55 degree F unless required otherwise by manufacturer's instructions.
- C. Apply adhesive when substrate surface temperature and ambient temperature is above 55 degrees F and relative humidity is below 40 percent.
- D. Maintain constant recommended temperature and humidity for at least 72 hours prior to and throughout the installation period, and for 72 hours after wallcovering installation completion.
- E. Provide not less than 80 foot-candles per square foot lighting level minimum measurement and height at substrate surfaces.

1.08 WARRANTY

- A. Submit manufacturer's limited ten-year written warranty against manufacturing defects.

1.09 MAINTENANCE

- A. Maintenance instructions: Include precautions against cleaning materials and methods that may be detrimental to finishes and performance.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. Wallcoverings: As indicted on the Finish Legend.
- B. Substitutions: Permitted under provisions of Section 01 16 00.

2.02 MATERIALS

- A. Acceptable Product: Speak Easy Dry Erase Wall Covering. www.speakeasydryerase.com
- B. Smooth, clear, dry erase surface over a vinyl material.
 - 1. Properties: 60 inches wide, 14 ounces per square yard, woven backing, 18.5 mils thickness. Designed as writable surface.
- C. Substitutions: Permitted under provisions of Section 01 16 00.

2.03 ACCESSORIES

- A. Adhesives: Heavy duty clay-based adhesive.
- B. Substrate Primer/Sealer: White pigmented acrylic/latex base primer specifically formulated for use with vinyl wallcoverings.
- C. Aluminum Tray:
 - 1. Clear satin anodized aluminum, blade tray for markers and erasers. Polished end edges requiring no end caps.
- D. Aluminum Trim:
 - 1. Clear satin anodized aluminum, beveled trim with attaching screws.
- E. Eraser
 - 1. Eraser with changeable erasing surface.
- F. Markers
 - 1. Multiple Color Markers. Specifically designated for use with the provided products.

PART 3 – EXECUTION

3.01 EXAMINATION

- A. Examine substrates and installation conditions to ensure surface conditions meet or exceed a Level 4 wall finish, GA-14-M-97 Recommended Levels of Gypsum Board Finish.
- B. Test substrates with suitable moisture meter and verify that moisture content does not exceed 5 percent.
- C. Verify substrate surfaces are clean, dry, smooth, structurally sound and free from surface defects and imperfections that would show through the finished surface.
- D. Evaluate all painted surfaces for the possibility of pigment bleed-through.
- E. Notify the contractor and architect in writing of any conditions detrimental to the proper and timely completion of the installation.
- F. Beginning of installation means acceptance of surface conditions.
- G. Installation over a minimum Level 4 wall surface is necessary.

3.02 INSTALLATION

- A. Acclimatize wallcovering to the area of installation a minimum of 72 hours before installation.
- B. Read and follow the instructions in the manufacturer's installation sheet contained in each shipment of the dry erase wallcovering.
- C. Examine all materials for pattern, color, quantity and quality as specified for the correct location prior to cutting.
- D. Adhesive: Use high quality, heavy duty, pre-mixed, strippable clay-based vinyl adhesive recommended for fabric backed vinyl wallcovering and approved by manufacturer.
- E. Primer: Use a high quality, white-pigmented acrylic/latex base primer specifically formulated for use with vinyl wallcoverings.
- F. Install each roll in sequence starting from the highest to the lowest number and in exact order as they are cut from the bolt.
- G. Install dry erase wallcovering panels in exact order as they are cut from the bolt. Reverse hang alternate strips. Do not crease the wallcovering.
- H. Install dry erase wallcovering horizontally using a level line. Using level or straight edge, double-cut the seam with a new razor or knife.
- I. When covering the entire wall, horizontal seams should be placed outside of the main writing area.
- J. Smooth wallcovering to the hanging surface using a clean paint roller or wallcovering smoothing tool wrapped in a clean, soft cloth to eliminate air bubbles, wrinkles, gaps and overlaps. Do not use hard, abrasive or sharp edge smoothing tools. Smooth material on the wall from the middle to the outside edge.
- K. Remove excess adhesive along finished seams immediately after each wallcovering strip is applied. Clean entire surface with warm, clean water and a natural sponge. Rinse thoroughly with water and towel dry. Change water often to maintain water cleanliness.
- L. Stop installation of material that is questionable in appearance and notify the manufacturer's representative for an inspection.

3.03 CLEAN-UP COMPLETION

- A. Upon completion of installation, wash the wallcovering with manufacturer provided cleaning solutions, then rinse thoroughly with clean water and towel dry prior to using.
- B. Upon completion of the work, remove surplus materials, rubbish and debris resulting from the wallcovering installation.

END OF SECTION

SECTION 09 90 00

PAINTS AND COATINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Surface preparation.
- B. Field application of paints, stains, varnishes, and other coatings.

1.02 RELATED SECTIONS

- A. Section 05 50 00 - Metal Fabrications: Shop-primed items.
- B. Division 23 - Mechanical Identification: Painted identification.
- C. Division 26 - Electrical Identification: Painted identification.

1.03 REFERENCES

- A. ASTM D 16 - Standard Terminology for Paint, Related Coatings, Materials, and Applications; 2000.
- B. ASTM D 4442 - Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Base Materials; 1992 (Reapproved 1997).
- C. AWI/AWMAC (QSI) - Architectural Woodwork Quality Standards Illustrated; Architectural Woodwork Institute and Architectural Woodwork Manufacturers Association of Canada; 2003.

1.04 DEFINITIONS

- A. Conform to ASTM D 16 for interpretation of terms used in this section.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on all finishing products.
- C. Manufacturer's Instructions: Indicate special surface preparation procedures and substrate conditions requiring special attention.
- D. Samples: Provide approval samples 24 inch x 24 inch of required specialty or "faux" finishes for Architect approval.

1.06 MOCK-UPS

- A. Provide mockups of all painted or stained surfaces. Mock-up may remain in place following approval of the Architect.

1.07 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience.
- B. Applicator Qualifications: Company specializing in performing the work of this section with minimum five years experience.

1.08 REGULATORY REQUIREMENTS

- A. Conform to applicable code for flame and smoke rating requirements for products and finishes.

1.09 DELIVERY, STORAGE, AND PROTECTION

- 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.

1.10 ENVIRONMENTAL REQUIREMENTS

- A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.
- B. Do not apply exterior coatings during rain or snow, or when relative humidity is outside the humidity ranges required by the paint product manufacturer.
- C. Minimum Application Temperatures for Latex Paints: 45 degrees F for interiors; 50 degrees F for exterior; unless required otherwise by manufacturer's instructions.
- D. Minimum Application Temperature for Varnish Finishes: 65 degrees F for interior or exterior, unless required otherwise by manufacturer's instructions.
- E. Provide lighting level of 80 ft candles measured mid-height at substrate surface.

1.11 EXTRA MATERIALS

- A. See Section 01 60 00 - Product Requirements, for additional provisions.
- B. Supply one gallons of each color; store where directed.
- C. Label each container with color in addition to the manufacturer's label.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Paints:
 - 1. Base Manufacturer: Sherwin Williams: www.sherwin-williams.com.
 - 2. Other Acceptable Manufacturers:
 - a. Duron, Inc: www.duron.com.
 - b. Glidden: www.glidden.com.
 - c. Benjamin Moore & Co: www.benjaminmoore.com.
 - d. Pittsburgh Paints: www.pittsburghpaints.com
 - e. Olympic Paint: www.olympic.com
- B. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 PAINTS AND COATINGS - GENERAL

- A. Paints and Coatings: Low or no VOC. Ready mixed, except field-catalyzed coatings. Prepare pigments:
 - 1. To a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating.
 - 2. For good flow and brushing properties.
 - 3. Capable of drying or curing free of streaks or sags.
- B. Specialty Finish Techniques: Coatings indicated on the drawings are to receive specialty or "faux" finishes matching approved submittals.

2.03 PAINT SYSTEMS - EXTERIOR

- A. Wood, Transparent, Varnish, Stain:
 - 1. Finish work in accordance with AWI/AWMAC Quality Standards Illustrated, Section 1500, System TR-2 (Transparent).
- B. Concrete/Masonry, Opaque, Alkyd, 3 Coat:
 - 1. One coat of block filler.
 - 2. Eggshell: Two coats of alkyd enamel.
- C. Gypsum Board and Plaster, Opaque, Latex, 3 Coat:
 - 1. One coat of latex primer sealer.
 - 2. Eggshell: Two coats of latex.
- D. Ferrous Metals, 2 Coat:
 - 1. Surface Preparation: SSPC SP6
 - 2. Primer: Organic zinc rich epoxy
 - 3. Top Coat: Aliphatic polyurethane, semi-gloss
- E. Galvanized Metals, Alkyd, 3 Coat:
 - 1. One coat galvanize primer.
 - 2. Eggshell: Two coats of alkyd enamel.
- F. Aluminum, Unprimed, Alkyd, 3 Coat:
 - 1. One coat etching primer.
 - 2. Eggshell: Two coats of alkyd enamel.

2.04 PAINT SYSTEMS - INTERIOR

- A. Wood, Opaque, Latex, 3 Coat:
 - 1. One coat of latex primer sealer.
 - 2. Eggshell: Two coats of latex enamel.
- B. Wood, Transparent, Varnish, Stain:
 - 1. Finish work in accordance with AWI/AWMAC Quality Standards Illustrated, Section 1500, System TR-2 (Transparent).
- C. Concrete/Masonry, Opaque, Alkyd, 3 Coat:
 - 1. One coat of block filler.
 - 2. Eggshell: Two coats of alkyd enamel.
- D. Ferrous Metals, Unprimed, Alkyd, 3 Coat:
 - 1. One coat of alkyd primer.
 - 2. Eggshell: Two coats of alkyd enamel.
- E. Ferrous Metals, Primed, Alkyd, 2 Coat:
 - 1. Touch-up with alkyd primer.
 - 2. Eggshell: Two coats of alkyd enamel.
- F. Galvanized Metals, Alkyd, 3 Coat:
 - 1. One coat galvanize primer.
 - 2. Eggshell: Two coats of alkyd enamel.

- G. Aluminum, Unprimed, Alkyd, 3 Coat:
 - 1. One coat etching primer.
 - 2. Eggshell: Two coats of alkyd enamel.
- H. Gypsum Board/Plaster, Latex-Acrylic, 3 Coat:
 - 1. One coat of alkyd primer sealer.
 - 2. Eggshell: Two coats of latex-acrylic enamel.
- I. Fabrics/Insulation Jackets, Alkyd, 3 Coat:
 - 1. One coat of alkyd primer sealer.
 - 2. Eggshell: Two coats of alkyd enamel.
- J. Specialty or "Faux" Finishes: Provide specialty finishes using application techniques required to match approved samples.

2.05 ACCESSORY MATERIALS

- A. Accessory Materials: Linseed oil, shellac, turpentine, paint thinners and other materials not specifically indicated but required to achieve the finishes specified; commercial quality.
- 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. Plaster and Gypsum Wallboard: 12 percent.
 - 2. Masonry, Concrete, and Concrete Unit Masonry: 12 percent.
 - 3. Interior Wood: 15 percent, measured in accordance with ASTM D 4442.
 - 4. Exterior Wood: 15 percent, measured in accordance with ASTM D 4442.

3.02 PREPARATION

- A. Surface Appurtenances: Remove electrical plates, hardware, light fixture trim, escutcheons, and fittings prior to preparing surfaces or finishing.
- B. Surfaces: Correct defects and clean surfaces which affect work of this section.
- C. Marks: Seal with shellac those which may bleed through surface finishes.
- D. Impervious Surfaces: Remove mildew by scrubbing with solution of tetra-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.
- E. Concrete and Unit Masonry Surfaces to be Painted: Remove dirt, loose mortar, scale, salt or alkali powder, and other foreign matter. Remove oil and grease with a solution of tri-sodium phosphate; rinse well and allow to dry. Remove stains caused by weathering of corroding metals with a solution of sodium metasilicate after thoroughly wetting with water. Allow to dry.

- F. Gypsum Board Surfaces to be Painted: Fill minor defects with filler compound. Spot prime defects after repair.
- G. Insulated Coverings to be Painted: Remove dirt, grease, and oil from canvas and cotton.
- H. Aluminum Surfaces to be Painted: Remove surface contamination by steam or high pressure water. Remove oxidation with acid etch and solvent washing. Apply etching primer immediately following cleaning.
- I. Galvanized Surfaces to be Painted: Remove surface contamination and oils and wash with solvent. Apply coat of etching primer.
- J. Uncoated Steel and Iron Surfaces to be Painted: Remove grease, mill scale, weld splatter, dirt, and rust. Where heavy coatings of scale are evident, remove by power tool wire brushing or sandblasting; clean by washing with solvent. Apply a treatment of phosphoric acid solution, ensuring weld joints, bolts, and nuts are similarly cleaned. Prime paint entire surface; spot prime after repairs.
- K. Shop-Primed Steel Surfaces to be Finish Painted: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces.
- L. Interior Wood Items to Receive Opaque Finish: Wipe off dust and grit prior to priming. Seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after primer has dried; sand between coats. Back prime concealed surfaces before installation.
- M. Interior Wood Items to Receive Transparent Finish: Wipe off dust and grit prior to sealing, seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after sealer has dried; sand lightly between coats. Prime concealed surfaces with gloss varnish reduced 25 percent with thinner.
- N. Exterior Wood to Receive Opaque Finish: Remove dust, grit, and foreign matter. Seal knots, pitch streaks, and sappy sections. Fill nail holes with tinted exterior calking compound after prime coat has been applied. Back prime concealed surfaces before installation.
- O. Metal Doors to be Painted: Prime metal door top and bottom edge surfaces.

3.03 APPLICATION

- A. Apply products in accordance with manufacturer's instructions.
- B. Where adjacent sealant is to be painted, do not apply finish coats until sealant is applied.
- C. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.
- D. Apply each coat to uniform appearance. Apply each coat of paint slightly darker than preceding coat unless otherwise approved.
- E. Sand wood surfaces lightly between coats to achieve required finish.
- F. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.
- G. Where clear finishes are required, tint fillers to match wood. Work fillers into the grain before set. Wipe excess from surface.

3.04 FINISHING MECHANICAL AND ELECTRICAL EQUIPMENT

- A. Refer to Division 15 and Division 16 for schedule of color coding of equipment, duct work, piping, and conduit.
- B. Paint shop-primed equipment, where indicated.
- C. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.
- D. Finish equipment, piping, conduit, and exposed duct work in utility areas in colors according to the color coding scheme indicated.
- E. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.05 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for general requirements for field inspection.

3.06 CLEANING

- A. Collect waste material which may constitute a fire hazard, place in closed metal containers, and remove daily from site.

3.07 SCHEDULE - SURFACES TO BE FINISHED

- A. Do Not Paint or Finish the Following Items:
 - 1. Items fully factory-finished unless specifically noted.
 - 2. Fire rating labels, equipment serial number and capacity labels.
 - 3. Stainless steel items.
- B. Mechanical and Electrical: Use paint systems defined for the substrates to be finished.
 - 1. Paint all insulated and exposed pipes occurring in finished areas to match background surfaces, unless otherwise indicated.
 - 2. Paint shop-primed items occurring in finished areas.
 - 3. Paint interior surfaces of air ducts and convector and baseboard heating cabinets that are visible through grilles and louvers with one coat of Eggshell black paint to visible surfaces.
 - 4. Paint dampers exposed behind louvers, grilles, and convector and baseboard cabinets to match face panels.
- C. Paint both sides and edges of plywood backboards for electrical and telephone equipment before installing equipment.

END OF SECTION

SECTION 09 96 53
ELASTOMERIC COATING

PART I - GENERAL

1.01 SECTION INCLUDES

- A. Elastomeric coating over exterior concrete panels.

1.03 SUBMITTALS

- A. Submit in accordance with Section 01 30 00.
- B. Manufacturer's Information
 - 1. Submit manufacturer's product information and specifications. Include application instructions.

1.04 QUALITY ASSURANCE

- A. Qualifications
 - 1. Materials shall be manufactured at a facility covered by a current ISO 9001:2000 certification. Certification of the facility shall be done by a registrar accredited by the American National Standards Institute, Registrar Accreditation Board (ANSI-RAB).
 - 2. The applicator shall be knowledgeable in the application of exterior acrylic and elastomeric architectural finishes and coatings and have five years of documented experience.
 - 3. The applicator shall verify that the proposed substrate is acceptable prior to application of elastomeric coatings.

1.05 DELIVERY, STORAGE AND HANDLING

- A. All materials to be delivered to the job site in the original, unopened packages with labels intact. Upon arrival, materials shall be inspected for physical damage, freezing or overheating. Questionable materials shall not be used. Store in a cool, dry location, out of direct sunlight and protected from weather and other damage.
- B. Minimum storage temperature as recommended by coating manufacturer.

1.06 JOB CONDITIONS

- A. Environmental Conditions:
 - 1. The ambient air and wall temperatures shall be minimum 40 °F for application of elastomeric finishes. The temperature shall remain so for at least 24 hours thereafter, or longer if necessary for the materials to be sufficiently dried.
- B. Protection
 - 1. Adjacent areas/materials shall be protected from damage, drops and spills during the application of materials.
 - 2. The materials shall be protected by permanent or temporary means from weather and other damage, prior to during, and immediately after application. Care must be taken to prevent condensation and/or heat buildup when using tarp or plastic to prevent damage to the materials.
- C. Sequencing and Scheduling:
 - 1. Application of the elastomeric materials shall be coordinated with other construction trades.
 - 2. Sufficient labor and equipment shall be employed to ensure a continuous operation, free of cold joints, texture variations and scaffold lines.

1.07 LIMITED MATERIALS WARRANTY

- A. Manufacturer five (5) year Limited Materials Warranty.

PART 2 - PRODUCTS

2.01 COMPONENTS

- A. Drawings and specifications are based on manufacturer's literature from Dryvit Systems Inc. unless otherwise indicated. Other manufacturers to comply with the minimum levels of material and detailing indicated on the drawings and in the specifications and in conformance with provisions of Section 01 60 00 – Product Requirements. www.dryvit.com
- B. Acceptable Product: Elastomeric Finishes and Coatings
 - 1. Weatherlastic® Sandpebble: A 100% acrylic based finish utilizing an elastomeric binder with a pebble like texture.
- C. Weathercoat Acrylic Coating: A smooth, nontextured 100% acrylic emulsion based exterior coating.
- D. Weatherprime Acrylic Primer: A pigmented, exterior acrylic primer.
- E. Weatherpatch Patching Compound: A flexible, non-shrink, elastomeric patching compound available in brush and knife grades.

2.02 MATERIALS

- A. Water: Shall be clean and potable.

2.03 EQUIPMENT

- A. Mixing shall be done with a clean Goldblatt Jiffler Mixer #15311H7 or equivalent powered by a ½ in drill at 400-500 RPM.
- B. Tools associated with the plastering and painting trades.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examination of Substrate.
 - 1. Ensure that the substrate is of a type and condition listed in Section 1.05.B.
- B. Ensure that minimum application temperatures are met per Section 1.07.B.

3.02 SUBSTRATE PREPARATION

- A. Noncoated Surfaces
 - 1. Surfaces shall be cleaned and free of dirt, dust, form release agents or other foreign matter which may interfere with the bond of a finish coating.
 - 2. Loose, delaminated or spalled areas shall be repaired with an appropriate cementitious patching compound and allowed to cure a minimum of 7 days.
 - 3. New concrete shall cure for a minimum of 28 days prior to application of the elastomeric products.
 - 4. Prime surfaces with acrylic primer.

5. Terminations and juncture of dissimilar materials:
 - a. Caulk as necessary using compatible sealant.
 - b. Sealant shall be compatible with elastomeric products.
 - c. Elastomeric materials shall be fully dried prior to sealant installation.
- B. Concrete
 1. Concrete to be allowed to cure a minimum of 28 days prior to application of surface coatings.
 2. Surfaces to be free of dirt, dust, form release agents, efflorescence, curing compounds, etc.
 3. Concrete to be cleaned by acid etching the surface to ensure a proper bond of surface coatings.
 4. Apply acrylic primer to the concrete surface and allow to dry.
- C. Cracks shall be treated as follows:
 1. Static cracks up to .8 mm (1/32 in) can be bridged by elastomeric finishes without special treatment.
 2. Static cracks up to 3 mm (1/8 in) in width.
 - a. Remove all loose material and clean the crack.
 - b. Apply knife or brush grade patching compound directly over the crack and feather out a minimum of 102 mm (4 in) on each side. Provide patching compound recommended by manufacturer of elastomeric coating.
 3. Static cracks 3 mm to 6.4 mm (1/8 in to 1/4 in) wide.
 - a. Chip or grind out crack to a minimum 6.4 mm (1/4 in) wide by 6.4 mm (1/4 in) deep groove.
 - b. Clean and remove all loose materials.
 - c. Fill groove with knife grade patching compound.
 - d. Bridge crack with brush grade patching compound. Apply at approximately 6.4 mm (1/4 in) thickness over the crack and feather out a minimum of 102 mm (4 in) on each side.
 4. Static cracks over 6.4 mm (1/4 in) wide.
 - a. Clean and remove all loose and unsound material from crack.
 - b. Repair crack with non-shrinking cementitious patching mortar or cement plaster mix and allow to cure a minimum of 7 days.
 - c. Coat with primer and top dress with brush grade patching if necessary.
 5. Dynamic cracks 1.6 mm to 13 mm (1/16 in to 1/2 in) wide.
 - a. Chip or grind out the crack so that the width is equal to the depth, but not less than 6.4 mm (1/4 in).
 - b. Clean and remove all loose material from crack.
 - c. Fill the crack with a high grade urethane sealant. Tool into joint and allow to cure minimum 24 hours.
 - d. Apply a coat of brush grade patching compound over the crack and feather out to a minimum of 102 mm (4 in) on each side.
 6. Prime patched surfaces with acrylic primer.

3.03 ELASTOMERICIC FINISH APPLICATION

- A. The substrate and substrate preparation shall be inspected by the contractor to ensure it is in compliance with this specification.
- B. Mixing
 1. Mix until a uniform workable consistency is attained.
- C. General
 1. The elastomericic finish can be brush, spray or trowel applied in accordance with specific product instructions.
 2. No additives to be added under any circumstances.

3. The finish shall be applied to the entire wall surface in a continuous application to a natural break.
 4. Finish shall be protected from airborne contamination such as dust, soot, etc. and from weather and other damage until fully dried.
- D. Weatherlastic Quarzputz, Sandpebble, Sandpebble Fine
1. A tight coat shall be applied to the base coat. When trowel applied, leveling and texture shall take place in one operation.
 2. The thickness shall be not greater than 1 1/2 times the thickness of the largest aggregate.

3.04 CLEAN-UP

- A. Materials left over by the applicator at the job site shall be removed by the applicator.
- B. The applicator shall clean adjacent materials and surfaces and the work area of foreign materials resulting from their work.

END OF SECTION

SECTION 10 14 23

INTERIOR SIGNS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Unframed signs, with embossed face, for interior applications.
- B. Vinyl cut letters for stick-on application.

1.02 QUALITY ASSURANCE

- A. Supplier: Obtain all products in this section from a single supplier.
- B. Regulatory Requirements: Products shall meet requirements of the Americans With Disabilities Act Accessibility Guidelines (ADAAG) and local amendments and modifications.
- C. Installer: Installation shall be performed by installer specialized and experienced in work similar to that required for this project.

1.03 SUBMITTALS

- A. Submit in accordance with requirements of section 01 30 00.
- B. Product Data: Submit product data for specified products. Include material details for each sign specified.
- C. Shop Drawings: Submit shop drawings showing layout, profiles, and product components, including dimensions, anchorage, and accessories.
- D. Samples: Submit supplier's standard color chart for selection purposes and selected colors for verification purposes.
- E. Installation: Submit supplier's installation instructions.
- F. Closeout Submittals:
 - 1. Submit operation and maintenance data for installed products, including precautions against harmful cleaning materials and methods.
 - 2. Submit warranty documents specified herein.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Comply with manufacturer's ordering instructions and lead time requirements to avoid construction delays.
- B. Deliver products in manufacturer's original, unopened, undamaged containers with identification labels intact.
- C. Store products protected from weather, temperature, and other harmful conditions as recommended by supplier.
- D. Handle products in accordance with manufacturer's instructions.

1.05 WARRANTY

- A. Project Warranty: Comply with requirements of Division 1.
- B. Manufacturer's Warranty: Submit manufacturer's standard warranty document executed by authorized company official.
- C. Warranty Period: One year from product ship date.

PART 2 PRODUCTS

2.01 SIGNAGE SYSTEMS

- A. Acceptable Manufacturers: Interior sign products indicated in this section are manufactured by ASI-Modulex and establish a standard of quality for products of this section. Substitutions permitted under provisions of Section 01 60 00. www.asimodullex.com
- B. Acceptable Product: EmBoss ADA-Ready Sign System, manufactured by ASI-Modulex with requirements indicated for materials, thickness, finish colors, designs, shapes, sizes and details.
 - 1. Provide signage as required by accessibility regulations and requirements of authorities having jurisdiction. These include, but are not limited to, the following:
 - a. Illuminated Exit Signs: Refer to Division 16.
 - b. Fire Doors: At horizontal exits
 - c. Room Capacity: For assembly rooms
 - d. Elevator Signs: At all lobbies.
 - e. Stairway Identification: At all stairs
 - f. Accessible Restrooms: At all restrooms except those accessible through private offices.
 - g. Signs for Accessible Spaces: As determined by Architect.

2.02 SIGN MATERIALS

- A. Mounting Panel: Acrylic.
- B. Face: Vacuum formed 1.5 mil, clear, scratch resistant PVC/vinyl acetate bonded to acrylic mounting panel.

2.03 FABRICATION OPTIONS

- A. Tactile Graphics and Text:
 - 1. Fabrication process: Provide tactile copy and grade 2 Braille raised 1/32 inch minimum from plaque first surface by manufacturer's vacuum formed embossing process.
 - 2. Provide lettering and graphics precisely formed, uniformly opaque to comply with relevant ADA regulations and requirements indicated for size, style, spacing, content, position, and colors.
- B. Mounting Panel Options:
 - 1. .080 inch thick matte finished acrylic.
- C. Background Appearance Options:
 - 1. Solid color: Select from manufacturer's standard range.
 - 2. Subsurface custom graphics.
- D. Tactile Lettering and Graphics Color Options: Select from 3M standard vinyl colors.
- E. Overall panel size: 6 x 8 inches.
- F. Shape: Standard.
- G. Selected from manufacturer's standard letter styles and color charts.

2.04 INSTALLATION METHODS

- A. System VT, vinyl tape.

2.05 VINYL LETTERS

- A. Acceptable Manufacturers for Vinyl Letters:
 - 1. Manufacturer capable of producing precision cut vinyl letters, adhesive application.
- B. Letter font and size: As indicated on drawings.
- C. Letter color: As selected by Architect from manufacturer's standard range of colors.

2.06 FABRICATION - GENERAL

- A. General: Comply with requirements indicated for materials, thicknesses, finishes, colors, designs, shapes, sizes, and details of construction.
- B. Preassemble signs in the shop to the greatest extent possible to minimize field assembly. Disassemble signs only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation, in a location not exposed to view after final assembly.
- C. Conceal fasteners if possible; otherwise, locate fasteners to appear inconspicuous.
- D. Form panels to required size and shape. Comply with requirements indicated for design, dimensions, finish, color, and details of construction.
- E. Coordinate dimensions and attachment methods to produce message panels with closely fitting joints. Align edges and surfaces with one another in the relationship indicated.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Site Verification of Conditions: Verify installation conditions previously established under other sections are acceptable for product installation in accordance with manufacturer's instructions.
- B. Scheduling of installation by Owner or it's representative implies that substrate and conditions are prepared and ready for product installation. Proceeding with installation implies installer's acceptance of substrate and conditions.

3.02 INSTALLATION

- A. Install product in accordance with supplier's instructions.
- B. Install product in locations indicated using mounting methods recommended by sign manufacturer and free from distortion, warp, or defect adversely affecting appearance.
- C. Install product level, plumb, and at heights indicated.
- D. Install product at heights to conform to Americans with Disabilities Act Accessibility Guidelines (ADAAG) and applicable local amendments and regulations.
- E. Install signs within the following tolerances and in accordance with manufacturer's recommendations:
 - 1. Interior Signs: Within 1/4 inch vertically and horizontally of intended location.

3.03 CLEANING, PROTECTION AND REPAIR

- A. Repair scratches and other damage which might have occurred during installation. Replace components where repairs were made but are still visible to the unaided eye from a distance of 5 feet.
- B. Remove temporary coverings and protection to adjacent work areas. Clean signs in accordance with manufacturer's instructions. Remove construction debris from project in accordance with provisions in Division 1

3.04 SIGN SCHEDULE

- A. Schedule: Refer to schedule on drawings.

END OF SECTION

SECTION 10 28 13

TOILET ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Toilet accessories.

1.02 SUBMITTALS

- A. Submit in accordance with provisions of Section 01 30 00 - Administrative Requirements.
- B. Product Data: Include construction details, material descriptions and thicknesses, dimensions, profiles, fastening and mounting methods, specified options, and finishes for each type of accessory specified.
- C. Setting Drawings: For cutouts required in other work; include templates, substrate preparation instructions, and directions for preparing cutouts and installing anchoring devices.
- D. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required. Use designations indicated in the Toilet Accessories Schedule and room designations indicated on Drawings in product schedule.

1.03 QUALITY ASSURANCE

- A. Source Limitations: Provide products of same manufacturer for each type of accessory unit and for units exposed to view in same areas, unless otherwise approved by Architect.

1.04 REFERENCES

- A. ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 1997a.
- B. ASTM A 269 - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service; 1998.
- C. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 1999a.
- D. ASTM A 666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 1999.
- E. ASTM C 1036 - Standard Specification for Flat Glass; 1991 (Reapproved 1997).
- F. GSA CID A-A-3002 - Mirrors, Glass; U.S. General Services Administration; 1996.
- G. ANSI/ICC A117.1 - American National Standard for Accessible and Usable Buildings and Facilities; International Code Council; 1998.
- H. TEXAS ACCESSIBILITY STANDARDS (TAS) of the Architectural Barriers Act Article 9102, Texas Civil Statutes.

1.05 COORDINATION

- A. Coordinate accessory locations with other work to prevent interference with clearances required for access by disabled persons, proper installation, adjustment, operation, cleaning, and servicing of accessories.
- B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

1.06 WARRANTY

- A. The Warranties submitted under this Section shall not deprive the Owner of other rights or remedies that the Owner may have under other provisions of the Contract Documents and the laws of governing jurisdictions and is in addition to and runs concurrently with other warranties made by the Contractor under requirements of the Contract Documents.
- B. Manufacturer's Mirror Warranty: Written warranty, executed by mirror manufacturer agreeing to replace mirrors that develop visible silver spoilage defects within minimum warranty period indicated.
 - 1. Minimum Warranty Period: 15 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide accessories by one of the following:
 - 1. American Specialties, Inc.
 - 2. Bobrick Washroom Equipment, Inc.
 - 3. Gamco Specialty Accessories: www.gamcousa.com
- B. Substitutions: Permitted under provisions of Section 01 60 00.

2.02 MATERIALS

- A. Drawings and specifications are based on manufacturer's literature from the manufacturer listed on the drawings accessory schedule unless otherwise indicated. Other manufacturers to comply with the minimum levels of material and detailing indicated on the drawings and in conformance with provisions of Section 01 60 00 – Product Requirements.
- B. Accessories - General: Shop assembled, free of dents and scratches and packaged complete with anchors and fittings, steel anchor plates, adapters, and anchor components for installation.
 - 1. Grind welded joints smooth.
 - 2. Fabricate units made of metal sheet of seamless sheets, with flat surfaces.
- C. Keys: Provide 3 keys for each accessory to Owner; master key all lockable accessories.
- D. Stainless Steel Sheet: ASTM A 666, Type 304.
- E. Stainless Steel Tubing: ASTM A 269, Type 304 or 316.
- F. Galvanized Sheet Steel: Hot-dipped galvanized steel sheet, ASTM A 653/A 653M, with G90/Z275 coating.
- G. Mirror Glass: Float glass, Type I, Class 1, Quality q2 (ASTM C 1036), with silvering, copper coating, and suitable protective organic coating to copper backing in accordance with GSA CID A-A-3002.
- H. Adhesive: Two component epoxy type, waterproof.
- I. Fasteners, Screws, and Bolts: Hot dip galvanized, tamper-proof, security type.
- J. Expansion Shields: Fiber, lead, or rubber as recommended by accessory manufacturer for component and substrate.

2.03 TOILET ROOM ACCESSORIES

- A. TA-1 - Toilet Paper Dispenser:
 - 1. Product: Surface Mounted, B2892 manufactured by Bobrick
- B. TA-2 – Grab Bars:
 - 1. Length and configuration: L-shaped, 36 x 54 inches.
 - 2. Product: B-5837.99 (36" x 54") manufactured by Bobrick.
- C. TA-3 – Mirror Glass:
 - 1. Product: Surface Mounted, B-165 2448 manufactured by Bobrick
- D. TA-4 – Soap Dispenser:
 - 1. Product: Surface Mounted, 818615 manufactured by Bobrick
- E. TA-5 – Paper Towel and Waste Receptacle:
 - 1. Product: Surface Mounted, B3949 manufactured by Bobrick
- F. TA-6 – Sanitary Napkin Disposal:
 - 1. Product: Surface Mounted, B-254 manufactured by Bobrick
- G. TA-7 – Seat Cover Dispenser:
 - 1. Product: Surface Mounted, B221 manufactured by Bobrick
- H. TA-8 – Coat Hook:
 - 1. Product: HK2A-SSS manufactured by Doug Mockett Co.
- I. TA-9 - Combination Utility Shelf/Mop and Broom Holder: 18 gage stainless steel, Type 304.
 - 1. Hooks: 4, 16 gage stainless steel rag hooks.
 - 2. Mop/broom holders: 3 spring-loaded rubber cam holders.
 - 3. Length: 34 inches.
 - 4. Product: 9933 manufactured by Bradley.

2.04 FABRICATION

- A. Surface-Mounted Toilet Accessories: Unless otherwise indicated, fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with continuous stainless-steel hinge. Provide concealed anchorage where possible.
- B. Framed Glass-Mirror Units: Fabricate frames for glass-mirror units to accommodate glass edge protection material. Provide mirror backing and support system that permits rigid, tamper-resistant glass installation and prevents moisture accumulation.
 - 1. Provide galvanized steel backing sheet, not less than 0.034 inch(0.85 mm) and full mirror size, with nonabsorptive filler material. Corrugated cardboard is not an acceptable filler material.
- C. Mirror-Unit Hangers: Provide mirror-unit mounting system that permits rigid, tamper- and theft-resistant installation, as follows:
 - 1. One-piece, galvanized steel, wall-hanger device with spring-action locking mechanism to hold mirror unit in position with no exposed screws or bolts.
 - 2. Heavy-duty wall brackets of galvanized steel, equipped with concealed locking devices requiring a special tool to remove.
- D. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
- B. Secure mirrors to walls in concealed, tamper-resistant manner with special hangers, toggle bolts, or screws. Set units level, plumb, and square at locations indicated, according to manufacturer's written instructions for substrate indicated.
- C. Install grab bars to withstand a downward load of at least 250 lbf when tested according to method in ASTM F 446.

3.02 ADJUSTING AND CLEANING

- A. Adjust accessories for unencumbered, smooth operation and verify that mechanisms function properly. Replace damaged or defective items.
- B. Remove temporary labels and protective coatings.
- C. Clean and polish exposed surfaces according to manufacturer's written recommendations.

END OF SECTION

SECTION 12 67 23

BENCHES

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Aluminum Benches

1.02 RELATED WORK

- A. Examine contract documents for requirements that affect work of this section. Other specification divisions and sections that directly relate to the work of this section include, but are not limited to:

Division 03 – Concrete; Sections: Cast-in-Place Concrete

Division 31 – Earthwork; Sections: Excavation and Backfill and Establishment of Sub-Grade Elevations

Division 32 – Exterior Improvements; Sections: Athletic and Recreational Surfacing, Concrete and Asphalt

1.02 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Manufacturer must have a minimum of ten years experience in the design and manufacture of benches.
- B. Welders must conform to AWS standards.
- C. Source Quality Control: Mill Test Certification.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable.

1.04 WARRANTY

- A. Warranty shall guarantee benches to be free from defect in materials and workmanship for a period of 1 year under normal use. Warranty period shall begin on date of substantial completion for projects installed by manufacturer or its subcontractors.
- B. Anodized finish of plank extrusions shall be covered by a 5 year warranty against loss of structural strength or finish deterioration due to exposure to weather conditions or UV rays. Discoloration of mill finish aluminum due to galvanic reaction not covered.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. National Recreation Systems, Inc., Model # BE-PH
- B. Sturdisteel
- C. Sporstfield Specialties, Model # LGS-STAL-BRSP

2.02 DESIGN

- A. Design Loads:
 - 1. Live Loads: Uniform loading - Structure = 100 psf
Uniform loading - Seat = 120 plf
 - 2. Sway Loads: Perpendicular to seats = 10 plf
Parallel to seats = 24 plf

2.03 STEEL FRAME BENCHES

- A. Quantity and Size: Reference floor plan for dimensions.
- B. Surface Mounted
- C. Framework: Prefabricated galvanized steel spaced at 6'-0" intervals consisting of 2 -3/8" O.D. schedule 40 pipe with seat and back supports of 1/4" x 3" hot-rolled steel bar (ASTM A-36). Imbedded end of bench legs are formed to help prevent leg from twisting in the concrete footer. No mechanical fastening of seat supports or legs supports shall be permitted.
- D. Shop Connections: Welded to meet AWS standards.
- E. Seats and Backs: Nominal 2" x 10" anodized aluminum with anodized end caps.

2.04 MATERIALS / FINISHES

- A. Framework:
 - 1. Galvanized Steel: Structural fabrication with ASTM A-36 steel galvanized finish. Each frame shall be unit-welded, using gas metal arc welding (GMAW) according to AWS specifications (D1.1). After fabrication all steel is hot dipped galvanized to ASTM A-123 specifications.
- B. Extruded Aluminum:
 - 1. Seat and back planks: Aluminum alloy 6063-T6, clear anodized 204R1, AA-M10C22A31, Class II with a wall thickness nominally .078" for impact and deformation resistance.
- C. Accessories:
 - 1. Channel End Caps: Aluminum alloy 6063-T6, clear anodized 204R1, AA-M10C22A31, Class II.
 - 2. Hardware: Bolts and Nuts shall be hot dipped galvanized.

3. Hold Down Clip Assembly: Aluminum alloy 6063-T6 mill finish.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Aluminum benches with backrest and accessories shall be installed as recommended per manufacturer's written instructions and as indicated on the drawings. Concrete anchoring foundations to be determined by others based on local soil conditions and building codes.

SECTION 13 37 30
GAS-FIRED TRAINING SIMULATORS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 DESCRIPTION

- A. Vendor to design, fabricate, factory test, install, and site test after installation complete live burn fire simulator and simulator systems; including but not limited to the following specification sections, which are considered primary to the work of this specification.
- B. Vendor shall furnish and install all labor, material, equipment and accessories necessary for a complete installation of live burn fire simulator systems including but not limited to: interior props, valve cabinet assemblies, burner control assemblies, ventilation cabinet assemblies, smoke generators, ventilation systems, fans, flammable gas sensors, electrical cabinets, pilot assemblies, burn platforms, temperature sensors, ductwork, and all associated accessories for complete and operational live burn fire simulators. All components of any and all supplied systems to be factory tested prior to shipping. Upon complete assembly of the simulators, the vendor will arrange third party Field Certification by CSA International of the completed system.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Submit manufacturer's specifications, design data, installation and maintenance instructions.
- C. Shop Drawings: Submit drawings showing layout, dimensions and construction details.
- D. Certificates: Submit manufacturer certification that products furnished meet specification requirements.
- E. Maintenance Instructions: Provide instructions for maintenance of equipment and spare parts list.

1.04 QUALITY ASSURANCE

- A. Manufacturer shall have not less than five years experience manufacturing and installing specified equipment.
- B. Installation shall be provided by the manufacturer. Supervisor shall have not less than two years experience installing specified equipment.
- C. Provide third party certification of overall system and labeling in accordance with NFPA 1402, 2012 Edition, Chapter 10. Third party certification must meet or exceed CSA B149 standards.
- D. Pre-Delivery Testing:
 - 1. Testing of all simulator systems to ensure proper operation of all systems such as failure modes, control system, operational and safety functions, and associated control for pressure, temperature, and times.
 - 2. Provide a record of the above testing.
- E. On Site Testing:
 - 1. Insure all mechanical and electrical components are installed correctly.

2. Testing of all simulator systems to ensure all systems such as failure modes, control system, operational and safety functions, and associated pressures, temperature, and times.
3. Provide a record of the above testing

1.05 PRE-CONSTRUCTION MEETING

- A. Convene a pre-construction conference to review gas-fired training simulators equipment specifications and procedures with the Architect, Contractor, gas-fired training simulator equipment manufacturer's representative, Owner and other trades relevant to the work, prior to ordering materials.
- B. Notify Architect at least 48 hours prior to starting Work.
- C. Contractor shall review materials, details, etc. and submit a report including any revised details to Architect and Owner. Incorporate any revised details approved by Architect and Owner in the Project at no additional cost to Owner.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Packing and Shipping: Deliver materials to site in manufacturer's original unopened packaging with labels intact. Protect finished surfaces with removable wrapping or coating which will not bond when exposed to sunlight.
- B. Storage: Adequately protect against damage while stored at the site.
- C. Handling: Comply with manufacturer's instructions.

1.07 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Repair or replace any part of simulator, simulator system, and ventilation systems within a 12-month period from date of acceptance.
- C. During warranty, preventive maintenance service to be included.

PART 2 PRODUCTS

2.01 EQUIPMENT

- A. Gas-Fired Training Simulators
 1. Approved manufacturer:
 - a. Draeger Safety Solutions, 1259 Gardiners Road, Unit #2, Kingston, ON K7P 3J6, telephone (613) 384-0279, attention Trevor Flynn.
 2. **Simulators:**
 - a. Design, fabricate, furnish, and install each simulator which includes liquefied-petroleum gas ("LP Gas") fueled props with high and low burn capability and associated available fires as per the equipment list plus smoke production machines and all ventilation systems.
 - b. The water bath, burner pilot, pilot probes and associated piping to be fabricated in stainless steel. All burn platforms to be constructed of minimum 3/16" Corten carbon steel.
 - c. All piping inside control enclosures to be stainless steel.
 - d. Water bath and burner components to be stainless steel.
 3. **Smoke Generation:**
 - a. Machine capable of producing non-toxic smoke in sufficient quantity and quality to simulate actual fire conditions

- b. Smoke machines capable of operating independently of the live burn simulator.
 - c. All smoke generating machines to have automatic purge feature.
 - d. Furnish, fabricate and install smoke generating machines, nitrogen regulator, fluid tanks and associated piping for each smoke machine.
4. **Emergency Stops:**
- a. Install an emergency stop button at each exit for each burn simulator room.
 - b. Install emergency shutoff with each control device.
 - c. All gas to be automatically shut off and automatic purge to occur when emergency stop activated.
5. **Control System:**
- a. Provide control system based on modern industrial Touch screen and PLC technology with redundant relay safety.
 - b. The system is designed to be controlled from a central location, by remote wireless pendant, and iPad/Tablet portable control. The simulator system is activated at a central post, while fires are enabled remotely by wireless pendant or a cabled dead-man switch.
 - c. Simulator system props shall be able to fully function independently of each other.
6. **Pendants:**
- a. Each pendant required to be wireless with a dead man switch with full control of, at minimum, the fire and rollover effect.
 - b. Each pendant to be equipped with man-down or dead-man button that must be activated to allow fires to occur. Release of this button shall cause fires to extinguish within 3-5 seconds.
7. **Temperature Sensors:**
- a. Each simulator to have a temperature sensor at the 5' level.
 - b. Normal operating temperature is 500°F.
 - c. All gas to be automatically shut off and automatic purge to occur at 700°F.
8. **Ventilation System:**
- a. Each pilot to have its own separate air supply independent from main air supply.
 - b. Each simulator to have its own monitored combustion air supply.
 - c. Each simulator to have its own monitored exhaust ventilation system.
 - d. Automatic building purge to occur on initial startup, high temperature, high gas and emergency stop.
9. **Gas Monitoring:**
- a. Each simulator to be provided with a minimum of two direct measuring LEL gas sensors in the burn room.
 - b. Each interior gas equipment room to have a direct measuring LEL gas sensor.
 - c. Normal operating concentration to be less than 10% LEL.
 - d. All gas to be automatically shut off and automatic purge to occur at 25% LEL.
10. **Monitored Pilot Systems:**
- a. Each fire within each simulator shall have its own dedicated and electronically monitored pilot system.
 - b. Flame controllers shall be of the electrically conductive type.
11. **Consultation and Coordination:**
- a. Manufacturer to provide consultation and coordinate with the owner, architect, and its contractors for the design, engineering, installation and testing of the live burn fire simulator(s), ventilation system(s), smoke machines, and other associated information. This includes, but not limited to the required BTU requirements, fuel regulator, fuel distributor lines, electrical pull schedule, preferred stub-up location, and any other information necessary to complete the project.
 - b. Manufacturer to provide information of fire loads and flame areas for each burn room for the installation of building protection systems.

12. **Manuals:**

- a. Provide 2 manuals on the operations, service, troubleshooting and maintenance of simulators and system.
- b. Provide detailed preventative maintenance schedules.
- c. Provide USB drive with an electronic version of items 12a and 12b.

13. **Training:**

- a. Provide an authorized factory technician for 2 days of training for 10 personnel in the proper operation, maintenance and troubleshooting of the systems
- b. Service/replacement procedures, preventive maintenance procedures, and system maintenance to be included in the training. The minimum sections of training are; instructors, instructor/operators, preventative maintenance, and maintenance/repairs.

14. **List of Base Price Gas-Fired Simulators:**

- a. Burn Tower

BASE Unit	Available Fires	No. of Fire Zones	Fire Levels
Bedroom- 4 th Floor	Double Bed	2	Low/High
	Wall fire	1	Low/High
	Flashover	1	Single

15. **List of Add Alternate Gas-Fired Training Simulators:**

Add Alternate Simulator:

- a. Burn Tower

BASE Unit	Available Fires	No. of Fire Zones	Fire Levels
Industrial Prop	Industrial Base w/ 4 removable mock props	2	Low/High
	Wall fire	1	Low/High
	Flashover	1	Single

BASE Unit	
Draeger Outdoor Quad Prop	Contact Draeger for Information

16. Parts Cache of all parts that could wear in the first five (5) years as outlined in Drager's proposal. This will better assist the technician and the Owner in facilitating repairs quickly.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions: Examine subsurfaces to receive Work and report detrimental conditions in writing to Architect. Commencement of Work will be construed as acceptance of subsurfaces.

- B. Coordination: Coordinate with other work which affects, connects with, or will be concealed by this Work.
- C. Obtain approval of Architect for methods of attachment to structure.

3.02 INSTALLATION

- A. Installation shall be provided by the trained personnel employed by the manufacturer.
- B. Coordinate equipment of this Section to create a complete system capable of providing total gas-fired training simulator systems.
- C. The electrical and gas-fired simulator systems and ventilation systems must meet or exceed the applicable sections of the following codes, latest edition, for this type of installation:
 - 1. NFPA 54- National Fuel Gas Code
 - 2. NFPA 58- Liquefied Petroleum Code
 - 3. NFPA 70- National Electrical Code
 - 4. NFPA 86- Standards for Ovens and Furnaces
 - 5. NFPA 100 Series
 - 6. NFPA 1402- Guide to Building Fire Service Training Centers
 - 7. NFPA 1403
 - 8. ISO 9000-2001 Quality Standard Certification
 - 9. CAN/CGA B149.2- Canadian Gas Code
 - 10. CSA 22.2 No. 142 & No. 213- Process Control Equipment and Non-Incendive Equipment for Hazardous Locations
 - 11. CWB W59- Canadian Welding Bureau- Welding Standards

3.03 PROTECTION OF FINISHED WORK

- A. During the course of the Work and on completion of the Work, remove and dispose of excess materials, equipment and debris away from premises. Leave Work in clean condition in accordance with Section 01 50 00.

END OF SECTION

SECTION 21 10 00

WATER-BASED FIRE-SUPPRESSION SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Pipes, fittings, and specialties.
 - 2. Fire-protection valves.
 - 3. Fire-department connections.
 - 4. Sprinklers.
 - 5. Alarm devices.
 - 6. Manual control stations.
 - 7. Control panels.
 - 8. Pressure gages.

1.3 DEFINITIONS

- A. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175 psig maximum.

1.4 SYSTEM DESCRIPTIONS

- A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply through alarm valve. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included.

1.5 PERFORMANCE REQUIREMENTS

- A. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.
- B. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
 - 1. Provide fire-hydrant flow test records indicating the following conditions:
 - a. Date:
 - b. Time:
 - c. Performed by:
 - d. Location of Residual Fire Hydrant R:
 - e. Location of Flow Fire Hydrant F:
 - f. Static Pressure at Residual Fire Hydrant R:
 - g. Measured Flow at Flow Fire Hydrant F:
 - h. Residual Pressure at Residual Fire Hydrant R:
- C. Sprinkler system design shall be approved by authorities having jurisdiction.
 - 1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.

2. Sprinkler Occupancy Hazard Classifications:
 - a. Building Service Areas: Ordinary Hazard, Group 1.
 - b. Electrical Equipment Rooms: Ordinary Hazard, Group 1.
 - c. General Storage Areas: Ordinary Hazard, Group 1.
 - d. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
 - e. Office and Public Areas: Light Hazard.
 3. Minimum Density for system shall comply with NFPA 13.
 4. Maximum Protection Area per Sprinkler: Per UL listing.
- D. Seismic Performance: Sprinkler piping shall withstand the effects of earthquake motions determined according to NFPA 13.

1.6 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. LEED Submittal:
 1. Product Data for Credit EQ 4.1: For solvent cements and adhesive primers, including printed statement of VOC content and chemical components.
- C. Shop Drawings: For wet-pipe sprinkler systems. Include plans, elevations, sections, details, and attachments to other work.
 1. Wiring Diagrams: For power, signal, and control wiring.
- D. Delegated-Design Submittal: For sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- E. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 1. Domestic water piping.
 2. Items penetrating finished ceiling include the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
- F. Qualification Data: For qualified installer and professional engineer.
- G. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.
- H. Fire-hydrant flow test report.
- I. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
- J. Field quality-control reports.
- K. Operation and Maintenance Data: For sprinkler specialties to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications:

1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
 - a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.
- B. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- 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. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
 1. NFPA 13, "Installation of Sprinkler Systems."
 2. NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances."

1.8 COORDINATION

- A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

1.9 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

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

2.2 STEEL PIPE AND FITTINGS

- A. Standard Weight, Black-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.
- B. Schedule 30, Black-Steel Pipe: ASTM A 135; ASTM A 795/A 795M, Type E; or ASME B36.10M, wrought steel; with wall thickness not less than Schedule 30 and not more than Schedule 40. Pipe ends may be factory or field formed to match joining method.

2.3 LISTED FIRE-PROTECTION VALVES

- A. General Requirements:
 1. Valves shall be UL listed or FM approved.
 2. Minimum Pressure Rating for Standard-Pressure Piping: 175 psig.
- B. Ball Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International, Inc.
 - b. Victaulic Company.
 2. Standard: UL 1091 except with ball instead of disc.
 3. Valves NPS 1-1/2 and Smaller: Bronze body with threaded ends.
 4. Valves NPS 2 and NPS 2-1/2: Bronze body with threaded ends or ductile-iron body with grooved ends.
 5. Valves NPS 3: Ductile-iron body with grooved ends.
- C. Bronze Butterfly Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Fivalco Inc.
 - b. Global Safety Products, Inc.
 - c. Milwaukee Valve Company.
 2. Standard: UL 1091.
 3. Pressure Rating: 175 psig.
 4. Body Material: Bronze.
 5. End Connections: Threaded.
- D. Iron Butterfly Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International, Inc.
 - b. Fivalco Inc.
 - c. Global Safety Products, Inc.
 - d. Kennedy Valve; a division of McWane, Inc.
 - e. Milwaukee Valve Company.
 - f. NIBCO INC.
 - g. Pratt, Henry Company.
 - h. Shurjoint Piping Products.
 - i. Tyco Fire & Building Products LP.
 - j. Victaulic Company.
 2. Standard: UL 1091.
 3. Pressure Rating: 175 psig.
 4. Body Material: Cast or ductile iron.
 5. Style: Lug or wafer.
 6. End Connections: Grooved.
- E. Check Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AFAC Inc.
 - b. American Cast Iron Pipe Company; Waterous Company Subsidiary.
 - c. Anvil International, Inc.
 - d. Clow Valve Company; a division of McWane, Inc.
 - e. Crane Co.; Crane Valve Group; Crane Valves.
 - f. Fire-End & Croker Corporation.
 - g. Fire Protection Products, Inc.
 - h. Globe Fire Sprinkler Corporation.
 - i. Groeniger & Company.
 - j. Kennedy Valve; a division of McWane, Inc.
 - k. Matco-Norca.
 - l. Milwaukee Valve Company.
 - m. Mueller Co.; Water Products Division.

- n. NIBCO INC.
 - o. Potter Roemer.
 - p. Reliable Automatic Sprinkler Co., Inc.
 - q. Shurjoint Piping Products.
 - r. Tyco Fire & Building Products LP.
 - s. United Brass Works, Inc.
 - t. Venus Fire Protection Ltd.
 - u. Victaulic Company.
 - v. Viking Corporation.
 - w. Watts Water Technologies, Inc.
 - 2. Standard: UL 312.
 - 3. Pressure Rating: 250 psig minimum.
 - 4. Type: Swing check.
 - 5. Body Material: Cast iron.
 - 6. End Connections: Flanged or grooved.
- F. Bronze OS&Y Gate Valves:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Milwaukee Valve Company.
 - c. NIBCO INC.
 - d. United Brass Works, Inc.
 - 2. Standard: UL 262.
 - 3. Pressure Rating: 175 psig.
 - 4. Body Material: Bronze.
 - 5. End Connections: Threaded.
- G. Iron OS&Y Gate Valves:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Cast Iron Pipe Company; Waterous Company Subsidiary.
 - b. American Valve, Inc.
 - c. Clow Valve Company; a division of McWane, Inc.
 - d. Crane Co.; Crane Valve Group; Crane Valves.
 - e. Hammond Valve.
 - f. Milwaukee Valve Company.
 - g. Mueller Co.; Water Products Division.
 - h. NIBCO INC.
 - i. Shurjoint Piping Products.
 - j. Tyco Fire & Building Products LP.
 - k. United Brass Works, Inc.
 - l. Watts Water Technologies, Inc.
 - 2. Standard: UL 262.
 - 3. Pressure Rating: 250 psig minimum.
 - 4. Body Material: Cast or ductile iron.
 - 5. End Connections: Flanged or grooved.
- H. Indicating-Type Butterfly Valves:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International, Inc.
 - b. Fivalco Inc.
 - c. Global Safety Products, Inc.
 - d. Kennedy Valve; a division of McWane, Inc.
 - e. Milwaukee Valve Company.

- f. NIBCO INC.
 - g. Shurjoint Piping Products.
 - h. Tyco Fire & Building Products LP.
 - i. Victaulic Company.
 - 2. Standard: UL 1091.
 - 3. Pressure Rating: 175 psig minimum.
 - 4. Valves NPS 2 and Smaller:
 - a. Valve Type: Ball or butterfly.
 - b. Body Material: Bronze.
 - c. End Connections: Threaded.
 - 5. Valves NPS 2-1/2 and Larger:
 - a. Valve Type: Butterfly.
 - b. Body Material: Cast or ductile iron.
 - c. End Connections: Flanged, grooved, or wafer.
 - 6. Valve Operation: Integral electrical, 115-V ac, prewired, single-circuit, supervisory switch indicating device.
- I. NRS Gate Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Cast Iron Pipe Company; Waterous Company Subsidiary.
 - b. American Valve, Inc.
 - c. Clow Valve Company; a division of McWane, Inc.
 - d. Kennedy Valve; a division of McWane, Inc.
 - e. Mueller Co.; Water Products Division.
 - f. NIBCO INC.
 - g. Tyco Fire & Building Products LP.
 - 2. Standard: UL 262.
 - 3. Pressure Rating: 250 psig minimum.
 - 4. Body Material: Cast iron with indicator post flange.
 - 5. Stem: Nonrising.
 - 6. End Connections: Flanged or grooved.
- J. Indicator Posts:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Cast Iron Pipe Company; Waterous Company Subsidiary.
 - b. American Valve, Inc.
 - c. Clow Valve Company; a division of McWane, Inc.
 - d. Kennedy Valve; a division of McWane, Inc.
 - e. Mueller Co.; Water Products Division.
 - f. NIBCO INC.
 - g. Tyco Fire & Building Products LP.
 - 2. Standard: UL 789.
 - 3. Type: Horizontal for wall mounting.
 - 4. Body Material: Cast iron with extension rod and locking device.
 - 5. Operation: Hand wheel.

2.4 SPECIALTY VALVES

- A. General Requirements:
 - 1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
 - 2. Pressure Rating:
 - a. Standard-Pressure Piping Specialty Valves: 175 psig minimum.
 - 3. Body Material: Cast or ductile iron.

4. Size: Same as connected piping.
5. End Connections: Flanged or grooved.

B. Alarm Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AFAC Inc.
 - b. Globe Fire Sprinkler Corporation.
 - c. Reliable Automatic Sprinkler Co., Inc.
 - d. Tyco Fire & Building Products LP.
 - e. Venus Fire Protection Ltd.
 - f. Victaulic Company.
 - g. Viking Corporation.
2. Standard: UL 193.
3. Design: For horizontal or vertical installation.
4. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, and fill-line attachment with strainer.

2.5 FIRE-DEPARTMENT CONNECTIONS

A. Exposed-Type, Fire-Department Connection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AFAC Inc.
 - b. Elkhart Brass Mfg. Company, Inc.
 - c. Fire-End & Croker Corporation.
 - d. Fire Protection Products, Inc.
 - e. GMR International Equipment Corporation.
 - f. Guardian Fire Equipment, Inc.
 - g. Tyco Fire & Building Products LP.
 - h. Wilson & Cousins Inc.
2. Standard: UL 405.
3. Type: Exposed, projecting, for wall mounting.
4. Pressure Rating: 175 psig minimum.
5. Body Material: Corrosion-resistant metal.
6. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
7. Caps: Brass, lugged type, with gasket and chain.
8. Escutcheon Plate: Round, brass, wall type.
9. Outlet: Back, with pipe threads.
10. Number of Inlets: Two.
11. Escutcheon Plate Marking: Similar to " AUTO SPKR."
12. Finish: Rough brass or bronze.
13. Outlet Size: NPS 4.

2.6 SPRINKLER SPECIALTY PIPE FITTINGS

A. Branch Outlet Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International, Inc.
 - b. National Fittings, Inc.
 - c. Shurjoint Piping Products.
 - d. Tyco Fire & Building Products LP.
 - e. Victaulic Company.

2. Standard: UL 213.
3. Pressure Rating: 175 psig minimum.
4. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
5. Type: Mechanical-T and -cross fittings.
6. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
7. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
8. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Flow Detection and Test Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AGF Manufacturing Inc.
 - b. Reliable Automatic Sprinkler Co., Inc.
 - c. Tyco Fire & Building Products LP.
 - d. Victaulic Company.
2. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
3. Pressure Rating: 175 psig minimum.
4. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded.

2.7 SPRINKLERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AFAC Inc.
2. Globe Fire Sprinkler Corporation.
3. Reliable Automatic Sprinkler Co., Inc.
4. Tyco Fire & Building Products LP.
5. Venus Fire Protection Ltd.
6. Victaulic Company.
7. Viking Corporation.

B. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating for Residential Sprinklers: 175 psig maximum.
3. Pressure Rating for Automatic Sprinklers: 175 psig minimum.

C. Automatic Sprinklers with Heat-Responsive Element:

1. Early-Suppression, Fast-Response Applications: UL 1767.
2. Nonresidential Applications: UL 199.
3. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

2.8 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Water-Motor-Operated Alarm:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Globe Fire Sprinkler Corporation.
 - b. Tyco Fire & Building Products LP.
 - c. Victaulic Company.
 - d. Viking Corporation.
 2. Standard: UL 753.
 3. Type: Mechanically operated, with Pelton wheel.
 4. Alarm Gong: Cast aluminum with red-enamel factory finish.
 5. Size: 10-inch diameter.
 6. Components: Shaft length, bearings, and sleeve to suit wall construction.
 7. Inlet: NPS 3/4.
 8. Outlet: NPS 1 drain connection.
- C. Electrically Operated Alarm Bell:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Fire-Lite Alarms, Inc.; a Honeywell company.
 - b. Notifier; a Honeywell company.
 - c. Potter Electric Signal Company.
 2. Standard: UL 464.
 3. Type: Vibrating, metal alarm bell.
 4. Size: 6-inch minimum- diameter.
 5. Finish: Red-enamel factory finish, suitable for outdoor use.
- D. Water-Flow Indicators:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ADT Security Services, Inc.
 - b. McDonnell & Miller; ITT Industries.
 - c. Potter Electric Signal Company.
 - d. System Sensor; a Honeywell company.
 - e. Viking Corporation.
 - f. Watts Industries (Canada) Inc.
 2. Standard: UL 346.
 3. Water-Flow Detector: Electrically supervised.
 4. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
 5. Type: Paddle operated.
 6. Pressure Rating: 250 psig.
 7. Design Installation: Horizontal or vertical.
- E. Pressure Switches:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AFAC Inc.
 - b. Barksdale, Inc.
 - c. Detroit Switch, Inc.
 - d. Potter Electric Signal Company.
 - e. System Sensor; a Honeywell company.
 - f. Tyco Fire & Building Products LP.
 - g. United Electric Controls Co.
 - h. Viking Corporation.
 2. Standard: UL 346.
 3. Type: Electrically supervised water-flow switch with retard feature.
 4. Components: Single-pole, double-throw switch with normally closed contacts.

5. Design Operation: Rising pressure signals water flow.
- F. Valve Supervisory Switches:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Fire-Lite Alarms, Inc.; a Honeywell company.
 - b. Kennedy Valve; a division of McWane, Inc.
 - c. Potter Electric Signal Company.
 - d. System Sensor; a Honeywell company.
 2. Standard: UL 346.
 3. Type: Electrically supervised.
 4. Components: Single-pole, double-throw switch with normally closed contacts.
 5. Design: Signals that controlled valve is in other than fully open position.
- G. Indicator-Post Supervisory Switches:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Potter Electric Signal Company.
 - b. System Sensor; a Honeywell company.
 2. Standard: UL 346.
 3. Type: Electrically supervised.
 4. Components: Single-pole, double-throw switch with normally closed contacts.
 5. Design: Signals that controlled indicator-post valve is in other than fully open position.

2.9 MANUAL CONTROL STATIONS

- A. Description: UL listed or FM approved, hydraulic operation, with union, NPS 1/2 pipe nipple, and bronze ball valve. Include metal enclosure labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.

2.10 CONTROL PANELS

- A. Description: Single-area, two-area, or single-area cross-zoned control panel as indicated, including NEMA ICS 6, Type 1 enclosure, detector, alarm, and solenoid-valve circuitry for operation of deluge valves. Panels contain power supply; battery charger; standby batteries; field-wiring terminal strip; electrically supervised solenoid valves and polarized fire-alarm bell; lamp test facility; single-pole, double-throw auxiliary alarm contacts; and rectifier.
1. Panels: UL listed and FM approved when used with thermal detectors and Class A detector circuit wiring. Electrical characteristics are 120-V ac, 60 Hz, with 24-V dc rechargeable batteries.
 2. Manual Control Stations: Electric operation, metal enclosure, labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.

2.11 PRESSURE GAGES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AMETEK; U.S. Gauge Division.
 2. Ashcroft, Inc.
 3. Brecco Corporation.
 4. WIKA Instrument Corporation.
- B. Standard: UL 393.

- C. Dial Size: 3-1/2- to 4-1/2-inch diameter.
- D. Pressure Gage Range: 0 to 250 psig minimum.
- E. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.

2.12 ESCUTCHEONS

- A. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.
- B. One-Piece, Cast-Brass Escutcheons: Polished chrome-plated finish with set-screws.
- C. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with chrome-plated finish.
- D. One-Piece, Stamped-Steel Escutcheons: Chrome-plated finish with set-screw.
- E. Split-Plate, Stamped-Steel Escutcheons: Chrome-plated finish with concealed hinge, set-screw or spring clips.

2.13 SLEEVES

- A. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, standard weight, zinc coated, plain ends.
- C. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

2.14 SLEEVE SEALS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Advance Products & Systems, Inc.
 - 2. Calpico, Inc.
 - 3. Metraflex, Inc.
 - 4. Pipeline Seal and Insulator, Inc.
- B. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

2.15 GROUT

- A. Standard: ASTM C 1107, Grade B, posthardening and volume adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink, and recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.
- B. Report test results promptly and in writing.

3.2 SERVICE-ENTRANCE PIPING

- A. Connect sprinkler piping to water-service piping for service entrance to building. Comply with requirements for exterior piping in Division 21 Section "Facility Fire-Suppression Water-Service Piping."
- B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-service piping. Comply with requirements for backflow preventers in Division 21 Section "Facility Fire-Suppression Water-Service Piping."

3.3 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
 - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
- B. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.
- C. Install seismic restraints on piping. Comply with requirements for seismic-restraint device materials and installation in NFPA 13.
- D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- E. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
- H. Install sprinkler piping with drains for complete system drainage.
- I. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- J. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.
- K. Install alarm devices in piping systems.

- L. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.
- M. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.
- N. Fill sprinkler system piping with water.
- O. Install electric heating cables and pipe insulation on sprinkler piping in areas subject to freezing. Comply with requirements for heating cables in Division 21 "Heat Tracing for Fire-Suppression Piping" and for piping insulation in Division 21 Section "Fire-Suppression Systems Insulation."

3.4 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
- G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- H. Twist-Locked Joints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer lugs one-quarter turn or tighten retainer pin.
- I. Steel-Piping, Pressure-Sealed Joints: Join lightwall steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.
- J. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
 - 1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.
- K. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.

- L. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- M. Steel-Piping, Pressure-Sealed Joints: Join Schedule 5 steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.
- N. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Braze Joints" Chapter.
- O. Copper-Tubing Grooved Joints: Roll rounded-edge groove in end of tube according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- P. Copper-Tubing, Pressure-Sealed Joints: Join copper tube and copper pressure-seal fittings with tools recommended by fitting manufacturer.
- Q. Extruded-Tee Connections: Form tee in copper tube according to ASTM F 2144. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.
- R. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.
- S. Plastic-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
 - 2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.

3.5 INSTALLATION OF COVER SYSTEM FOR SPRINKLER PIPING

- A. Install cover system, brackets, and cover components for sprinkler piping according to manufacturer's "Installation Manual" and with NFPA 13 or NFPA 13R for supports.

3.6 VALVE AND SPECIALTIES INSTALLATION

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.
- B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
- D. Specialty Valves:
 - 1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
 - 2. Alarm Valves: Include bypass check valve and retarding chamber drain-line connection.
 - 3. Deluge Valves: Install in vertical position, in proper direction of flow, and in main supply to deluge system. Install trim sets for drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.

3.7 SPRINKLER INSTALLATION

- A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels.
- B. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.
- C. Install sprinklers into flexible, sprinkler hose fittings and install hose into bracket on ceiling grid.

3.8 FIRE-DEPARTMENT CONNECTION INSTALLATION

- A. Install yard-type, fire-department connections in concrete slab support. Comply with requirements for concrete in Division 03 Section "Cast-in-Place Concrete."
 - 1. Install three protective pipe bollards around each fire-department connection. Comply with requirements for bollards in Division 05 Section "Metal Fabrications."
- B. Install automatic (ball drip) drain valve at each check valve for fire-department connection.

3.9 ESCUTCHEON INSTALLATION

- A. Install escutcheons for penetrations of walls, ceilings, and floors.
- B. Escutcheons for New Piping:
 - 1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
 - 2. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
 - 3. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
 - 4. Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chrome-plated finish.
 - 5. Bare Piping in Equipment Rooms: One piece, cast brass.
 - 6. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

3.10 SLEEVE INSTALLATION

- A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.
- B. Sleeves are not required for core-drilled holes.
- C. Permanent sleeves are not required for holes formed by removable PE sleeves.
- D. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.
- E. Install sleeves in new partitions, slabs, and walls as they are built.
- F. For interior wall penetrations, seal annular space between sleeve and pipe or pipe insulation using joint sealants appropriate for size, depth, and location of joint. Comply with requirements for joint sealants in Division 07 Section "Joint Sealants."
- G. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint. Comply with requirements for joint sealants in Division 07 Section "Joint Sealants."

- H. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using sleeve seals.
- I. Seal space outside of sleeves in concrete slabs and walls with grout.
- J. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation unless otherwise indicated.
- K. Install sleeve materials according to the following applications:
 - 1. Sleeves for Piping Passing through Concrete Floor Slabs: Galvanized-steel pipe.
 - 2. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Galvanized-steel pipe.
 - a. Extend sleeves 2 inches above finished floor level.
 - b. For pipes penetrating floors with membrane waterproofing, extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Comply with requirements for flashing in Division 07 Section "Sheet Metal Flashing and Trim."
 - 3. Sleeves for Piping Passing through Gypsum-Board Partitions:
 - a. Galvanized-steel-pipe sleeves for pipes smaller than NPS 6.
 - b. Galvanized-steel-sheet sleeves for pipes NPS 6 and larger.
 - c. Exception: Sleeves are not required for water-supply tubes and waste pipes for individual plumbing fixtures if escutcheons will cover openings.
 - 4. Sleeves for Piping Passing through Concrete Roof Slabs: Galvanized-steel pipe.
 - 5. Sleeves for Piping Passing through Exterior Concrete Walls:
 - a. Galvanized-steel-pipe sleeves for pipes smaller than NPS 6.
 - b. Cast-iron wall-pipe sleeves for pipes NPS 6 and larger.
 - c. Install sleeves that are large enough to provide 1-inch annular clear space between sleeve and pipe or pipe insulation when sleeve seals are used.
 - 6. Sleeves for Piping Passing through Interior Concrete Walls:
 - a. Galvanized-steel-pipe sleeves for pipes smaller than NPS 6.
 - b. Galvanized-steel-sheet sleeves for pipes NPS 6 and larger.
- L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestop materials and installations in Division 07 Section "Penetration Firestopping."

3.11 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.12 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
 4. Energize circuits to electrical equipment and devices.
 5. Start and run excess-pressure pumps.
 6. Coordinate with fire-alarm tests. Operate as required.
 7. Verify that equipment hose threads are same as local fire-department equipment.
- C. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.13 CLEANING

- A. Clean dirt and debris from sprinklers.
- B. Remove and replace sprinklers with paint other than factory finish.

3.14 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specialty valves.

3.15 PIPING SCHEDULE

- A. Piping between Fire-Department Connections and Check Valves: Galvanized, standard-weight steel pipe with grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.
- B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.
- C. Standard-pressure, wet-pipe sprinkler system, NPS 2 and smaller, shall be one of the following:
1. Schedule 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
 2. Schedule 30, black-steel pipe with plain ends; uncoated, plain-end-pipe fittings; and twist-locked joints.
 3. Schedule 30, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 4. Schedule 30, black-steel pipe with plain ends; steel welding fittings; and welded joints.
- D. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 to NPS 4, shall be one of the following:
1. Schedule 30 galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
 2. Schedule 30, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 3. Schedule 30, black-steel pipe with plain ends; steel welding fittings; and welded joints.
- E. Standard-pressure, wet-pipe sprinkler system, NPS 5 and larger, shall be one of the following:
1. Standard-weight, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 2. Standard-weight, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 3. Standard-weight, black-steel pipe with plain ends; steel welding fittings; and welded joints.

3.16 SPRINKLER SCHEDULE

- A. Use sprinkler types in subparagraphs below for the following applications:
 - 1. Rooms without Ceilings: Upright sprinklers.
 - 2. Rooms with Suspended Ceilings: Concealed sprinklers.
 - 3. Wall Mounting: Sidewall sprinklers.
 - 4. Spaces Subject to Freezing: Upright, pendent, dry sprinklers; and sidewall, dry sprinklers as indicated.

- B. Provide sprinkler types in subparagraphs below with finishes indicated.
 - 1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
 - 2. Flush Sprinklers: Bright chrome, with painted white escutcheon.
 - 3. Recessed Sprinklers: White chrome, with white chrome escutcheon.

END OF SECTION

SECTION 21 13 13

WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Pipes, fittings, and specialties.
 - 2. Fire-protection valves.
 - 3. Fire-department connections.
 - 4. Sprinklers.
 - 5. Alarm devices.
 - 6. Manual control stations.
 - 7. Control panels.
 - 8. Pressure gages.

1.3 DEFINITIONS

- A. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175 psig maximum.

1.4 SYSTEM DESCRIPTIONS

- A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply through alarm valve. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included.

1.5 PERFORMANCE REQUIREMENTS

- A. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.
- B. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
 - 1. Provide fire-hydrant flow test records indicating the following conditions:
 - a. Date:
 - b. Time:
 - c. Performed by:
 - d. Location of Residual Fire Hydrant R:
 - e. Location of Flow Fire Hydrant F:
 - f. Static Pressure at Residual Fire Hydrant R:
 - g. Measured Flow at Flow Fire Hydrant F:
 - h. Residual Pressure at Residual Fire Hydrant R:
- C. Sprinkler system design shall be approved by authorities having jurisdiction.

1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
 2. Sprinkler Occupancy Hazard Classifications:
 - a. Building Service Areas: Ordinary Hazard, Group 1.
 - b. Electrical Equipment Rooms: Ordinary Hazard, Group 1.
 - c. General Storage Areas: Ordinary Hazard, Group 1.
 - d. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
 - e. Office and Public Areas: Light Hazard.
 3. Minimum Density for system shall comply with NFPA 13.
 4. Maximum Protection Area per Sprinkler: Per UL listing.
- D. Seismic Performance: Sprinkler piping shall withstand the effects of earthquake motions determined according to NFPA 13.

1.6 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. LEED Submittal:
 1. Product Data for Credit EQ 4.1: For solvent cements and adhesive primers, including printed statement of VOC content and chemical components.
- C. Shop Drawings: For wet-pipe sprinkler systems. Include plans, elevations, sections, details, and attachments to other work.
 1. Wiring Diagrams: For power, signal, and control wiring.
- D. Delegated-Design Submittal: For sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- E. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 1. Domestic water piping.
 2. Items penetrating finished ceiling include the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
- F. Qualification Data: For qualified installer and professional engineer.
- G. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.
- H. Fire-hydrant flow test report.
- I. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
- J. Field quality-control reports.
- K. Operation and Maintenance Data: For sprinkler specialties to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
 - a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.
- B. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- 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. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
 - 1. NFPA 13, "Installation of Sprinkler Systems."
 - 2. NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances."

1.8 COORDINATION

- A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

1.9 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

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

2.2 STEEL PIPE AND FITTINGS

- A. Standard Weight, Black-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.
- B. Schedule 30, Black-Steel Pipe: ASTM A 135; ASTM A 795/A 795M, Type E; or ASME B36.10M, wrought steel; with wall thickness not less than Schedule 30 and not more than Schedule 40. Pipe ends may be factory or field formed to match joining method.

2.3 LISTED FIRE-PROTECTION VALVES

- A. General Requirements:
 - 1. Valves shall be UL listed or FM approved.
 - 2. Minimum Pressure Rating for Standard-Pressure Piping: 175 psig.

- B. Ball Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International, Inc.
 - b. Victaulic Company.
 - 2. Standard: UL 1091 except with ball instead of disc.
 - 3. Valves NPS 1-1/2 and Smaller: Bronze body with threaded ends.
 - 4. Valves NPS 2 and NPS 2-1/2: Bronze body with threaded ends or ductile-iron body with grooved ends.
 - 5. Valves NPS 3: Ductile-iron body with grooved ends.
- C. Bronze Butterfly Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Fivalco Inc.
 - b. Global Safety Products, Inc.
 - c. Milwaukee Valve Company.
 - 2. Standard: UL 1091.
 - 3. Pressure Rating: 175 psig.
 - 4. Body Material: Bronze.
 - 5. End Connections: Threaded.
- D. Iron Butterfly Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International, Inc.
 - b. Fivalco Inc.
 - c. Global Safety Products, Inc.
 - d. Kennedy Valve; a division of McWane, Inc.
 - e. Milwaukee Valve Company.
 - f. NIBCO INC.
 - g. Pratt, Henry Company.
 - h. Shurjoint Piping Products.
 - i. Tyco Fire & Building Products LP.
 - j. Victaulic Company.
 - 2. Standard: UL 1091.
 - 3. Pressure Rating: 175 psig.
 - 4. Body Material: Cast or ductile iron.
 - 5. Style: Lug or wafer.
 - 6. End Connections: Grooved.
- E. Check Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AFAC Inc.
 - b. American Cast Iron Pipe Company; Waterous Company Subsidiary.
 - c. Anvil International, Inc.
 - d. Clow Valve Company; a division of McWane, Inc.
 - e. Crane Co.; Crane Valve Group; Crane Valves.
 - f. Fire-End & Croker Corporation.
 - g. Fire Protection Products, Inc.
 - h. Globe Fire Sprinkler Corporation.
 - i. Groeniger & Company.
 - j. Kennedy Valve; a division of McWane, Inc.
 - k. Matco-Norca.
 - l. Milwaukee Valve Company.

- m. Mueller Co.; Water Products Division.
 - n. NIBCO INC.
 - o. Potter Roemer.
 - p. Reliable Automatic Sprinkler Co., Inc.
 - q. Shurjoint Piping Products.
 - r. Tyco Fire & Building Products LP.
 - s. United Brass Works, Inc.
 - t. Venus Fire Protection Ltd.
 - u. Victaulic Company.
 - v. Viking Corporation.
 - w. Watts Water Technologies, Inc.
 - 2. Standard: UL 312.
 - 3. Pressure Rating: 250 psig minimum.
 - 4. Type: Swing check.
 - 5. Body Material: Cast iron.
 - 6. End Connections: Flanged or grooved.
- F. Bronze OS&Y Gate Valves:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Milwaukee Valve Company.
 - c. NIBCO INC.
 - d. United Brass Works, Inc.
 - 2. Standard: UL 262.
 - 3. Pressure Rating: 175 psig.
 - 4. Body Material: Bronze.
 - 5. End Connections: Threaded.
- G. Iron OS&Y Gate Valves:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Cast Iron Pipe Company; Waterous Company Subsidiary.
 - b. American Valve, Inc.
 - c. Clow Valve Company; a division of McWane, Inc.
 - d. Crane Co.; Crane Valve Group; Crane Valves.
 - e. Hammond Valve.
 - f. Milwaukee Valve Company.
 - g. Mueller Co.; Water Products Division.
 - h. NIBCO INC.
 - i. Shurjoint Piping Products.
 - j. Tyco Fire & Building Products LP.
 - k. United Brass Works, Inc.
 - l. Watts Water Technologies, Inc.
 - 2. Standard: UL 262.
 - 3. Pressure Rating: 250 psig minimum.
 - 4. Body Material: Cast or ductile iron.
 - 5. End Connections: Flanged or grooved.
- H. Indicating-Type Butterfly Valves:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International, Inc.
 - b. Fivalco Inc.
 - c. Global Safety Products, Inc.
 - d. Kennedy Valve; a division of McWane, Inc.

- e. Milwaukee Valve Company.
 - f. NIBCO INC.
 - g. Shurjoint Piping Products.
 - h. Tyco Fire & Building Products LP.
 - i. Victaulic Company.
 - 2. Standard: UL 1091.
 - 3. Pressure Rating: 175 psig minimum.
 - 4. Valves NPS 2 and Smaller:
 - a. Valve Type: Ball or butterfly.
 - b. Body Material: Bronze.
 - c. End Connections: Threaded.
 - 5. Valves NPS 2-1/2 and Larger:
 - a. Valve Type: Butterfly.
 - b. Body Material: Cast or ductile iron.
 - c. End Connections: Flanged, grooved, or wafer.
 - 6. Valve Operation: Integral electrical, 115-V ac, prewired, single-circuit, supervisory switch indicating device.
- I. NRS Gate Valves:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Cast Iron Pipe Company; Waterous Company Subsidiary.
 - b. American Valve, Inc.
 - c. Clow Valve Company; a division of McWane, Inc.
 - d. Kennedy Valve; a division of McWane, Inc.
 - e. Mueller Co.; Water Products Division.
 - f. NIBCO INC.
 - g. Tyco Fire & Building Products LP.
 - 2. Standard: UL 262.
 - 3. Pressure Rating: 250 psig minimum.
 - 4. Body Material: Cast iron with indicator post flange.
 - 5. Stem: Nonrising.
 - 6. End Connections: Flanged or grooved.
- J. Indicator Posts:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Cast Iron Pipe Company; Waterous Company Subsidiary.
 - b. American Valve, Inc.
 - c. Clow Valve Company; a division of McWane, Inc.
 - d. Kennedy Valve; a division of McWane, Inc.
 - e. Mueller Co.; Water Products Division.
 - f. NIBCO INC.
 - g. Tyco Fire & Building Products LP.
 - 2. Standard: UL 789.
 - 3. Type: Horizontal for wall mounting.
 - 4. Body Material: Cast iron with extension rod and locking device.
 - 5. Operation: Hand wheel.

2.4 SPECIALTY VALVES

- A. General Requirements:
- 1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
 - 2. Pressure Rating:
 - a. Standard-Pressure Piping Specialty Valves: 175 psig minimum.

3. Body Material: Cast or ductile iron.
4. Size: Same as connected piping.
5. End Connections: Flanged or grooved.

B. Alarm Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AFAC Inc.
 - b. Globe Fire Sprinkler Corporation.
 - c. Reliable Automatic Sprinkler Co., Inc.
 - d. Tyco Fire & Building Products LP.
 - e. Venus Fire Protection Ltd.
 - f. Victaulic Company.
 - g. Viking Corporation.
2. Standard: UL 193.
3. Design: For horizontal or vertical installation.
4. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, and fill-line attachment with strainer.

2.5 FIRE-DEPARTMENT CONNECTIONS

A. Exposed-Type, Fire-Department Connection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AFAC Inc.
 - b. Elkhart Brass Mfg. Company, Inc.
 - c. Fire-End & Croker Corporation.
 - d. Fire Protection Products, Inc.
 - e. GMR International Equipment Corporation.
 - f. Guardian Fire Equipment, Inc.
 - g. Tyco Fire & Building Products LP.
 - h. Wilson & Cousins Inc.
2. Standard: UL 405.
3. Type: Exposed, projecting, for wall mounting.
4. Pressure Rating: 175 psig minimum.
5. Body Material: Corrosion-resistant metal.
6. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
7. Caps: Brass, lugged type, with gasket and chain.
8. Escutcheon Plate: Round, brass, wall type.
9. Outlet: Back, with pipe threads.
10. Number of Inlets: Two.
11. Escutcheon Plate Marking: Similar to " AUTO SPKR."
12. Finish: Rough brass or bronze.
13. Outlet Size: NPS 4.

B. Yard-Type, Fire-Department Connection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AFAC Inc.
 - b. Elkhart Brass Mfg. Company, Inc.
 - c. Fire-End & Croker Corporation.
 - d. Fire Protection Products, Inc.
 - e. GMR International Equipment Corporation.
 - f. Guardian Fire Equipment, Inc.

- g. Wilson & Cousins Inc.
- 2. Standard: UL 405.
- 3. Type: Exposed, freestanding.
- 4. Pressure Rating: 175 psig minimum.
- 5. Body Material: Corrosion-resistant metal.
- 6. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
- 7. Caps: Brass, lugged type, with gasket and chain.
- 8. Escutcheon Plate: Round, brass, floor type.
- 9. Outlet: Bottom, with pipe threads.
- 10. Number of Inlets: Two.
- 11. Sleeve: Brass.
- 12. Sleeve Height: 18 inches.
- 13. Escutcheon Plate Marking: Similar to " AUTO SPKR."
- 14. Finish: Rough brass or bronze.
- 15. Outlet Size: NPS 4.

2.6 SPRINKLER SPECIALTY PIPE FITTINGS

- A. Branch Outlet Fittings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International, Inc.
 - b. National Fittings, Inc.
 - c. Shurjoint Piping Products.
 - d. Tyco Fire & Building Products LP.
 - e. Victaulic Company.
 - 2. Standard: UL 213.
 - 3. Pressure Rating: 175 psig minimum.
 - 4. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
 - 5. Type: Mechanical-T and -cross fittings.
 - 6. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
 - 7. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
 - 8. Branch Outlets: Grooved, plain-end pipe, or threaded.
- B. Flow Detection and Test Assemblies:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AGF Manufacturing Inc.
 - b. Reliable Automatic Sprinkler Co., Inc.
 - c. Tyco Fire & Building Products LP.
 - d. Victaulic Company.
 - 2. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
 - 3. Pressure Rating: 175 psig minimum.
 - 4. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
 - 5. Size: Same as connected piping.
 - 6. Inlet and Outlet: Threaded.

2.7 SPRINKLERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AFAC Inc.
 2. Globe Fire Sprinkler Corporation.
 3. Reliable Automatic Sprinkler Co., Inc.
 4. Tyco Fire & Building Products LP.
 5. Venus Fire Protection Ltd.
 6. Victaulic Company.
 7. Viking Corporation.
- B. General Requirements:
1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
 2. Pressure Rating for Residential Sprinklers: 175 psig maximum.
 3. Pressure Rating for Automatic Sprinklers: 175 psig minimum.
- C. Automatic Sprinklers with Heat-Responsive Element:
1. Early-Suppression, Fast-Response Applications: UL 1767.
 2. Nonresidential Applications: UL 199.
 3. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

2.8 ALARM DEVICES

- A. Alarm-device types shall match piping and equipment connections.
- B. Water-Motor-Operated Alarm:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Globe Fire Sprinkler Corporation.
 - b. Tyco Fire & Building Products LP.
 - c. Victaulic Company.
 - d. Viking Corporation.
 2. Standard: UL 753.
 3. Type: Mechanically operated, with Pelton wheel.
 4. Alarm Gong: Cast aluminum with red-enamel factory finish.
 5. Size: 10-inch diameter.
 6. Components: Shaft length, bearings, and sleeve to suit wall construction.
 7. Inlet: NPS 3/4.
 8. Outlet: NPS 1 drain connection.
- C. Electrically Operated Alarm Bell:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Fire-Lite Alarms, Inc.; a Honeywell company.
 - b. Notifier; a Honeywell company.
 - c. Potter Electric Signal Company.
 2. Standard: UL 464.
 3. Type: Vibrating, metal alarm bell.
 4. Size: 6-inch minimum- diameter.
 5. Finish: Red-enamel factory finish, suitable for outdoor use.
- D. Water-Flow Indicators:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ADT Security Services, Inc.
 - b. McDonnell & Miller; ITT Industries.

- c. Potter Electric Signal Company.
 - d. System Sensor; a Honeywell company.
 - e. Viking Corporation.
 - f. Watts Industries (Canada) Inc.
 2. Standard: UL 346.
 3. Water-Flow Detector: Electrically supervised.
 4. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
 5. Type: Paddle operated.
 6. Pressure Rating: 250 psig.
 7. Design Installation: Horizontal or vertical.
- E. Pressure Switches:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AFAC Inc.
 - b. Barksdale, Inc.
 - c. Detroit Switch, Inc.
 - d. Potter Electric Signal Company.
 - e. System Sensor; a Honeywell company.
 - f. Tyco Fire & Building Products LP.
 - g. United Electric Controls Co.
 - h. Viking Corporation.
 2. Standard: UL 346.
 3. Type: Electrically supervised water-flow switch with retard feature.
 4. Components: Single-pole, double-throw switch with normally closed contacts.
 5. Design Operation: Rising pressure signals water flow.
- F. Valve Supervisory Switches:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Fire-Lite Alarms, Inc.; a Honeywell company.
 - b. Kennedy Valve; a division of McWane, Inc.
 - c. Potter Electric Signal Company.
 - d. System Sensor; a Honeywell company.
 2. Standard: UL 346.
 3. Type: Electrically supervised.
 4. Components: Single-pole, double-throw switch with normally closed contacts.
 5. Design: Signals that controlled valve is in other than fully open position.
- G. Indicator-Post Supervisory Switches:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Potter Electric Signal Company.
 - b. System Sensor; a Honeywell company.
 2. Standard: UL 346.
 3. Type: Electrically supervised.
 4. Components: Single-pole, double-throw switch with normally closed contacts.
 5. Design: Signals that controlled indicator-post valve is in other than fully open position.

2.9 MANUAL CONTROL STATIONS

- A. Description: UL listed or FM approved, hydraulic operation, with union, NPS 1/2 pipe nipple, and bronze ball valve. Include metal enclosure labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.

2.10 CONTROL PANELS

- A. Description: Single-area, two-area, or single-area cross-zoned control panel as indicated, including NEMA ICS 6, Type 1 enclosure, detector, alarm, and solenoid-valve circuitry for operation of deluge valves. Panels contain power supply; battery charger; standby batteries; field-wiring terminal strip; electrically supervised solenoid valves and polarized fire-alarm bell; lamp test facility; single-pole, double-throw auxiliary alarm contacts; and rectifier.
 - 1. Panels: UL listed and FM approved when used with thermal detectors and Class A detector circuit wiring. Electrical characteristics are 120-V ac, 60 Hz, with 24-V dc rechargeable batteries.
 - 2. Manual Control Stations: Electric operation, metal enclosure, labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.

2.11 PRESSURE GAGES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AMETEK; U.S. Gauge Division.
 - 2. Ashcroft, Inc.
 - 3. Brecco Corporation.
 - 4. WIKA Instrument Corporation.
- B. Standard: UL 393.
- C. Dial Size: 3-1/2- to 4-1/2-inch diameter.
- D. Pressure Gage Range: 0 to 250 psig minimum.
- E. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.

2.12 ESCUTCHEONS

- A. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.
- B. One-Piece, Cast-Brass Escutcheons: Polished chrome-plated finish with set-screws.
- C. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with chrome-plated finish.
- D. One-Piece, Stamped-Steel Escutcheons: Chrome-plated finish with set-screw.
- E. Split-Plate, Stamped-Steel Escutcheons: Chrome-plated finish with concealed hinge, set-screw or spring clips.

2.13 SLEEVES

- A. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

- B. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, standard weight, zinc coated, plain ends.
- C. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

2.14 SLEEVE SEALS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Advance Products & Systems, Inc.
 - 2. Calpico, Inc.
 - 3. Metraflex, Inc.
 - 4. Pipeline Seal and Insulator, Inc.
- B. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

2.15 GROUT

- A. Standard: ASTM C 1107, Grade B, posthardening and volume adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink, and recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.
- B. Report test results promptly and in writing.

3.2 SERVICE-ENTRANCE PIPING

- A. Connect sprinkler piping to water-service piping for service entrance to building. Comply with requirements for exterior piping in Division 21 Section "Facility Fire-Suppression Water-Service Piping."
- B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-service piping. Comply with requirements for backflow preventers in Division 21 Section "Facility Fire-Suppression Water-Service Piping."

3.3 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
 - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.

- B. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.
- C. Install seismic restraints on piping. Comply with requirements for seismic-restraint device materials and installation in NFPA 13.
- D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- E. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
- H. Install sprinkler piping with drains for complete system drainage.
- I. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- J. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.
- K. Install alarm devices in piping systems.
- L. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.
- M. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.
- N. Fill sprinkler system piping with water.
- O. Install electric heating cables and pipe insulation on sprinkler piping in areas subject to freezing. Comply with requirements for heating cables in Division 21 "Heat Tracing for Fire-Suppression Piping" and for piping insulation in Division 21 Section "Fire-Suppression Systems Insulation."

3.4 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
- G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- H. Twist-Locked Joints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer lugs one-quarter turn or tighten retainer pin.
- I. Steel-Piping, Pressure-Sealed Joints: Join lightwall steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.
- J. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
 - 1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.
- K. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.
- L. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- M. Steel-Piping, Pressure-Sealed Joints: Join Schedule 5 steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.
- N. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.
- O. Copper-Tubing Grooved Joints: Roll rounded-edge groove in end of tube according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- P. Copper-Tubing, Pressure-Sealed Joints: Join copper tube and copper pressure-seal fittings with tools recommended by fitting manufacturer.
- Q. Extruded-Tee Connections: Form tee in copper tube according to ASTM F 2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.
- R. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.
- S. Plastic-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.

3.5 INSTALLATION OF COVER SYSTEM FOR SPRINKLER PIPING

- A. Install cover system, brackets, and cover components for sprinkler piping according to manufacturer's "Installation Manual" and with NFPA 13 or NFPA 13R for supports.

3.6 VALVE AND SPECIALTIES INSTALLATION

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.
- B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
- D. Specialty Valves:
 1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
 2. Alarm Valves: Include bypass check valve and retarding chamber drain-line connection.
 3. Deluge Valves: Install in vertical position, in proper direction of flow, and in main supply to deluge system. Install trim sets for drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.

3.7 SPRINKLER INSTALLATION

- A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels.
- B. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.
- C. Install sprinklers into flexible, sprinkler hose fittings and install hose into bracket on ceiling grid.

3.8 FIRE-DEPARTMENT CONNECTION INSTALLATION

- A. Install yard-type, fire-department connections in concrete slab support. Comply with requirements for concrete in Division 03 Section "Cast-in-Place Concrete."
 1. Install three protective pipe bollards around each fire-department connection. Comply with requirements for bollards in Division 05 Section "Metal Fabrications."
- B. Install automatic (ball drip) drain valve at each check valve for fire-department connection.

3.9 ESCUTCHEON INSTALLATION

- A. Install escutcheons for penetrations of walls, ceilings, and floors.
- B. Escutcheons for New Piping:
 1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
 2. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.

3. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
4. Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chrome-plated finish.
5. Bare Piping in Equipment Rooms: One piece, cast brass.
6. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

3.10 SLEEVE INSTALLATION

- A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.
- B. Sleeves are not required for core-drilled holes.
- C. Permanent sleeves are not required for holes formed by removable PE sleeves.
- D. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.
- E. Install sleeves in new partitions, slabs, and walls as they are built.
- F. For interior wall penetrations, seal annular space between sleeve and pipe or pipe insulation using joint sealants appropriate for size, depth, and location of joint. Comply with requirements for joint sealants in Division 07 Section "Joint Sealants."
- G. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint. Comply with requirements for joint sealants in Division 07 Section "Joint Sealants."
- H. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using sleeve seals.
- I. Seal space outside of sleeves in concrete slabs and walls with grout.
- J. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation unless otherwise indicated.
- K. Install sleeve materials according to the following applications:
 1. Sleeves for Piping Passing through Concrete Floor Slabs: Galvanized-steel pipe.
 2. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Galvanized-steel pipe.
 - a. Extend sleeves 2 inches above finished floor level.
 - b. For pipes penetrating floors with membrane waterproofing, extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Comply with requirements for flashing in Division 07 Section "Sheet Metal Flashing and Trim."
 3. Sleeves for Piping Passing through Gypsum-Board Partitions:
 - a. Galvanized-steel-pipe sleeves for pipes smaller than NPS 6.
 - b. Galvanized-steel-sheet sleeves for pipes NPS 6 and larger.
 - c. Exception: Sleeves are not required for water-supply tubes and waste pipes for individual plumbing fixtures if escutcheons will cover openings.
 4. Sleeves for Piping Passing through Concrete Roof Slabs: Galvanized-steel pipe.
 5. Sleeves for Piping Passing through Exterior Concrete Walls:
 - a. Galvanized-steel-pipe sleeves for pipes smaller than NPS 6.
 - b. Cast-iron wall-pipe sleeves for pipes NPS 6 and larger.

- c. Install sleeves that are large enough to provide 1-inch annular clear space between sleeve and pipe or pipe insulation when sleeve seals are used.
- 6. Sleeves for Piping Passing through Interior Concrete Walls:
 - a. Galvanized-steel-pipe sleeves for pipes smaller than NPS 6.
 - b. Galvanized-steel-sheet sleeves for pipes NPS 6 and larger.
- L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestop materials and installations in Division 07 Section "Penetration Firestopping."

3.11 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.12 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
 - 4. Energize circuits to electrical equipment and devices.
 - 5. Start and run excess-pressure pumps.
 - 6. Coordinate with fire-alarm tests. Operate as required.
 - 7. Verify that equipment hose threads are same as local fire-department equipment.
- C. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.13 CLEANING

- A. Clean dirt and debris from sprinklers.
- B. Remove and replace sprinklers with paint other than factory finish.

3.14 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specialty valves.

3.15 PIPING SCHEDULE

- A. Piping between Fire-Department Connections and Check Valves: Galvanized, standard-weight steel pipe with grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.

- B. Sprinkler specialty fittings may be used, downstream of control vales, instead of specified fittings.
- C. Standard-pressure, wet-pipe sprinkler system, NPS 2 and smaller, shall be one of the following:
 - 1. Schedule 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
 - 2. Schedule 30, black-steel pipe with plain ends; uncoated, plain-end-pipe fittings; and twist-locked joints.
 - 3. Schedule 30, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 - 4. Schedule 30, black-steel pipe with plain ends; steel welding fittings; and welded joints.
- D. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 to NPS 4, shall be one of the following:
 - 1. Schedule 30 galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
 - 2. Schedule 30, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 - 3. Schedule 30, black-steel pipe with plain ends; steel welding fittings; and welded joints.
- E. Standard-pressure, wet-pipe sprinkler system, NPS 5 and larger, shall be one of the following:
 - 1. Standard-weight, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 - 2. Standard-weight, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 - 3. Standard-weight, black-steel pipe with plain ends; steel welding fittings; and welded joints.

3.16 SPRINKLER SCHEDULE

- A. Use sprinkler types in subparagraphs below for the following applications:
 - 1. Rooms without Ceilings: Upright sprinklers.
 - 2. Rooms with Suspended Ceilings: Concealed sprinklers.
 - 3. Wall Mounting: Sidewall sprinklers.
 - 4. Spaces Subject to Freezing: Upright, pendent, dry sprinklers; and sidewall, dry sprinklers as indicated.
- B. Provide sprinkler types in subparagraphs below with finishes indicated.
 - 1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
 - 2. Flush Sprinklers: Bright chrome, with painted white escutcheon.
 - 3. Recessed Sprinklers: White chrome, with white chrome escutcheon.

END OF SECTION

SECTION 22 05 00

COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Transition fittings.
 - 3. Dielectric fittings.
 - 4. Mechanical sleeve seals.
 - 5. Sleeves.
 - 6. Escutcheons.
 - 7. Grout.
 - 8. Equipment installation requirements common to equipment sections.
 - 9. Painting and finishing.
 - 10. Concrete bases.
 - 11. Supports and anchorages.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for plastic materials:
 - 1. PVC: Polyvinyl chloride plastic.
- G. The following are industry abbreviations for rubber materials:
 - 1. EPDM: Ethylene-propylene-diene terpolymer rubber.
 - 2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

- A. Product Data: For the following:

1. Transition fittings.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Escutcheons.

- B. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
 2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

- A. Refer to individual Division 22 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
 - 2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
- G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- H. Solvent Cements for Joining Plastic Piping:
 - 1. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
- I. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.4 TRANSITION FITTINGS

- A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
 - 1. Manufacturers:
 - a. Cascade Waterworks Mfg. Co.
 - b. Dresser Industries, Inc.; DMD Div.
 - c. Ford Meter Box Company, Incorporated (The); Pipe Products Div.
 - d. JCM Industries.
 - e. Smith-Blair, Inc.
 - f. Viking Johnson.
 - 2. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.
 - 3. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.
 - 4. Aboveground Pressure Piping: Pipe fitting.

- B. Plastic-to-Metal Transition Fittings: PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
 - 1. Manufacturers:
 - a. Eslon Thermoplastics.
- C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
 - 1. Manufacturers:
 - a. Thompson Plastics, Inc.
- D. Plastic-to-Metal Transition Unions: MSS SP-107, PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
 - 1. Manufacturers:
 - a. NIBCO INC.
 - b. NIBCO, Inc.; Chemtrol Div.
- E. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.
 - 1. Manufacturers:
 - a. Cascade Waterworks Mfg. Co.
 - b. Fernco, Inc.
 - c. Mission Rubber Company.
 - d. Plastic Oddities, Inc.

2.5 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
 - 1. Manufacturers:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Company.
 - c. Eclipse, Inc.
 - d. Epco Sales, Inc.
 - e. Hart Industries, International, Inc.
 - f. Watts Industries, Inc.; Water Products Div.
 - g. Zurn Industries, Inc.; Wilkins Div.
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
 - 1. Manufacturers:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Company.
 - c. Epco Sales, Inc.
 - d. Watts Industries, Inc.; Water Products Div.
- E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
 - 1. Manufacturers:

- a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Central Plastics Company.
 - d. Pipeline Seal and Insulator, Inc.
 2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.
- F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
 1. Manufacturers:
 - a. Calpico, Inc.
 - b. Lochinvar Corp.
- G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.
 1. Manufacturers:
 - a. Perfection Corp.
 - b. Precision Plumbing Products, Inc.
 - c. Sioux Chief Manufacturing Co., Inc.
 - d. Victaulic Co. of America.

2.6 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
 1. Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. Pipeline Seal and Insulator, Inc.
 2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 3. Pressure Plates: Carbon steel. Include two for each sealing element.
 4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.7 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 1. Underdeck Clamp: Clamping ring with set screws.
- E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
- F. PVC Pipe: ASTM D 1785, Schedule 40.

2.8 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type: With set screw.
 - 1. Finish: Polished chrome-plated.
- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
 - 1. Finish: Polished chrome-plated.
- E. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.
- F. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw or spring clips, and chrome-plated finish.
- G. One-Piece, Floor-Plate Type: Cast-iron floor plate.
- H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.9 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- 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 otherwise.
- 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. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 1. Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
 - c. Insulated Piping: One-piece, stamped-steel type with spring clips.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
 - f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.
 - g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge and set screw.
 - h. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
 - i. Bare Piping in Equipment Rooms: One-piece, stamped-steel type with set screw or spring clips.
 - j. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

3.2 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. PVC Nonpressure Piping: Join according to ASTM D 2855.
- J. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.
- K. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.3 PIPING CONNECTIONS

- A. Make connections according to 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. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
 - 4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.5 PAINTING

- A. Painting of plumbing systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.6 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

3.8 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor plumbing materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.9 GROUTING

- A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

END OF SECTION

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SECTION 22 05 29

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following hangers and supports for plumbing system piping and equipment:
 - 1. Steel pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Fastener systems.
 - 5. Equipment supports.
- B. Related Sections include the following:
 - 1. Division 21 Section "Water-Based Fire-Suppression Systems" for pipe hangers for fire-suppression piping.
 - 2. Division 22 Section "Expansion Fittings and Loops for Plumbing Piping" for pipe guides and anchors.
 - 3. Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for vibration isolation devices.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel pipe hangers and supports.
 - 2. Powder-actuated fastener systems.
 - 3. Pipe positioning systems.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze pipe hangers. Include Product Data for components.
 - 2. Metal framing systems. Include Product Data for components.
 - 3. Equipment supports.

PART 2 - PRODUCTS

2.1 STEEL PIPE HANGERS AND SUPPORTS

- A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

- B. Manufacturers:
 - 1. B-Line Systems, Inc.; a division of Cooper Industries.
 - 2. Empire Industries, Inc.
 - 3. Globe Pipe Hanger Products, Inc.
 - 4. Grinnell Corp.
 - 5. National Pipe Hanger Corporation.
- C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.
- E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.2 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.3 METAL FRAMING SYSTEMS

- A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
- B. Manufacturers:
 - 1. B-Line Systems, Inc.; a division of Cooper Industries.
 - 2. Power-Strut Div.; Tyco International, Ltd.
 - 3. Unistrut Corp.; Tyco International, Ltd.
- C. Coatings: Manufacturer's standard finish unless bare metal surfaces are indicated.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.4 THERMAL-HANGER SHIELD INSERTS

- A. Description: 100-psig- minimum, compressive-strength insulation insert encased in sheet metal shield.
- B. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with vapor barrier.
- C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate.
- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use padded hangers for piping that is subject to scratching.
- F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
 - 2. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
 - 3. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
 - 4. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 - 5. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8.
 - 6. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
 - 7. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
 - 8. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.
 - 9. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8.
 - 10. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3.
 - 11. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
 - 12. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 - 13. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
 - 14. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
 - 15. Adjustable, Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
- G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.

2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
- H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
- J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- K. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.
- L. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
- M. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
- C. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- D. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- E. Install lateral bracing with pipe hangers and supports to prevent swaying.
- F. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- G. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- H. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.
- I. Insulated Piping: Comply with the following:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits according to ASME B31.9 for building services piping.
 - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make smooth bearing surface.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers.

3.5 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

- A. Touch Up: 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. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

SECTION 22 05 53

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Stencils.
 - 5. Valve tags.
 - 6. Warning tags.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

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

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Metal Labels for Equipment:

1. Material and Thickness: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 4. Fasteners: Stainless-steel self-tapping screws.
 5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Plastic Labels for Equipment:
1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
 2. Letter Color: Black, Red.
 3. Background Color: Blue, Red, White, Yellow.
 4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 7. Fasteners: Stainless-steel rivets or self-tapping screws.
 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
- D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: Black.
- C. Background Color: Yellow.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches high.

2.4 STENCILS

- A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.
 - 1. Stencil Material: Fiberboard or metal.
 - 2. Stencil Paint: Exterior, gloss, acrylic enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
 - 3. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1 unless otherwise indicated.

2.5 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
 - 1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Fasteners: Brass S-hook.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or

space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

2.6 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
 1. Size: Approximately 4 by 7 inches.
 2. Fasteners: Brass grommet and wire.
 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 EQUIPMENT LABEL INSTALLATION

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

3.3 PIPE LABEL INSTALLATION

- A. Piping Color-Coding: Painting of piping is specified in Division 09 Section " High-Performance Coatings."
- B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, on each piping system.
 1. Identification Paint: Use for contrasting background.
 2. Stencil Paint: Use for pipe marking.
- C. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 1. Near each valve and control device.
 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 5. Near major equipment items and other points of origination and termination.

6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
8. Domestic Water Piping:
 - a. Background Color: Yellow.
 - b. Letter Color: Black.
9. Sanitary Waste and Storm Drainage Piping:
 - a. Background Color: White.
 - b. Letter Color: Black.

3.4 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

Valve-Tag Size and Shape:

- a. Cold Water: 1-1/2 inches, round.
 - b. Hot Water: 1-1/2 inches, round.
- C. Valve-Tag Color:
 - a. Cold Water: Green.
 - b. Hot Water: Green.
2. Letter Color:
 - a. Cold Water: Black.
 - b. Hot Water: Black.

3.5 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required

END OF SECTION

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SECTION 22 07 00

PLUMBING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Insulation Materials:
 - a. Cellular glass.
 - b. Flexible elastomeric.
 - c. Mineral fiber.
 - 2. Factory-applied jackets.
 - 3. Field-applied jackets.
 - 4. Securements.
- B. Related Sections include the following:
 - 1. Division 21 Section "Fire-Suppression Systems Insulation."
 - 2. Division 23 Section "HVAC Insulation."

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).
- B. Qualification Data: For qualified Installer.
- C. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- D. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application and equipment Installer for equipment insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cell-U-Foam Corporation; Ultra-CUF.
 - b. Pittsburgh Corning Corporation; Foamglas Super K.
 - 2. Block Insulation: ASTM C 552, Type I.
 - 3. Special-Shaped Insulation: ASTM C 552, Type III.
 - 4. Board Insulation: ASTM C 552, Type IV.
 - 5. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.

6. Preformed Pipe Insulation with Factory-Applied ASJ-SSL]: Comply with ASTM C 552, Type II, Class 2.
 7. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- G. Mineral-Fiber, Preformed Pipe Insulation:
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Johns Manville; Micro-Lok.
 - b. Knauf Insulation; 1000(Pipe Insulation.
 - c. Owens Corning; Fiberglas Pipe Insulation.
 2. Type I, 850 deg F (454 deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
1. Verify that systems and equipment to be insulated have been tested and are free of defects.
 2. Verify that surfaces to be insulated are clean and dry.
 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
1. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F (0 and 149 deg C) with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment and pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- O. For above ambient services, do not install insulation to the following:
 - 1. Vibration-control devices.
 - 2. Testing agency labels and stamps.
 - 3. Nameplates and data plates.
 - 4. Manholes.
 - 5. Handholes.
 - 6. Cleanouts.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).
 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
1. Comply with requirements in Division 07 Section "Penetration Firestopping" firestopping and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
1. Pipe: Install insulation continuously through floor penetrations.
 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 6. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 7. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 8. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches (50 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
 5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 CELLULAR-GLASS INSULATION INSTALLATION

- A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 3. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
 4. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- B. Insulation Installation on Pipe Flanges:
1. Install preformed pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
 4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.
- C. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
 2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.
- D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of cellular-glass insulation to valve body.
 2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 3. Install insulation to flanges as specified for flange insulation application.

3.7 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
1. Install pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
 4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
1. Install mitered sections of pipe insulation.
 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed valve covers manufactured of same material as pipe insulation when available.
 2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 3. Install insulation to flanges as specified for flange insulation application.
 4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.8 MINERAL-FIBER INSULATION INSTALLATION

- A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
 4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- B. Insulation Installation on Pipe Flanges:
1. Install preformed pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
 4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.
- C. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
 2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.
- D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
 2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
 3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 4. Install insulation to flanges as specified for flange insulation application.

3.9 FINISHES

- A. Equipment and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.
1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

3.10 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 - 1. Drainage piping located in crawl spaces.
 - 2. Underground piping.
 - 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.11 INDOOR PIPING INSULATION SCHEDULE

- A. Domestic Cold Water:
 - 1. NPS 1 and Smaller: Insulation shall be one of the following:
 - 2. Retain one or more of six subparagraphs below.
 - 3. Cellular Glass: 1/2 inch thick.
 - 4. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.
 - 5. NPS 1-1/4 and Larger: Insulation shall be one of the following:
 - a. Retain one or more of six subparagraphs below.
 - b. Cellular Glass: 1 inch thick.
 - c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
- B. Domestic Hot and Recirculated Hot Water:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Retain one or more of six subparagraphs below.
 - b. Cellular Glass: 1 inch thick.
 - c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
- C. Stormwater and Overflow:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Retain one or more of six subparagraphs below.
 - b. Cellular Glass: 1 inch thick.
 - c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
 - 2. Insulation on horizontal piping shall be provided until piping turns down to vertical riser. Elbow turning down to vertical riser shall be insulated.
- D. Roof Drain and Overflow Drain Bodies:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Retain one or more of six subparagraphs below.
 - b. Cellular Glass: 1 inch thick.
 - c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
- E. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - 2. Retain one or more of three subparagraphs below.
 - 3. Flexible Elastomeric: 1/2 inch thick.
 - 4. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.
- F. Sanitary Waste Piping Where Heat Tracing Is Installed:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - 2. Retain one or more of four subparagraphs below.
 - 3. Cellular Glass: 1-1/2 inches thick.
 - 4. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 inches thick.

- G. Condensate and Equipment Drain Water:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - 2. Retain one or more of six subparagraphs below.
 - 3. Cellular Glass: 1/2 inches thick.
 - 4. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.

- H. Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet of Drain Receiving Condensate and Equipment Drain Water:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Cellular Glass: 1 inch thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

END OF SECTION

SECTION 22 11 16

DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
 - 2. Encasement for piping.
 - 3. Specialty valves.
 - 4. Flexible connectors.
 - 5. Escutcheons.
 - 6. Sleeves and sleeve seals.
 - 7. Wall penetration systems.

1.3 SUBMITTALS

- A. Product Data: For the following products:
 - 1. Specialty valves.
 - 2. Transition fittings.
 - 3. Dielectric fittings.
 - 4. Flexible connectors.
 - 5. Backflow preventers.
 - 6. Escutcheons.
 - 7. Sleeves and sleeve seals.
 - 8. Water penetration systems.
- B. Water Samples: Specified in "Cleaning" Article.
- C. Coordination Drawings: For piping in equipment rooms and other congested areas, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
 - 1. Fire-suppression-water piping.
 - 2. Domestic water piping.
- D. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14 for plastic, potable domestic water piping and components.
- C. Comply with NSF 61 for potable domestic water piping and components.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. 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.

2.2 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: Type L water tube, drawn temper.
 - 1. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
 - 2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
 - 3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

2.3 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.
- B. Dielectric Unions:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hart Industries International, Inc.
 - b. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - c. Zurn Plumbing Products Group; Wilkins Water Control Products.
 - 2. Description:
 - a. Pressure Rating: 150 psig.
 - b. End Connections: Solder-joint copper alloy and threaded ferrous.

2.4 SLEEVES

- A. Cast-Iron Wall Pipes: Fabricated of cast iron, and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc-coated, with plain ends.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

- B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- C. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages and Division 22 Section "Domestic Water Piping Specialties" for drain valves and strainers.
- D. Install shutoff valve immediately upstream of each dielectric fitting.
- E. Install domestic water piping level and plumb.
- F. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- G. 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.
- H. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- I. Install piping adjacent to equipment and specialties to allow service and maintenance.
- J. Install piping to permit valve servicing.
- K. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.
- L. Install piping free of sags and bends.
- M. Install fittings for changes in direction and branch connections.
- N. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- O. Install thermostats in hot-water circulation piping. Comply with requirements in Division 22 Section "Domestic Water Pumps" for thermostats.
- P. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers,

3.3 VALVE INSTALLATION

- A. General-Duty Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for valve installations.
- B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball or gate valves for piping NPS 2 and smaller. Use butterfly or gate valves for piping NPS 2-1/2 and larger.
- C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Division 22 Section "Domestic Water Piping Specialties."
 - 1. Hose-End Drain Valves: At low points in water mains, risers, and branches.

2. Stop-and-Waste Drain Valves: Instead of hose-end drain valves where indicated.
- D. Install balancing valve in each hot-water circulation return branch and discharge side of each pump and circulator. Set balancing valves partly open to restrict but not stop flow. Use ball valves for piping NPS 2 and smaller and butterfly valves for piping NPS 2-1/2 and larger. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.
 1. Vertical Piping: MSS Type 8 or 42 clamps.
 2. Individual, Straight, Horizontal Piping Runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet If Indicated: MSS Type 49, spring cushion rolls.
 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Support vertical piping and tubing at base and at each floor.
- C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.
- D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
 2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
 3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 4. NPS 2-1/2: 108 inches with 1/2-inch rod.
 5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
 6. NPS 6: 10 feet with 5/8-inch rod.
 7. NPS 8: 10 feet with 3/4-inch rod.
- E. Install supports for vertical copper tubing every 10 feet.
- F. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
 3. NPS 2: 10 feet with 3/8-inch rod.
 4. NPS 2-1/2: 11 feet with 1/2-inch rod.
 5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
 6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
 7. NPS 6: 12 feet with 3/4-inch rod.
 8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.
- G. Install supports for vertical steel piping every 15 feet.

3.5 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment and machines to allow service and maintenance.

- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
 - 1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
 - 2. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements in Division 22 plumbing fixture Sections for connection sizes.
 - 3. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.6 IDENTIFICATION

- A. Identify system components. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment" for identification materials and installation.
- B. Label pressure piping with system operating pressure.

3.7 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Piping Inspections:
 - 1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 - 2. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
 - 3. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
 - 4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- C. Piping Tests:
 - 1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 - 2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
 - 3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 4. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - 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 for corrective action required.

- D. Domestic water piping will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.8 ADJUSTING

- A. Perform the following adjustments before operation:
 - 1. Close drain valves, hydrants, and hose bibbs.
 - 2. Open shutoff valves to fully open position.
 - 3. Open throttling valves to proper setting.
 - 4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
 - b. Adjust calibrated balancing valves to flows indicated.
 - 5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
 - 6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
 - 7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
 - 8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.9 CLEANING

- A. Clean and disinfect potable domestic water piping as follows:
 - 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 - 2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
 - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

3.10 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

END OF SECTION

SECTION 22 13 16

SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following for soil, waste, and vent piping inside the building:
 - 1. Pipe, tube, and fittings.
 - 2. Special pipe fittings.

1.3 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:
 - 1. Soil, Waste, and Vent Piping: 30 foot head of water.

1.4 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.
- B. Shop Drawings: Submit storm piping shop drawings.

1.5 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 74, Service class.
- B. Gaskets: ASTM C 564, rubber.
- C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.3 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
 - 1. Standard, Shielded, Stainless-Steel Couplings: CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve.
 - a. Manufacturers:

- 1) Charlotte Pipe and Foundry Company.
- 2) Fernco, Inc.
- 3) Ideal Div.; Stant Corp.
- 4) Mission Rubber Co.
- 5) Tyler Pipe; Soil Pipe Div.

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

- A. Aboveground, soil and waste piping shall be the following:
 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless cast-iron soil pipe and fittings, couplings, and hubless-coupling joints.
- B. Aboveground, vent piping shall be the following:
 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless cast-iron soil pipe and fittings; couplings; and hubless-coupling joints.
- C. Underground, soil, waste, and vent piping shall be the following:
 1. Service class, cast-iron soil piping; gasketed joints.

3.3 PIPING INSTALLATION

- A. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- B. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.
- C. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight.
- D. Install wall-penetration fitting at each service pipe penetration through foundation wall. Make installation watertight.
- E. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
- F. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. 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. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- G. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants,

cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

- H. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
 - 1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
 - 2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
 - 3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- I. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.
- J. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:
 - 1. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 2. Install individual, straight, horizontal piping runs according to the following:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
 - 2. NPS 3: 60 inches with 1/2-inch rod.
 - 3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
 - 4. NPS 6: 60 inches with 3/4-inch rod.
 - 5. NPS 8 to NPS 12: 60 inches with 7/8-inch rod.
- F. Install supports for vertical cast-iron soil piping every 15 feet.

3.5 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 drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage 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 drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

3.6 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 drainage and vent piping according to 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. 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 drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. 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. 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. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. 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.

3.7 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains 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.

END OF SECTION 22 13 16

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SECTION 22 33 00

ELECTRIC DOMESTIC WATER HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following electric water heaters:
 - 1. Flow-control, instantaneous electric water heaters.
 - 2. Commercial, storage electric water heaters.
 - 3. Water heater accessories.

1.3 SUBMITTALS

- A. Product Data: For each type and size of water heater indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Product Certificates: For each type of commercial and instantaneous electric water heater, signed by product manufacturer.
- C. Source quality-control test reports.
- D. Operation and Maintenance Data: For electric water heaters to include in emergency, operation, and maintenance manuals.
- E. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain same type of electric water heaters through one source from a single manufacturer.
- B. Product Options: Drawings indicate size, profiles, and dimensional requirements of electric water heaters and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. ASME Compliance: Where indicated, fabricate and label commercial water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- E. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," for all components that will be in contact with potable water.

1.5 COORDINATION

- A. Coordinate size and location of concrete bases with Architectural and Structural Drawings.

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric water heaters that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including storage tank and supports.
 - b. Faulty operation of controls.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
 - 2. Warranty Period(s): From date of Substantial Completion:
 - a. Instantaneous Electric Water Heaters: One year.
 - b. Commercial Electric Water Heaters:
 - 1) Storage Tank: Three years.
 - 2) Controls and Other Components: Three years.
 - c. Compression Tanks: One year.

PART 2 - PRODUCTS

2.1 INSTANTANEOUS ELECTRIC WATER HEATERS

- A. Flow-Control, Instantaneous Electric Water Heaters: Comply with UL 499 for tankless electric (water heater) heating appliance.
 - 1. Manufacturers:
 - a. Chronomite Laboratories, Inc.
 - b. Controlled Energy Corporation.
 - c. Eemax, Inc.
 - d. Hot Aqua, Inc.
 - e. IMI Waterheating, Ltd.
 - f. Stiebel Eltron, Inc.
 - 2. Construction: Copper piping or tubing complying with NSF 61 barrier materials for potable water, without storage capacity.
 - a. Connections: ASME B1.20.1 pipe thread.
 - b. Pressure Rating: 150 psig.
 - c. Heating Element: Resistance heating system.
 - d. Temperature Control: Flow-control fitting.
 - e. Safety Control: High-temperature-limit cutoff device or system.
 - f. Jacket: Aluminum or steel with enameled finish or plastic.
 - 3. Support: Bracket for wall mounting.

2.2 COMMERCIAL ELECTRIC WATER HEATERS

- A. Commercial Electric Heaters: Comply with UL 1453.
 - 1. Manufacturers:
 - a. Bradford White Corporation.
 - b. Lochinvar Corporation.
 - c. PVI.
 - d. Smith, A. O. Water Products Company.
 - 2. Storage-Tank Construction: Corrosion-resistant metal or steel.
 - a. Tappings: ASME B1.20.1 pipe thread.
 - b. Pressure Rating: 150 psig.
 - c. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.

3. Factory-Installed Storage-Tank Appurtenances:
 - a. Anode Rod: Replaceable magnesium.
 - b. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
 - c. Insulation: Comply with ASHRAE/IESNA 90.1.
 - d. Jacket: Rectangular shaped, with stainless-steel front panel, unless otherwise indicated.
 - e. Heating Elements: Electric, screw-in or bolt-on immersion type arranged in multiples of three.
 - 1) Option: Booster heaters with 9 kW or less total may have 2 or 3 elements.
 - 2) Staging: Input not exceeding 18 kW per step.
 - f. Temperature Control: Adjustable thermostat, to setting of at least 180 deg F.
 - g. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
 - h. Relief Valve: ASME rated and stamped and complying with ASME PTC 25.3, combination temperature and pressure relief valve. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valve with sensing element that extends into storage tank.
 - i. Gages: Combination temperature and pressure type or separate thermometer and pressure gage.
4. Special Requirements: NSF 5 construction with legs for floor installation.

2.3 COMPRESSION TANKS

- A. Description: Steel pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
 1. Manufacturers:
 - a. AMTROL Inc.
 - b. Armstrong Pumps, Inc.
 - c. Smith, A. O.; Aqua-Air Div.
 - d. State Industries, Inc.
 - e. Taco, Inc.
 - f. Watts Regulator Co.
 2. Construction:
 - a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1, pipe thread.
 - b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
 - c. Air-Charging Valve: Factory installed.

2.4 WATER HEATER ACCESSORIES

- A. Combination Temperature and Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.
- B. Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include pressure setting less than water heater working-pressure rating.
- C. Drain Pans: Corrosion-resistant metal with raised edge. Include dimensions not less than base of water heater and include drain outlet not less than NPS 3/4.
- D. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1 or ASHRAE 90.2.

- E. Water Regulators: ASSE 1003, water-pressure reducing valve. Set at 25-psig- maximum outlet pressure, unless otherwise indicated.
- F. Shock Absorbers: ASSE 1010 or PDI WH 201, Size A water hammer arrester.

2.5 SOURCE QUALITY CONTROL

- A. Test and inspect water heater storage tanks, specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.
- B. Hydrostatically test commercial water heater storage tanks before shipment to minimum of one and one-half times pressure rating.
- C. Prepare test reports.

PART 3 - EXECUTION

3.1 WATER HEATER INSTALLATION

- A. Install commercial water heaters on concrete bases.
 - 1. Exception: Omit concrete bases for commercial water heaters if installation on stand, bracket, suspended platform, or direct on floor is indicated.
 - 2. Concrete base construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- B. Install water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
- C. Install combination temperature and pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- D. Install combination temperature and pressure relief valves in water piping for water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- E. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for water heaters that do not have tank drains. Refer to Division 22 Section "Domestic Water Piping Specialties" for hose-end drain valves.
- F. Install thermometer on outlet piping of water heaters. Refer to Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers.
- G. Install piping-type heat traps on inlet and outlet piping of water heater storage tanks without integral or fitting-type heat traps.
- H. Fill water heaters with water.
- I. Charge compression tanks with air.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to water heaters to allow service and maintenance. Arrange piping for easy removal of water heaters.

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, confirm proper operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace water heaters that do not pass tests and inspections and retest as specified above.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial and instantaneous electric water heaters. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

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SECTION 22 40 00

PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following conventional plumbing fixtures and related components:
 - 1. Faucets for lavatories, showers and sinks.
 - 2. Laminar-flow faucet-spout outlets.
 - 3. Flushometers.
 - 4. Toilet seats.
 - 5. Protective shielding guards.
 - 6. Fixture supports.
 - 7. Shower receptors.
 - 8. Disposers.
 - 9. Water closets.
 - 10. Urinals.
 - 11. Lavatories.
 - 12. Break Room sinks.
 - 13. Individual showers.
 - 14. Service sinks.
 - 15. Service basins.
- B. Related Sections include the following:
 - 1. Division 10 Section "Toilet and Laundry Accessories."
 - 2. Division 22 Section "Domestic Water Piping Specialties" for backflow preventers, floor drains, and specialty fixtures not included in this Section.
 - 3. Division 31 Section "Facility Water Distribution Piping" for exterior plumbing fixtures and hydrants.

1.3 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.
- C. Cast Polymer: Cast-filled-polymer-plastic material. This material includes cultured-marble and solid-surface materials.
- D. Cultured Marble: Cast-filled-polymer-plastic material with surface coating.
- E. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.
- F. FRP: Fiberglass-reinforced plastic.

- G. PMMA: Polymethyl methacrylate (acrylic) plastic.
- H. PVC: Polyvinyl chloride plastic.
- I. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.

1.4 SUBMITTALS

- A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Operation and Maintenance Data: For plumbing fixtures to include in emergency, operation, and maintenance manuals.
- D. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.
 - 1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities" and Texas Accessibility Standard for plumbing fixtures for people with disabilities.
- D. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
- E. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
- F. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.
- G. Comply with the following applicable standards and other requirements specified for plumbing fixtures:
 - 1. Plastic Mop-Service Basins: ANSI Z124.6.
 - 2. Plastic Shower Enclosures: ANSI Z124.2.
 - 3. Solid-Surface-Material Lavatories and Sinks: ANSI/ICPA SS-1.
 - 4. Stainless-Steel Residential Sinks: ASME A112.19.3.
 - 5. Vitreous-China Fixtures: ASME A112.19.2M.
 - 6. Water-Closet, Flushometer Tank Trim: ASSE 1037.

1.6 WARRANTY

- A. Special Warranties: Manufacturer's standard form in which manufacturer agrees to repair or replace components of whirlpools that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures of unit shell.
 - b. Faulty operation of controls, blowers, pumps, heaters, and timers.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
 - 2. Warranty Period for Commercial Applications: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PLUMBING FIXTURES

- A. Refer to Drawings for fixture specifications.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.
- B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.
- B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.
 - 1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
 - 2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
 - 3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.
- C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.
- D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.
- E. Install wall-mounting fixtures with tubular waste piping attached to supports.
- F. Install counter-mounting fixtures in and attached to casework.
- G. Install fixtures level and plumb according to roughing-in drawings.
- H. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

1. Exception: Use ball, gate, or globe valves if supply stops are not specified with fixture. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
- I. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.
- J. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.
- K. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.
- L. Install toilet seats on water closets.
- M. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- N. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.
- O. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- P. Install traps on fixture outlets.
- Q. Install disposer in outlet of each sink indicated to have disposer. Install switch where indicated or in wall adjacent to sink if location is not indicated.
- R. Install dishwasher air-gap fitting at each sink indicated to have air-gap fitting. Connect inlet hose to dishwasher and outlet hose to disposer.
- S. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."
- T. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

3.4 FIELD QUALITY CONTROL

- A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.
- B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.

- C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.
- D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

3.5 ADJUSTING

- A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
- B. Adjust water pressure at faucets and flushometer valves to produce proper flow and stream.
- C. Replace washers and seals of leaking and dripping faucets and stops.

3.6 CLEANING

- A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:
 - 1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
 - 2. Remove sediment and debris from drains.
- B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.7 PROTECTION

- A. Provide protective covering for installed fixtures and fittings.
- B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION

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SECTION 23 05 00

COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Transition fittings.
 - 3. Dielectric fittings.
 - 4. Mechanical sleeve seals.
 - 5. Sleeves.
 - 6. Escutcheons.
 - 7. Grout.
 - 8. HVAC demolition.
 - 9. Equipment installation requirements common to equipment sections.
 - 10. Painting and finishing.
 - 11. Concrete bases.
 - 12. Supports and anchorages.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for plastic materials:
 - 1. CPVC: Chlorinated polyvinyl chloride plastic.
 - 2. PVC: Polyvinyl chloride plastic.
- G. The following are industry abbreviations for rubber materials:
 - 1. EPDM: Ethylene-propylene-diene terpolymer rubber.
 - 2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Transition fittings.
 - 2. Dielectric fittings.
 - 3. Mechanical sleeve seals.
 - 4. Escutcheons.
- B. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

- A. Refer to individual Division 23 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
 2. AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
- G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- H. Solvent Cements for Joining Plastic Piping:
 1. CPVC Piping: ASTM F 493.
 2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
- I. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.4 TRANSITION FITTINGS

- A. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
 1. Manufacturer:
 - a. Eslon Thermoplastics.
- B. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
 1. Manufacturer:

- a. Thompson Plastics, Inc.
- C. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
 - 1. Manufacturer:
 - a. NIBCO INC.

2.5 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C).
 - 1. Manufacturers:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Company.
 - c. Eclipse, Inc.
 - d. Epco Sales, Inc.
 - e. Hart Industries, International, Inc.
 - f. Watts Industries, Inc.; Water Products Div.
 - g. Zurn Industries, Inc.; Wilkins Div.
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.
 - 1. Manufacturers:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Company.
 - c. Epco Sales, Inc.
 - d. Watts Industries, Inc.; Water Products Div.
- E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
 - 1. Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Central Plastics Company.
 - d. Pipeline Seal and Insulator, Inc.
 - 2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig (1035- or 2070-kPa) minimum working pressure where required to suit system pressures.
- F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).
 - 1. Manufacturers:
 - a. Calpico, Inc.
 - b. Lochinvar Corp.
- G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).
 - 1. Manufacturers:

- a. Perfection Corp.
- b. Precision Plumbing Products, Inc.
- c. Sioux Chief Manufacturing Co., Inc.
- d. Victaulic Co. of America.

2.6 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
 - 1. Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. Pipeline Seal and Insulator, Inc.
 - 2. Sealing Elements: EPDM or NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 3. Pressure Plates: Carbon steel or stainless steel. Include two for each sealing element.
 - 4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating or stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.7 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

2.8 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type: With set screw.
 - 1. Finish: Polished chrome-plated.
- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
 - 1. Finish: Polished chrome-plated.
- E. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.
- F. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw or spring clips, and chrome-plated finish.
- G. One-Piece, Floor-Plate Type: Cast-iron floor plate.
- H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.9 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 HVAC DEMOLITION

- A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.
- B. Disconnect, demolish, and remove HVAC systems, equipment, and components indicated to be removed.
 - 1. Piping to Be Removed: Remove portion of piping in its entirety. If a portion of piping is to remain active, plug remaining piping with same or compatible piping material.
 - 2. Ducts to Be Removed: Remove portion of duct in its entirety. If a portion of duct is to remain active, cap and seal with same or compatible ductwork material.
 - 3. Equipment to Be Removed: Disconnect and cap services and remove equipment including housekeeping pad.
- C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- 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 otherwise.
- 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. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors.
- M. Install sleeves for pipes passing through concrete and masonry walls, rated gypsum-board partitions, and concrete floor and roof slabs.
- N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.
 - 2. Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) and larger in diameter.
 - 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- O. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
- Q. Verify final equipment locations for roughing-in.
- R. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.3 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
 - 3. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
 - 4. PVC Nonpressure Piping: Join according to ASTM D 2855.
- J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.
- K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.
- L. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
 - 1. Plain-End Pipe and Fittings: Use butt fusion.
 - 2. Plain-End Pipe and Socket Fittings: Use socket fusion.
- M. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.4 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.
 - 3. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

- C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.6 PAINTING

- A. Painting of HVAC systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.7 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
 - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.
 - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of the base.
 - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
 - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
 - 7. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

3.8 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

3.9 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor HVAC materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.10 GROUTING

- A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

END OF SECTION

SECTION 23 05 29

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following hangers and supports for HVAC system piping and equipment:
 - 1. Steel pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Fiberglass pipe hangers.
 - 4. Metal framing systems.
 - 5. Fiberglass strut systems.
 - 6. Thermal-hanger shield inserts.
 - 7. Fastener systems.
 - 8. Pipe stands.
 - 9. Equipment supports.
- B. Related Sections include the following:
 - 1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
 - 2. Division 21 Section "Water-Based Fire-Suppression Systems" for pipe hangers for fire-protection piping.
 - 3. Division 23 Section "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
 - 4. Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for vibration isolation devices.
 - 5. Division 23 Section(s) "Metal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- C. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.5 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel pipe hangers and supports.
 - 2. Fiberglass pipe hangers.
 - 3. Thermal-hanger shield inserts.
 - 4. Powder-actuated fastener systems.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze pipe hangers. Include Product Data for components.
 - 2. Metal framing systems. Include Product Data for components.
 - 3. Fiberglass strut systems. Include Product Data for components.
 - 4. Pipe stands. Include Product Data for components.
 - 5. Equipment supports.
- C. Welding certificates.

1.6 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1, "Structural Welding Code--Steel."
 - 2. AWS D1.2, "Structural Welding Code--Aluminum."
 - 3. AWS D1.3, "Structural Welding Code--Sheet Steel."
 - 4. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
 - 5. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 STEEL PIPE HANGERS AND SUPPORTS

- A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
- B. Available Manufacturers:
 - 1. B-Line Systems, Inc.; a division of Cooper Industries.
 - 2. ERICO/Michigan Hanger Co.
 - 3. Grinnell Corp.
 - 4. National Pipe Hanger Corporation.
 - 5. Piping Technology & Products, Inc.
- C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

- E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.3 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.4 FIBERGLASS PIPE HANGERS

- A. Clevis-Type, Fiberglass Pipe Hangers: Similar to MSS Type 1, steel pipe hanger except hanger is made of fiberglass and continuous-thread rod and nuts are made of stainless steel.
 - 1. Available Manufacturers:
 - a. B-Line Systems, Inc.; a division of Cooper Industries.
 - b. Cope, T. J., Inc.; Tyco International, Ltd.
 - c. Unistrut Corp.; Tyco International, Ltd.
- B. Strap-Type, Fiberglass Pipe Hangers: Made of fiberglass loop with stainless-steel continuous-thread rod, nuts, and support hook.
 - 1. Available Manufacturers:
 - a. Plasti-Fab, Inc.

2.5 METAL FRAMING SYSTEMS

- A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
- B. Available Manufacturers:
 - 1. B-Line Systems, Inc.; a division of Cooper Industries.
 - 2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
 - 3. Power-Strut Div.; Tyco International, Ltd.
 - 4. Unistrut Corp.; Tyco International, Ltd.
- C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.6 FIBERGLASS STRUT SYSTEMS

- A. Description: Shop- or field-fabricated pipe-support assembly, similar to MFMA-3, made of fiberglass channels and other components.
- B. Available Manufacturers:
 - 1. B-Line Systems, Inc.; a division of Cooper Industries.
 - 2. Champion Fiberglass, Inc.
 - 3. Cope, T. J., Inc.; Tyco International Ltd.

2.7 THERMAL-HANGER SHIELD INSERTS

- A. Description: 100-psig- (690-kPa-) minimum, compressive-strength insulation insert encased in sheet metal shield.
- B. Available Manufacturers:
 - 1. ERICO/Michigan Hanger Co.
 - 2. Pipe Shields, Inc.

3. Rilco Manufacturing Company, Inc.
- C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass with vapor barrier.
- D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.
- E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- G. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.8 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 1. Available Manufacturers:
 - a. Hilti, Inc.
 - b. Masterset Fastening Systems, Inc.
 - c. MKT Fastening, LLC.
- B. Mechanical-Expansion Anchors: Insert-wedge-type stainless steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 1. Available Manufacturers:
 - a. B-Line Systems, Inc.; a division of Cooper Industries.
 - b. Hilti, Inc.
 - c. MKT Fastening, LLC.

2.9 EQUIPMENT SUPPORTS

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

2.10 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.

- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use padded hangers for piping that is subject to scratching.
- F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30 (DN 15 to DN 750).
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F (49 to 232 deg C) pipes, NPS 4 to NPS 16 (DN 100 to DN 400), requiring up to 4 inches (100 mm) of insulation.
 - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24 (DN 20 to DN 600), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
 - 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24 (DN 15 to DN 600), if little or no insulation is required.
 - 5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4 (DN 15 to DN 100), to allow off-center closure for hanger installation before pipe erection.
 - 6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8 (DN 20 to DN 200).
 - 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8 (DN 15 to DN 200).
 - 8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8 (DN 15 to DN 200).
 - 9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2 (DN 15 to DN 50).
 - 10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8 (DN 10 to DN 200).
 - 11. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3 (DN 10 to DN 80).
 - 12. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30 (DN 15 to DN 750).
 - 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 - 14. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36 (DN 100 to DN 900), with steel pipe base stanchion support and cast-iron floor flange.
 - 15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36 (DN 100 to DN 900), with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
 - 16. Adjustable, Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36 (DN 65 to DN 900), if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
 - 17. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30 (DN 25 to DN 750), from 2 rods if longitudinal movement caused by expansion and contraction might occur.
 - 18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20 (DN 65 to DN 500), from single rod if horizontal movement caused by expansion and contraction might occur.

19. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42 (DN 50 to DN 1050), if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
 20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24 (DN 50 to DN 600), if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
 21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30 (DN 50 to DN 750), if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20 (DN 20 to DN 500).
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20 (DN 20 to DN 500), if longer ends are required for riser clamps.
- H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F (49 to 232 deg C) piping installations.
- I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb (340 kg).
 - b. Medium (MSS Type 32): 1500 lb (680 kg).
 - c. Heavy (MSS Type 33): 3000 lb (1360 kg).
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
 8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.
- M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.

2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
- C. Fiberglass Pipe Hanger Installation: Comply with applicable portions of MSS SP-69 and MSS SP-89. Install hangers and attachments as required to properly support piping from building structure.
- D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
- E. Fiberglass Strut System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled fiberglass struts.
- F. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- G. Fastener System Installation:
 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- H. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- I. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- J. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- K. Install lateral bracing with pipe hangers and supports to prevent swaying.
- L. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.
- N. Insulated Piping: Comply with the following:
 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.
 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

- a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
 - b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
 - c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
 - d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
 - e. NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.
5. Pipes NPS 8 (DN 200) and Larger: Include wood inserts.
6. Insert Material: Length at least as long as protective shield.
7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make smooth bearing surface.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.
 4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm).

3.6 PAINTING

- A. Touch Up: 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 (0.05 mm).
- B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

SECTION 23 05 33

HEAT TRACING FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes heat tracing with the following electric heating cables:
 - 1. Plastic insulated, series resistance.
 - 2. Self-regulating, parallel resistance.
- B. Related Sections include the following:
 - 1. Division 21 Section "Heat Tracing for Fire-Suppression Piping."
 - 2. Division 22 Section "Heat Tracing for Plumbing Piping."

1.3 SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each type of product indicated.
 - 1. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.
- B. Shop Drawings: For electric heating cable. Include plans, sections, details, and attachments to other work.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For electric heating cables to include in operation and maintenance manuals.
- E. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.5 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - 1. Chromalox, Inc.; Wiegard Industrial Division; Emerson Electric Company.
 - 2. Raychem; a division of Tyco Thermal Controls.
 - 3. Thermon Manufacturing Co.
- D. Heating Element: Pair of parallel No. 16 AWG, tinned stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled nonheating leads with connectors at one end, and seal the opposite end watertight. Cable shall be capable of crossing over itself once without overheating.
- E. Electrical Insulating Jacket: Flame-retardant polyolefin.
- F. Cable Cover: Tinned-copper braid, and polyolefin outer jacket with UV inhibitor.
- G. Maximum Operating Temperature (Power On): 150 deg F (65 deg C).
- H. Maximum Exposure Temperature (Power Off): 185 deg F (85 deg C).
- I. Maximum Operating Temperature: 300 deg F (150 deg C).
- J. The heater shall be XL-Trace as manufactured by Raychem Corporation or XL-Econotrace as manufactured by Thermon Manufacturing Company.

2.2 CONTROLS

- A. Remote bulb unit with adjustable temperature range from 30 to 50 deg F (minus 1 to plus 10 deg C).
- B. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected cable.
- C. Remote bulb on capillary, resistance temperature device, or thermistor for directly sensing pipe-wall temperature.
- D. Corrosion-resistant, waterproof control enclosure.

2.3 ACCESSORIES

- A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.
- B. Warning Labels: Refer to Division 23 Section "Identification for HVAC Piping and Equipment."

- C. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils (0.08 mm) thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.
 - 1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches (150 mm): 3/4 inch (19 mm) minimum.
 - 2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches (150 mm) or Larger: 1-1/2 inches (38 mm) minimum.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.
 - 1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.
 - 2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install electric heating cable across expansion joints according to manufacturer's written recommendations using slack cable to allow movement without damage to cable.
- B. Install electric heating cables after piping has been tested and before insulation is installed.
- C. Install electric heating cables according to IEEE 515.1.
- D. Install insulation over piping with electric cables according to Division 23 Section "HVAC Insulation."
- E. Install warning tape on piping insulation where piping is equipped with electric heating cables.
- F. Set field-adjustable switches and circuit-breaker trip ranges.
- G. Protect installed heating cables, including nonheating leads, from damage.

3.3 CONNECTIONS

- A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Testing: Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.
 - 1. Test cables for electrical continuity and insulation integrity before energizing.
 - 2. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.
- B. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounting cables.

- C. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Balancing Air Systems:
 - a. Variable-air-volume systems.

1.3 DEFINITIONS

- A. AABC: Associated Air Balance Council.

1.4 SUBMITTALS

- A. LEED Submittal:
 - 1. Air-Balance Report for LEED Prerequisite EQ 1: Documentation of work performed for ASHRAE 62.1-2004, Section 7.2.2, "Air Balancing."
- B. Contract Documents Examination Report: Within 15 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.
- C. Certified TAB reports.
- D. Instrument calibration reports, to include the following:
 - 1. Instrument type and make.
 - 2. Serial number.
 - 3. Application.
 - 4. Dates of use.
 - 5. Dates of calibration.

1.5 QUALITY ASSURANCE

- A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC.
- B. TAB Conference: Meet with Construction Manager and Commissioning Authority on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven days' advance notice of scheduled meeting time and location.
 - 1. Agenda Items:
 - a. The Contract Documents examination report.
 - b. The TAB plan.
 - c. Coordination and cooperation of trades and subcontractors.
 - d. Coordination of documentation and communication flow.

1.6 COORDINATION

- A. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.
- B. Perform TAB after leakage and pressure tests on air distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
- B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine equipment performance data including fan and pump curves.
 - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
 - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
- F. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- G. Examine test reports specified in individual system and equipment Sections.
- H. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- I. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.
- J. Examine operating safety interlocks and controls on HVAC equipment.
- K. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures.
- B. Complete system-readiness checks and prepare reports. Verify the following:
 - 1. Permanent electrical-power wiring is complete.
 - 2. Automatic temperature-control systems are operational.
 - 3. Equipment and duct access doors are securely closed.
 - 4. Balance, smoke, and fire dampers are open.
 - 5. Isolating and balancing valves are open and control valves are operational.
 - 6. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
 - 7. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" and in this Section.
 - 1. Comply with requirements in ASHRAE 62.1-2004, Section 7.2.2, "Air Balancing."
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
 - 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts or install test ports and duct access doors that comply with requirements in Division 23 Section "Air Duct Accessories."
 - 2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "HVAC Insulation."
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.

- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling-unit components.
- L. Verify that air duct system is sealed as specified in Division 23 Section "Metal Ducts."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure total airflow.
 - a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
 - 2. Measure fan static pressures as follows to determine actual static pressure:
 - a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet or through the flexible connection.
 - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 - 3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
 - a. Report the cleanliness status of filters and the time static pressures are measured.
 - 4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
 - 5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
 - 1. Measure airflow of submain and branch ducts.
 - a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
 - 2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
 - 3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
- C. Measure air outlets and inlets without making adjustments.
 - 1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
 - 1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 - 2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

- A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a minimum set-point airflow with the remainder at maximum-airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.
- B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
 - 1. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.
 - 2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
 - 3. Measure total system airflow. Adjust to within indicated airflow.
 - 4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
 - 5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.
 - a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.
 - 6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
 - a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.
 - 7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
 - 8. Record final fan-performance data.

3.7 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 - 1. Manufacturer's name, model number, and serial number.
 - 2. Motor horsepower rating.
 - 3. Motor rpm.
 - 4. Efficiency rating.
 - 5. Nameplate and measured voltage, each phase.
 - 6. Nameplate and measured amperage, each phase.
 - 7. Starter thermal-protection-element rating.
- B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.8 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.

- B. Measure entering- and leaving-air temperatures.
- C. Record compressor data.

3.9 TOLERANCES

- A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
 - 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 10 or minus 5 percent.
 - 2. Air Outlets and Inlets: Plus 10 or minus 5 percent.

3.10 REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
- B. Status Reports: Prepare progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.11 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
 - 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 - 2. Include a list of instruments used for procedures, along with proof of calibration.
- B. Final Report Contents: In addition to certified field-report data, include the following:
 - 1. Pump curves.
 - 2. Fan curves.
 - 3. Manufacturers' test data.
 - 4. Field test reports prepared by system and equipment installers.
 - 5. Other information relative to equipment performance; do not include Shop Drawings and product data.
- C. General Report Data: In addition to form titles and entries, include the following data:
 - 1. Title page.
 - 2. Name and address of the TAB contractor.
 - 3. Project name.
 - 4. Project location.
 - 5. Architect's name and address.
 - 6. Engineer's name and address.
 - 7. Contractor's name and address.
 - 8. Report date.
 - 9. Signature of TAB supervisor who certifies the report.
 - 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 - 11. Summary of contents including the following:
 - a. Indicated versus final performance.

- b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 - 12. Nomenclature sheets for each item of equipment.
 - 13. Data for terminal units, including manufacturer's name, type, size, and fittings.
 - 14. Notes to explain why certain final data in the body of reports vary from indicated values.
 - 15. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outdoor-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Fan drive settings including settings and percentage of maximum pitch diameter.
 - e. Inlet vane settings for variable-air-volume systems.
 - f. Settings for supply-air, static-pressure controller.
 - g. Other system operating conditions that affect performance.
- D. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
 - 1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Sheave make, size in inches (mm), and bore.
 - i. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
 - j. Number, make, and size of belts.
 - k. Number, type, and size of filters.
 - 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches (mm), and bore.
 - f. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
 - 3. Test Data (Indicated and Actual Values):
 - a. Total air flow rate in cfm (L/s).
 - b. Total system static pressure in inches wg (Pa).
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg (Pa).
 - e. Filter static-pressure differential in inches wg (Pa).
 - f. Preheat-coil static-pressure differential in inches wg (Pa).
 - g. Cooling-coil static-pressure differential in inches wg (Pa).
 - h. Heating-coil static-pressure differential in inches wg (Pa).
 - i. Outdoor airflow in cfm (L/s).
 - j. Return airflow in cfm (L/s).
 - k. Outdoor-air damper position.
 - l. Return-air damper position.
 - m. Vortex damper position.
- E. Apparatus-Coil Test Reports:
 - 1. Coil Data:
 - a. System identification.
 - b. Location.

- c. Coil type.
 - d. Number of rows.
 - e. Fin spacing in fins per inch (mm) o.c.
 - f. Make and model number.
 - g. Face area in sq. ft. (sq. m).
 - h. Tube size in NPS (DN).
 - i. Tube and fin materials.
 - j. Circuiting arrangement.
 - 2. Test Data (Indicated and Actual Values):
 - a. Air flow rate in cfm (L/s).
 - b. Average face velocity in fpm (m/s).
 - c. Air pressure drop in inches wg (Pa).
 - d. Outdoor-air, wet- and dry-bulb temperatures in deg F (deg C).
 - e. Return-air, wet- and dry-bulb temperatures in deg F (deg C).
 - f. Entering-air, wet- and dry-bulb temperatures in deg F (deg C).
 - g. Leaving-air, wet- and dry-bulb temperatures in deg F (deg C).
 - h. Refrigerant expansion valve and refrigerant types.
 - i. Refrigerant suction pressure in psig (kPa).
 - j. Refrigerant suction temperature in deg F (deg C).
 - k. Inlet steam pressure in psig (kPa).
- F. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:
- 1. Unit Data:
 - a. System identification.
 - b. Location.
 - c. Coil identification.
 - d. Capacity in Btu/h (kW).
 - e. Number of stages.
 - f. Connected volts, phase, and hertz.
 - g. Rated amperage.
 - h. Air flow rate in cfm (L/s).
 - i. Face area in sq. ft. (sq. m).
 - j. Minimum face velocity in fpm (m/s).
 - 2. Test Data (Indicated and Actual Values):
 - a. Heat output in Btu/h (kW).
 - b. Air flow rate in cfm (L/s).
 - c. Air velocity in fpm (m/s).
 - d. Entering-air temperature in deg F (deg C).
 - e. Leaving-air temperature in deg F (deg C).
 - f. Voltage at each connection.
 - g. Amperage for each phase.
- G. Fan Test Reports: For supply, return, and exhaust fans, include the following:
- 1. Fan Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches (mm), and bore.
 - h. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
 - 2. Motor Data:
 - a. Motor make, and frame type and size.

- b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches (mm), and bore.
 - f. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
 - g. Number, make, and size of belts.
 - 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm (L/s).
 - b. Total system static pressure in inches wg (Pa).
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg (Pa).
 - e. Suction static pressure in inches wg (Pa).
- H. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
 - 1. Report Data:
 - a. System and air-handling-unit number.
 - b. Location and zone.
 - c. Traverse air temperature in deg F (deg C).
 - d. Duct static pressure in inches wg (Pa).
 - e. Duct size in inches (mm).
 - f. Duct area in sq. ft. (sq. m).
 - g. Indicated air flow rate in cfm (L/s).
 - h. Indicated velocity in fpm (m/s).
 - i. Actual air flow rate in cfm (L/s).
 - j. Actual average velocity in fpm (m/s).
 - k. Barometric pressure in psig (Pa).
- I. Air-Terminal-Device Reports:
 - 1. Unit Data:
 - a. System and air-handling unit identification.
 - b. Location and zone.
 - c. Apparatus used for test.
 - d. Area served.
 - e. Make.
 - f. Number from system diagram.
 - g. Type and model number.
 - h. Size.
 - i. Effective area in sq. ft. (sq. m).
 - 2. Test Data (Indicated and Actual Values):
 - a. Air flow rate in cfm (L/s).
 - b. Air velocity in fpm (m/s).
 - c. Preliminary air flow rate as needed in cfm (L/s).
 - d. Preliminary velocity as needed in fpm (m/s).
 - e. Final air flow rate in cfm (L/s).
 - f. Final velocity in fpm (m/s).
 - g. Space temperature in deg F (deg C).
- J. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
 - 1. Unit Data:
 - a. System and air-handling-unit identification.
 - b. Location and zone.
 - c. Room or riser served.
 - d. Coil make and size.

2. Test Data (Indicated and Actual Values):
 - a. Air flow rate in cfm (L/s).
 - b. Entering-air temperature in deg F (deg C).
 - c. Leaving-air temperature in deg F (deg C).
- K. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:
 1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Service.
 - d. Make and size.
 - e. Model number and serial number.
 - f. Water flow rate in gpm (L/s).
 - g. Water pressure differential in feet of head or psig (kPa).
 - h. Required net positive suction head in feet of head or psig (kPa).
 - i. Pump rpm.
 - j. Impeller diameter in inches (mm).
 - k. Motor make and frame size.
 - l. Motor horsepower and rpm.
 - m. Voltage at each connection.
 - n. Amperage for each phase.
 - o. Full-load amperage and service factor.
 - p. Seal type.
 2. Test Data (Indicated and Actual Values):
 - a. Static head in feet of head or psig (kPa).
 - b. Pump shutoff pressure in feet of head or psig (kPa).
 - c. Actual impeller size in inches (mm).
 - d. Full-open flow rate in gpm (L/s).
 - e. Full-open pressure in feet of head or psig (kPa).
 - f. Final discharge pressure in feet of head or psig (kPa).
 - g. Final suction pressure in feet of head or psig (kPa).
 - h. Final total pressure in feet of head or psig (kPa).
 - i. Final water flow rate in gpm (L/s).
 - j. Voltage at each connection.
 - k. Amperage for each phase.
- L. Instrument Calibration Reports:
 1. Report Data:
 - a. Instrument type and make.
 - b. Serial number.
 - c. Application.
 - d. Dates of use.
 - e. Dates of calibration.

3.12 INSPECTIONS

- A. Initial Inspection:
 1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
 2. Check the following for each system:
 - a. Measure airflow of at least 5 percent of air outlets.
 - b. Measure water flow of at least 5 percent of terminals.
 - c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.

- d. Verify that balancing devices are marked with final balance position.
 - e. Note deviations from the Contract Documents in the final report.
- B. Final Inspection:
 - 1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Architect.
 - 2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Architect .
 - 3. Architect shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to 5 percent of the total measurements recorded.
 - 4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
 - 5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
- C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:
 - 1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
 - 2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.
- D. Prepare test and inspection reports.

3.13 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION

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SECTION 23 07 00

HVAC INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Insulation Materials:
 - a. Calcium silicate.
 - b. Cellular glass.
 - c. Flexible elastomeric.
 - d. Mineral fiber.
 - 2. Fire-rated insulation systems.
 - 3. Factory-applied jackets.
 - 4. Field-applied jackets.
 - 5. Securements.
- B. Related Sections:
 - 1. Division 21 Section "Fire-Suppression Systems Insulation."
 - 2. Division 22 Section "Plumbing Insulation."
 - 3. Division 23 Section "Metal Ducts" for duct liners.
 - 4. Division 33 Section "Underground Hydronic Energy Distribution" for underground piping outside the building.
 - 5. Division 33 Section "Underground Steam and Condensate Distribution Piping" for underground piping outside the building.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).
- B. LEED Submittal:
 - 1. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.
- C. Qualification Data: For qualified Installer.
- D. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- E. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Calcium Silicate:
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Industrial Insulation Group (The); Thermo-12 Gold.
 - 2. Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
 - 3. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
 - 4. Prefabricated Fitting Covers: Comply with ASTM C 450 and ASTM C 585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.
- G. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cell-U-Foam Corporation; Ultra-CUF.
 - b. Pittsburgh Corning Corporation; Foamglas Super K.
 - 2. Block Insulation: ASTM C 552, Type I.
 - 3. Special-Shaped Insulation: ASTM C 552, Type III.
 - 4. Board Insulation: ASTM C 552, Type IV.
 - 5. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
 - 6. Preformed Pipe Insulation with Factory-Applied ASJ: Comply with ASTM C 552, Type II, Class 2.
 - 7. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- H. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Aeroflex USA Inc.; Aerocel.
 - b. Armacell LLC; AP Armaflex.
 - c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.
- I. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Products: Subject to compliance with requirements, provide the following provide one of the following:
 - a. CertainTeed Corp.; Duct Wrap.
 - b. Johns Manville; Microlite.
 - c. Knauf Insulation; Duct Wrap.
 - d. Owens Corning; All-Service Duct Wrap.
- J. High-Temperature, Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type V, without factory-applied jacket.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Johns Manville; HTB 23 Spin-Glas.
 - b. Owens Corning; High Temperature Flexible Batt Insulations.

- K. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. For equipment applications, provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. CertainTeed Corp.; Commercial Board.
 - b. Johns Manville; 800 Series Spin-Glas.
 - c. Knauf Insulation; Insulation Board.
 - d. Owens Corning; Fiberglas 700 Series.
- L. High-Temperature, Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type III, without factory-applied jacket.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Johns Manville; 1000 Series Spin-Glas.
 - b. Owens Corning; High Temperature Industrial Board Insulations.
 - c. Rock Wool Manufacturing Company; Delta Board.
 - d. Thermafiber; Thermafiber Industrial Felt.
- M. Mineral-Fiber, Preformed Pipe Insulation:
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Johns Manville; Micro-Lok.
 - b. Knauf Insulation; 1000 Pipe Insulation.
 - c. Owens Corning; Fiberglas Pipe Insulation.
 2. Type I, 850 deg F (454 deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 3. Type II, 1200 deg F (649 deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type II, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- N. Mineral-Fiber, Pipe Insulation Wicking System: Preformed pipe insulation complying with ASTM C 547, Type I, Grade A, with absorbent cloth factory applied to the entire inside surface of preformed pipe insulation and extended through the longitudinal joint to outside surface of insulation under insulation jacket. Factory apply a white, polymer, vapor-retarder jacket with self-sealing adhesive tape seam and evaporation holes running continuously along the longitudinal seam, exposing the absorbent cloth.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Knauf Insulation; Permawick Pipe Insulation.
 - b. Owens Corning; VaporWick Pipe Insulation.
- O. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. (40 kg/cu. m) or more. Thermal conductivity (k-value) at 100 deg F (55 deg C) is 0.29 Btu x in./h x sq. ft. x deg F (0.042 W/m x K) or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. CertainTeed Corp.; CrimpWrap.
 - b. Johns Manville; MicroFlex.
 - c. Knauf Insulation; Pipe and Tank Insulation.
 - d. Owens Corning; Fiberglas Pipe and Tank Insulation.
- P. Phenolic:

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Kingspan Corp.; Koolphen K.
2. Preformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type III, Grade 1.
3. Block insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type II, Grade 1.
4. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
5. Factory-Applied Jacket: Requirements are specified in "Factory-Applied Jackets" Article.
 - a. Preformed Pipe Insulation: ASJ.
 - b. Board for Duct and Plenum Applications: ASJ.
 - c. Board for Equipment Applications: ASJ.

2.2 FIRE-RATED INSULATION SYSTEMS

- A. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 2-hour fire rating by a NRTL acceptable to authority having jurisdiction.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. CertainTeed Corp.; FlameChek.
 - b. Johns Manville; Firetemp Wrap.
 - c. Thermal Ceramics; FireMaster Duct Wrap.
 - d. 3M; Fire Barrier Wrap Products.
 - e. Unifrax Corporation; FyreWrap.

2.3 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
 1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
 4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.

2.4 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
- C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Johns Manville; Zeston.
 - b. P.I.C. Plastics, Inc.; FG Series.
 - c. Proto PVC Corporation; LoSmoke.
 2. Color: As selected by the Engineer.
 3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
 4. Factory-fabricated tank heads and tank side panels.

D. Metal Jacket:

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; Metal Jacketing Systems.
 - b. PABCO Metals Corporation; Surefit.
 - c. RPR Products, Inc.; Insul-Mate.
2. Aluminum Jacket: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105 or 5005, Temper H-14.
 - a. Sheet and roll stock ready for shop or field sizing.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper.
 - d. Moisture Barrier for Outdoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper.
 - e. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.
 - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

E. Self-Adhesive Outdoor Jacket: 60-mil- (1.5-mm-) thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with stucco-embossed aluminum-foil facing.

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Polyguard; Alumaguard 60.

2.5 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch (0.38 mm) thick, 1/2 inch (13 mm) wide.
2. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- (3.5-mm-) diameter shank, length to suit depth of insulation indicated.
2. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.
 - a. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
 - 1. Verify that systems and equipment to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.
 - 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
 - 1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils (0.127 mm) thick and an epoxy finish 5 mils (0.127 mm) thick if operating in a temperature range between 140 and 300 deg F (60 and 149 deg C). Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
 - 2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F (0 and 149 deg C) with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.

- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches (50 mm) o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above ambient services, do not install insulation to the following:
 - 1. Vibration-control devices.
 - 2. Testing agency labels and stamps.
 - 3. Nameplates and data plates.
 - 4. Manholes.
 - 5. Handholes.
 - 6. Cleanouts.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches (50 mm) below top of roof flashing.
 - 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).
 - 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches (50 mm).
 - 1. Comply with requirements in Division 07 Section "Penetration Firestopping" firestopping and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
 - 1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches (50 mm).
 - 2. Pipe: Install insulation continuously through floor penetrations.
 - 3. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.5 CALCIUM SILICATE INSULATION INSTALLATION

- A. Insulation Installation on Boiler Breechings and Ducts:
 - 1. Secure single-layer insulation with stainless-steel bands at 12-inch (300-mm) intervals and tighten bands without deforming insulation material.
 - 2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches (75 mm). Secure inner layer with wire spaced at 12-inch (300-mm) intervals. Secure outer layer with stainless-steel bands at 12-inch (300-mm) intervals.
 - 3. On exposed applications without metal jacket, finish insulation surface with a skim coat of mineral-fiber, hydraulic-setting cement. When cement is dry, apply flood coat of lagging

adhesive and press on one layer of glass cloth. Overlap edges at least 1 inch (25 mm). Apply finish coat of lagging adhesive over glass cloth. Thin finish coat to achieve smooth, uniform finish.

- B. Insulation Installation on Straight Pipes and Tubes:
 - 1. Secure single-layer insulation with stainless-steel bands at 12-inch (300-mm) intervals and tighten bands without deforming insulation materials.
 - 2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches (75 mm). Secure inner layer with wire spaced at 12-inch (300-mm) intervals. Secure outer layer with stainless-steel bands at 12-inch (300-mm) intervals.
 - 3. Apply a skim coat of mineral-fiber, hydraulic-setting cement to insulation surface. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least 1 inch (25 mm). Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.
- C. Insulation Installation on Pipe Flanges:
 - 1. Install preformed pipe insulation to outer diameter of pipe flange.
 - 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 - 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.
 - 4. Finish flange insulation same as pipe insulation.
- D. Insulation Installation on Pipe Fittings and Elbows:
 - 1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
 - 2. When preformed insulation sections of insulation are not available, install mitered sections of calcium silicate insulation. Secure insulation materials with wire or bands.
 - 3. Finish fittings insulation same as pipe insulation.
- E. Insulation Installation on Valves and Pipe Specialties:
 - 1. Install mitered segments of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 - 2. Install insulation to flanges as specified for flange insulation application.
 - 3. Finish valve and specialty insulation same as pipe insulation.

3.6 CELLULAR-GLASS INSULATION INSTALLATION

- A. Insulation Installation on Straight Pipes and Tubes:
 - 1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
 - 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 - 3. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
 - 4. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- B. Insulation Installation on Pipe Flanges:
 - 1. Install preformed pipe insulation to outer diameter of pipe flange.
 - 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
 4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.
- C. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
 2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.
- D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of cellular-glass insulation to valve body.
 2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 3. Install insulation to flanges as specified for flange insulation application.

3.7 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
1. Install pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
 4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
1. Install mitered sections of pipe insulation.
 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed valve covers manufactured of same material as pipe insulation when available.
 2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 3. Install insulation to flanges as specified for flange insulation application.
 4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.8 MINERAL-FIBER INSULATION INSTALLATION

- A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.

2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
 4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- B. Insulation Installation on Pipe Flanges:
1. Install preformed pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
 4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.
- C. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
 2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.
- D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
 2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
 3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 4. Install insulation to flanges as specified for flange insulation application.
- E. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches (450 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) o.c.
 - b. On duct sides with dimensions larger than 18 inches (450 mm), place pins 16 inches (400 mm) o.c. each way, and 3 inches (75 mm) maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Impale insulation over pins and attach speed washers.
 - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, 1 inch (25 mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F (10 deg C) at 18-foot (5.5-m) intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches (75 mm).
 5. Overlap unfaced blankets a minimum of 2 inches (50 mm) on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches (450 mm) o.c.
 6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- (150-mm-) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches (150 mm) o.c.
- F. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches (450 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) o.c.
 - b. On duct sides with dimensions larger than 18 inches (450 mm), space pins 16 inches (400 mm) o.c. each way, and 3 inches (75 mm) maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, 1 inch (25 mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F (10 deg C) at 18-foot (5.5-m) intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and

over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches (75 mm).

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- (150-mm-) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches (150 mm) o.c.

3.9 FIELD-APPLIED JACKET INSTALLATION

- A. Where glass-cloth jackets are required, install directly over bare insulation or insulation with factory-applied jackets.
 1. Draw jacket smooth and tight to surface with 2-inch (50-mm) overlap at seams and joints.
 2. Embed glass cloth between two 0.062-inch- (1.6-mm-) thick coats of lagging adhesive.
 3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- B. Where FSK jackets are indicated, install as follows:
 1. Draw jacket material smooth and tight.
 2. Install lap or joint strips with same material as jacket.
 3. Secure jacket to insulation with manufacturer's recommended adhesive.
 4. Install jacket with 1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.
 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- C. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- D. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches (300 mm) o.c. and at end joints.

3.10 FIRE-RATED INSULATION SYSTEM INSTALLATION

- A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.
- B. Insulate duct access panels and doors to achieve same fire rating as duct.
- C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Division 07 Section "Penetration Firestopping."

3.11 FINISHES

- A. Duct, Equipment, and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.
 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.

- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

3.12 DUCT INSULATION SCHEDULE, GENERAL

- A. Plenums and Ducts Requiring Insulation:
 - 1. Indoor, concealed supply and outdoor air.
 - 2. Indoor, exposed supply and outdoor air.
 - 3. Indoor, concealed return located in nonconditioned space.
 - 4. Indoor, exposed return located in nonconditioned space.
 - 5. Indoor, concealed, Type I, commercial, kitchen hood exhaust.
 - 6. Indoor, exposed, Type I, commercial, kitchen hood exhaust.
 - 7. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
 - 8. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
 - 9. Outdoor, concealed supply and return.
 - 10. Outdoor, exposed supply and return.
- B. Items Not Insulated:
 - 1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
 - 2. Factory-insulated flexible ducts.
 - 3. Factory-insulated plenums and casings.
 - 4. Flexible connectors.
 - 5. Vibration-control devices.
 - 6. Factory-insulated access panels and doors.

3.13 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

- A. Concealed, outdoor air, outdoor air plenums, and, supply-air duct insulation shall be the following:
 - 1. Mineral-Fiber Blanket: 2 inches (50 mm) thick and 1.5-lb/cu. ft. (24-kg/cu. m) nominal density.
 - 2. Mineral-Fiber Board: 2 inches (50 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
- B. Concealed, Type I, Commercial, Kitchen Hood Exhaust Duct and Plenum Insulation: Fire-rated blanket; thickness as required to achieve 2-hour fire rating.
- C. Concealed, supply-air plenum insulation shall be the following:
 - 1. Mineral-Fiber Blanket: 3 inches (75 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
- D. Concealed, outdoor-air plenum insulation shall be one of the following:
 - 1. Mineral-Fiber Blanket: 2 inches (50 mm) thick and 1.5-lb/cu. ft. (24-kg/cu. m) nominal density.
- E. Exposed, outside air, outside air plenums and supply-air duct insulation shall be the following:
 - 1. Mineral-Fiber Board: 2 inches (50 mm) thick and nominal density.

3.14 ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SCHEDULE

- A. Insulation materials and thicknesses are identified below. If more than one material is listed for a duct system, selection from materials listed is Contractor's option.
- B. Exposed outside air, outside air plenums and supply-air duct insulation shall be one of the following:
 - 1. Mineral-Fiber Board: 2 layers of 2" (50 mm) with 1/4" weatherproof mastic with glass mesh reinforcement, nominal density.

3.15 EQUIPMENT INSULATION SCHEDULE

- A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.
- B. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.
- C. Chillers: To be factory insulated.
- D. Heat-exchanger (water-to-water for cooling service) insulation shall be the following:
 - 1. Cellular Glass: 2 inches (50 mm) thick.
 - 2. Flexible Elastomeric: 1 inch (25 mm) thick.
- E. Heat-exchanger (water-to-water for heating service) insulation shall be the following:
 - 1. Cellular Glass: 3 inches (75 mm) thick.
- F. Steam-to-hot-water converter insulation shall be the following:
 - 1. Calcium Silicate: 3 inches (75 mm) thick.
- G. Hot-water-to-steam converter insulation shall be the following:
 - 1. Calcium Silicate: 3 inches (75 mm) thick.
- H. Chilled-water pump insulation shall be the following:
 - 1. Cellular Glass: 3 inches (75 mm) thick.
- I. Condenser-water pump insulation (if building has water side economizer) shall be the following:
 - 1. Cellular Glass: 2 inches (50 mm) thick.
- J. Heating-hot-water pump insulation shall be the following:
 - 1. Cellular Glass: 3 inches (75 mm) thick.
- K. Heat-recovery pump insulation shall be the following:
 - 1. Cellular Glass: 2 inches (50 mm) thick.
- L. Chilled-water expansion/compression tank and air separator insulation shall be the following:
 - 1. Cellular Glass: 1-1/2 inches (38 mm) thick.
- M. Heating-hot-water expansion/compression tank and air separator insulation shall be the following:
 - 1. Cellular Glass: 1-1/2 inches (38 mm) thick.

3.16 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

3.17 INDOOR PIPING INSULATION SCHEDULE

- A. Condensate and Equipment Drain Water:
1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Cellular Glass: 1/2 inches (13 mm) thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch (13 mm) thick.
- B. Chilled Water:
1. NPS 12 (DN 300) and Smaller: Insulation shall be the following:
 - a. Cellular Glass: 1-1/2 inches (38 mm) thick.
 - b. Mineral-Fiber, Preformed Pipe, Type I: 1-1/2 inches (38 mm) thick.
 2. NPS 14 (DN 350) and Larger: Insulation shall be the following:
 - a. Cellular Glass: 2 inches (50 mm) thick.
 - b. Mineral-Fiber Preformed Pipe, Type I: 2 inches (50 mm) thick.
- C. Condenser-Water Supply and Return (Always outdoors but only indoors when water-side economizer is used):
1. NPS 12 (DN 300) and Smaller: Insulation shall be the following:
 - a. Cellular Glass: 1-1/2 inches (38 mm) thick.
 - b. Mineral-Fiber, Preformed Pipe, Type I: 1-1/2 inches (38 mm) thick.
 2. NPS 14 (DN 350) and Larger: Insulation shall be the following:
 - a. Cellular Glass: 2 inches (50 mm) thick.
 - b. Mineral-Fiber, Preformed Pipe, Type I: 1-1/2 inches (38 mm) thick.
- D. Heating-Hot-Water Supply and Return:
1. NPS 12 (DN 300) and Smaller: Insulation shall be the following:
 - a. Cellular Glass: 2 inches (50 mm) thick.
 - b. Mineral-Fiber, Preformed Pipe, Type I: 2 inches (50 mm) thick.
 2. NPS 14 (DN 350) and Larger: Insulation shall be the following:
 - a. Cellular Glass: 2 inches (50 mm) thick.
 - b. Mineral-Fiber, Preformed Pipe, Type I: 2 inches (50 mm) thick.
- E. Steam and Steam Condensate:
1. NPS 3/4 (DN 20) and Smaller: Insulation shall be the following:
 - a. Calcium Silicate: 2 inches (50 mm) thick.
 2. NPS 1 (DN 25) and Larger: Insulation shall be the following:
 - a. Calcium Silicate: 3 inches (75 mm) thick.
- F. Refrigerant Suction and Hot-Gas Piping:
1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 1 inch (25 mm) thick.
- G. Heat-Recovery Piping:
1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 1 inch (25 mm) thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.

3.18 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Chilled Water:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Cellular Glass: 3 inches (75 mm) thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 3 inches (75 mm) thick.
- B. Condenser-Water Supply and Return:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Cellular Glass: 2 inches (50 mm) thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches (50 mm) thick.
- C. Heating-Hot-Water Supply and Return:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Cellular Glass: 2 inches (50 mm) thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches (50 mm) thick.
- D. Generator Exhaust Piping and Muffler:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Calcium Silicate: 4 inches (100 mm) thick.
- E. Steam and Steam Condensate:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Calcium Silicate: 4 inches (100 mm) thick.
- F. Refrigerant Suction and Hot-Gas Piping:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 2 inches (50 mm) thick with water-based latex enamel, weather resistant and UV resistant. Finish equal to Armaflex ____ finish.
- G. Heat-Recovery Piping:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 2 inches (50 mm) thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches (50 mm) thick.

3.19 OUTDOOR, UNDERGROUND PIPING INSULATION SCHEDULE

- A. All underground piping requiring insulation shall be factory insulated. Field insulated underground piping is NOT allowed.

3.20 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Exposed in all mechanical rooms:
 - 1. PVC, Color-Coded by System: 20 mils (0.5 mm) thick.
- D. Piping, Exposed:
 - 1. Aluminum Corrugated 0.016 inch (0.41 mm) thick up through 24:" pipe size and 0.024 inch (0.61 mm) thick larger than 24" pipe size.

- E. Generator Exhaust Piping:
 - 1. Smooth aluminum, 0.016" (0.41 mm) thick up through 12" pipe size, 0.024" (0.61 mm) thick for larger than 12"

END OF SECTION

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SECTION 23 09 00

INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.
- B. Related Sections include the following:
 - 1. Division 23 Section "Meters and Gages for HVAC Piping" for measuring equipment that relates to this Section.
 - 2. Division 23 Section "Sequence of Operations for HVAC Controls" for requirements that relate to this Section.

1.3 DEFINITIONS

- A. DDC: Direct digital control.
- B. I/O: Input/output.
- C. BACnet LonWorks, Modbus: A control network technology platform for designing and implementing interoperable control devices and networks.
- D. MS/TP: Master slave/token passing.
- E. PID: Proportional plus integral plus derivative.
- F. RTD: Resistance temperature detector.

1.4 SYSTEM PERFORMANCE

- A. Comply with the following performance requirements:
 - 1. Graphic Display: Display graphic with current state of the art dynamic points and refresh speed.
 - 2. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
 - 3. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
 - 4. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
 - 5. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
 - 6. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
 - 7. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
 - a. Space Temperature: Plus or minus 1 deg F (0.5 deg C).

- b. Ducted Air Temperature: Plus or minus 1 deg F (0.5 deg C).
- c. Outside Air Temperature: Plus or minus 2 deg F (1.0 deg C).
- d. Dew Point Temperature: Plus or minus 3 deg F (1.5 deg C).
- e. Temperature Differential: Plus or minus 0.25 deg F (0.15 deg C).
- f. Relative Humidity: Plus or minus 5 percent.
- g. Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale.
- h. Airflow (Measuring Stations): Plus or minus 5 percent of full scale.
- i. Airflow (Terminal): Plus or minus 10 percent of full scale.
- j. Air Pressure (Space): Plus or minus 0.01-inch wg (2.5 Pa).
- k. Air Pressure (Ducts): Plus or minus 0.1-inch wg (25 Pa).
- l. Carbon Monoxide: Plus or minus 5 percent of reading.
- m. Carbon Dioxide: Plus or minus 50 ppm.
- n. Electrical: Plus or minus 5 percent of reading.

1.5 SUBMITTALS

- A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
 - 1. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
 - 2. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.
 - 3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Bill of materials of equipment indicating quantity, manufacturer, and model number.
 - 2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
 - 3. Wiring Diagrams: Power, signal, and control wiring.
 - 4. Details of control panel faces, including controls, instruments, and labeling.
 - 5. Floor plans indicating control panel locations.
 - 6. Written description of sequence of operation.
 - 7. Schedule of dampers including size, leakage, and flow characteristics.
 - 8. Schedule of valves including flow characteristics.
 - 9. DDC System Hardware:
 - a. Wiring diagrams for control units with termination numbers.
 - b. Schematic diagrams and floor plans for field sensors and control hardware.
 - c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.
 - 10. Control System Software: Graphics outline and "Print Page" examples of final product indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
 - 11. Controlled Systems:
 - a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
 - b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
 - c. Written description of sequence of operation including schematic diagram.

d. Points list.

- C. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE 135.
- D. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with BACnet LonWorks or Modbus.
- E. Samples for Initial Selection: For each type of sensor cover with factory-applied color finishes.
- F. Software and Firmware Operational Documentation: Include the following:
 - 1. Software operating and upgrade manuals.
 - 2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
 - 3. Device address list.
 - 4. Printout of software application and graphic screens.
 - 5. Software license required by and installed for DDC workstations and control systems.
- G. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.
- H. Qualification Data: For installer and manufacturer.
- I. Field quality-control test reports.
- J. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.
 - 2. Interconnection wiring diagrams with identified and numbered system components and devices.
 - 3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
 - 4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
 - 5. Calibration records and list of set points.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with ASHRAE 135 for DDC system components.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.
- B. System Software: Update to latest version of software at Project completion.

1.8 COORDINATION

- A. Coordinate location of temperature sensors, humidistats, and other exposed control sensors with plans and room details before installation.
- B. Coordinate equipment with Division 28 Section "Intrusion Detection" to achieve compatibility with equipment that interfaces with that system and with building master clock.
- C. Coordinate equipment with Division 28 Section "Access Control" to achieve compatibility with equipment that interfaces with that system.
- D. Coordinate equipment with Division 28 Section "PLC Electronic Detention Monitoring and Control Systems" to achieve compatibility with equipment that interfaces with that system.
- E. Coordinate equipment with Division 26 Section "Network Lighting Controls" to achieve compatibility with equipment that interfaces with that system.
- F. Coordinate equipment with Division 28 Section "Fire Detection and Alarm" to achieve compatibility with equipment that interfaces with that system.
- G. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.
- H. Coordinate equipment with Division 26 Section "Electrical Power Monitoring and Control" to achieve compatibility of communication interfaces.
- I. Coordinate equipment with Division 26 Section "Panelboards" to achieve compatibility with starter coils and annunciation devices.
- J. Coordinate equipment with Division 26 Section "Motor-Control Centers" to achieve compatibility with motor starters and annunciation devices.
- K. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 CONTROL SYSTEM

- A. Allowable EMS Vendors/Manufacturers:
 - 1. TAC
- B. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers

operating in multiuser, multitasking environment on token-passing network and programmed to control systems. An operator workstation permits interface with the network via dynamic color graphics with each system, building floor plan, and control device depicted by point-and-click graphics.

- C. Control system shall include the following:
 - 1. Building lighting control system specified in Division 26 Section "Network Lighting Controls."
 - 2. Fire alarm system specified in Division 28 Section "Fire Detection and Alarm."

2.3 DDC EQUIPMENT

- A. Operator Workstation: One desktop with configuration commercially available three months before substantial completion:
 - 1. Motherboard with 8 integrated USB 2.0 ports, integrated Intel Ethernet, integrated audio, bios, and hardware monitoring.
 - 2. Intel Processor:
 - 3. Random-Access Memory.
 - 4. Graphics Video Adapter
 - 5. Monitor 19" LCD color.
 - 6. Keyboard: QWERTY, 105 keys in ergonomic shape.
 - 7. Hard-Disk Drive.
 - 8. CD-ROM Read/Write Drive.
 - 9. Mouse: Three button, optical.
 - 10. 2 kVA UPS.
 - 11. Operating System: Microsoft Windows or Vista with high-speed Internet access.
 - a. Protocol Compliance: Control units shall use BACnet LonTalk or Modbus protocol.
 - 12. Printer: Color, ink-jet type commercial printer with print speed of 12 color pages per minute.
 - 13. Application Software:
 - a. I/O capability from operator station.
 - b. System security for each operator via software password and access levels.
 - c. Automatic system diagnostics; monitor system and report failures.
 - d. Database creation and support.
 - e. Automatic and manual database save and restore.
 - f. Dynamic color graphic displays with up to 10 screen displays at once.
 - g. Custom graphics generation and graphics library of HVAC equipment and symbols.
 - h. Alarm processing, messages, and reactions.
 - i. Trend logs retrievable in spreadsheets and database programs.
 - j. Alarm and event processing.
 - k. Object and property status and control.
 - l. Automatic restart of field equipment on restoration of power.
 - m. Data collection, reports, and logs. Include standard reports for the following:
 - 1) Current values of all objects.
 - 2) Current alarm summary.
 - 3) Disabled objects.
 - 4) Alarm lockout objects.
 - 5) Logs.
 - n. Custom report development.
 - o. Utility and weather reports.
 - p. Workstation application editors for controllers and schedules.
 - q. Maintenance management.
 - 14. Custom Application Software:
 - a. English language oriented.
 - b. Full-screen character editor/programming environment.

- c. Allow development of independently executing program modules with debugging/simulation capability.
 - d. Support conditional statements.
 - e. Support floating-point arithmetic with mathematic functions.
 - f. Contains predefined time variables.
- B. One Diagnostic Terminal Unit: Portable notebook-style, PC-based microcomputer terminal capable of accessing system data by connecting to system network with state of the art configuration, commercially available three months before substantial completion.
 - 1. System: With one integrated USB 2.0 port, integrated Intel Ethernet, integrated audio, bios, and hardware monitoring.
 - 2. Processor: Intel.
 - 3. Random-Access Memory.
 - 4. Graphics: Video adapter.
 - 5. Monitor: 17 inches, LCD color.
 - 6. Keyboard: QWERTY 105 keys in ergonomic shape.
 - 7. Hard-Disk Drive.
 - 8. CD-ROM Read/Write Drive.
 - 9. Pointing Device, Touch pad.
- C. Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.
 - 1. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation or diagnostic terminal unit.
 - 2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
 - a. Global communications.
 - b. Discrete/digital, analog, and pulse I/O.
 - c. Monitoring, controlling, or addressing data points.
 - d. Software applications, scheduling, and alarm processing.
 - e. Testing and developing control algorithms without disrupting field hardware and controlled environment.
 - 3. Standard Application Programs:
 - a. Electric Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, night setback/setup, on-off control with differential sequencing, staggered start, antishort cycling, PID control, DDC with fine tuning, and trend logging.
 - b. HVAC Control Programs: Optimal run time, supply-air reset, and enthalpy switchover.
 - c. Chiller Control Programs: Control function of condenser-water reset, chilled-water reset, and equipment sequencing.
 - d. Programming Application Features: Include trend point; alarm processing and messaging; weekly, monthly, and annual scheduling; energy calculations; run-time totalization; and security access.
 - e. Remote communications.
 - f. Maintenance management.
 - g. Units of Measure: Inch-pound and SI (metric).
 - 4. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
 - 5. Protocol Compliance: Control units shall use BACnet LonTalk or Modbus protocol.
- D. Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.

1. Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.
 2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
 - a. Global communications.
 - b. Discrete/digital, analog, and pulse I/O.
 - c. Monitoring, controlling, or addressing data points.
 3. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
- E. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.
1. Binary Inputs: Allow monitoring of on-off signals without external power.
 2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
 3. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.
 4. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation.
 5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA).
 6. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.
 7. Universal I/Os: Provide software selectable binary or analog outputs.
- F. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:
1. Output ripple of 5.0 mV maximum peak to peak.
 2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
 3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.
- G. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:
1. Minimum dielectric strength of 1000 V.
 2. Maximum response time of 10 nanoseconds.
 3. Minimum transverse-mode noise attenuation of 65 dB.
 4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

2.4 UNITARY CONTROLLERS

- A. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.
1. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 72-hour battery backup.
 2. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform automatic system diagnostics; monitor system and report failures.
 3. ASHRAE 135 Compliance: Communicate using read (execute and initiate) and write (execute and initiate) property services defined in ASHRAE 135. Reside on network using MS/TP datalink/physical layer protocol and have service communication port for connection to diagnostic terminal unit.
 4. Protocol Compliance: Communicate using BACnet, LonTalk or Modbus..

5. Enclosure: Dustproof rated for operation at 32 to 120 deg F (0 to 50 deg C).
6. Enclosure: If outdoors or in wet ambient conditions, waterproof rated for operation at 40 to 150 deg F (5 to 65 deg C).

2.5 ELECTRONIC SENSORS

- A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.
- B. Thermistor Temperature Sensors and Transmitters:
 1. Manufacturers:
 - a. BEC Controls Corporation.
 - b. Ebtron, Inc.
 - c. I.T.M. Instruments Inc.
 - d. MAMAC Systems, Inc.
 - e. RDF Corporation.
 2. Accuracy: Plus or minus 0.5 deg F (0.3 deg C) at calibration point.
 3. Wire: Twisted, shielded-pair cable.
 4. Insertion Elements in Ducts: Single point, use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft. (0.84 sq. m).
 5. Averaging Elements in Ducts: Use where prone to temperature stratification or where ducts are larger than 10 sq. ft. (1 sq. m).
 6. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches (64 mm).
 7. Room Sensor Cover Construction: Manufacturer's standard locking covers.
 - a. Set-Point Adjustment: Exposed.
 - b. Set-Point Indication: Exposed.
 - c. Temperature: LED.
 8. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
 9. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.
- C. RTDs and Transmitters:
 1. Manufacturers:
 - a. BEC Controls Corporation.
 - b. MAMAC Systems, Inc.
 - c. RDF Corporation.
 2. Accuracy: Plus or minus 0.2 percent at calibration point.
 3. Wire: Twisted, shielded-pair cable.
 4. Insertion Elements in Ducts: Single point; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft. (0.84 sq. m).
 5. Averaging Elements in Ducts: Use where prone to temperature stratification or where ducts are larger than 9 sq. ft. (0.84 sq. m); length as required.
 6. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches (64 mm).
 7. Room Sensor Cover Construction: Manufacturer's standard locking covers.
- D. Pressure Transmitters/Transducers:
 1. Manufacturers:
 - a. BEC Controls Corporation.
 - b. General Eastern Instruments.
 - c. MAMAC Systems, Inc.
 - d. ROTRONIC Instrument Corp.
 - e. TCS/Basys Controls.
 - f. Vaisala.

2. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.
 - a. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
 - b. Output: 4 to 20 mA.
 - c. Building Static-Pressure Range: 0- to 0.25-inch wg (0 to 62 Pa).
 - d. Duct Static-Pressure Range: 0- to 5-inch wg (0 to 1240 Pa).
3. Water Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig (1034-kPa) operating pressure; linear output 4 to 20 mA.
4. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig (1034-kPa) operating pressure and tested to 300-psig (2070-kPa); linear output 4 to 20 mA.
5. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.
6. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; linear output 4 to 20 mA.

2.6 STATUS SENSORS

- A. Status Inputs for Fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch wg (0 to 1240 Pa).
- B. Status Inputs for Pumps: Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range of 8 to 60 psig (55 to 414 kPa), piped across pump.
- C. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.
- D. Voltage Transmitter (100- to 600-V ac): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.
- E. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.
- F. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.
- G. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
- H. Water-Flow Switches: Bellows-actuated mercury or snap-acting type with pilot-duty rating, stainless-steel or bronze paddle, with appropriate range and differential adjustment, in NEMA 250, Type 1 enclosure.
 1. Manufacturers:
 - a. BEC Controls Corporation.
 - b. I.T.M. Instruments Inc.

2.7 GAS DETECTION EQUIPMENT

- A. Available Manufacturers:
 1. B. W. Technologies.
 2. CEA Instruments, Inc.
 3. Ebtron, Inc.
 4. Gems Sensors Inc.

- B. Carbon Monoxide Detectors: Single or multichannel, dual-level detectors using solid-state plug-in sensors with a 3-year minimum life; suitable over a temperature range of 32 to 104 deg F (0 to 40 deg C); with 2 factory-calibrated alarm levels at 50 and 100 ppm.
- C. Carbon Dioxide Sensor and Transmitter: Single detectors using solid-state infrared sensors; suitable over a temperature range of 23 to 130 deg F (minus 5 to plus 55 deg C) and calibrated for 0 to 2 percent, with continuous or averaged reading, 4- to 20-mA output; for wall mounting.
- D. Oxygen Sensor and Transmitter: Single detectors using solid-state zircon cell sensing; suitable over a temperature range of minus 32 to plus 1100 deg F (0 to 593 deg C) and calibrated for 0 to 5 percent, with continuous or averaged reading, 4- to 20-mA output; for wall mounting.

2.8 FLOW MEASURING STATIONS

- A. Duct Airflow Station: Combination of air straightener and multiport, self-averaging pitot tube station.
 - 1. Manufacturers:
 - a. Paragon.
 - 2. Casing: Galvanized-steel frame.
 - 3. Flow Straightener: Aluminum honeycomb, 3/4-inch (20-mm) parallel cell, 3 inches (75 mm) deep.
 - 4. Sensing Manifold: Copper manifold with bullet-nosed static pressure sensors positioned on equal area basis.

2.9 ACTUATORS

- A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
 - 1. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 - 2. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
 - 3. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2 (DN 65): Size for running torque of 150 in. x lbf (16.9 N x m) and breakaway torque of 300 in. x lbf (33.9 N x m).
 - 4. Spring-Return Motors for Valves Larger Than NPS 2-1/2 (DN 65): Size for running and breakaway torque of 150 in. x lbf (16.9 N x m).
 - 5. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running torque of 150 in. x lbf (16.9 N x m) and breakaway torque of 300 in. x lbf (33.9 N x m).
 - 6. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running and breakaway torque of 150 in. x lbf (16.9 N x m).
- B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
 - 1. Manufacturers:
 - a. Belimo Aircontrols (USA), Inc.
 - 2. Valves: Size for torque required for valve close off at maximum pump differential pressure.
 - 3. Dampers: Size for running torque calculated as follows:
 - a. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. (62 kg-cm/sq. m) of damper.
 - b. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. (37.2 kg-cm/sq. m) of damper.

- c. Dampers with 2- to 3-Inch wg (500 to 750 Pa) of Pressure Drop or Face Velocities of 1000 to 2500 fpm (5 to 13 m/s): Increase running torque by 1.5.
- d. Dampers with 3- to 4-Inch wg (750 to 1000 Pa) of Pressure Drop or Face Velocities of 2500 to 3000 fpm (13 to 15 m/s): Increase running torque by 2.0.
- 4. Coupling: V-bolt and V-shaped, toothed cradle.
- 5. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
- 6. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
- 7. Power Requirements (Two-Position Spring Return): 24-Vac.
- 8. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
- 9. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
- 10. Temperature Rating: Minus 0 degrees to plus 122 deg F.
- 11. Actuator Housing: Molded or die-cast zinc or aluminum.

2.10 DAMPERS

- A. Manufacturers:
 - 1. Ruskin.
 - 2. Air Balance Inc.
 - 3. Vent Products Company, Inc.
- B. Dampers: AMCA-rated, opposed-blade design; 0.108-inch- (2.8-mm-) minimum thick, galvanized-steel or 0.125-inch- (3.2-mm-) minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-inch- (1.6-mm-) thick galvanized steel with maximum blade width of 8 inches (200 mm) and length of 48 inches (1220 mm).
 - 1. Secure blades to 1/2-inch- (13-mm-) diameter, zinc-plated axles using zinc-plated hardware, with oil-impregnated sintered bronze blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
 - 2. Operating Temperature Range: From minus 40 to plus 200 deg F (minus 40 to plus 93 deg C).
 - 3. Edge Seals, Low-Leakage Applications: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for leakage at less than 10 cfm per sq. ft. (50 L/s per sq. m) of damper area, at differential pressure of 4-inch wg (1000 Pa) when damper is held by torque of 50 in. x lbf (5.6 N x m); when tested according to AMCA 500D.
 - 4. Dampers shall be Ruskin CD-50 or approved equal.

2.11 CONTROL CABLE

- A. Electronic and fiber-optic cables for control wiring are specified in Division 27 Section "Communications Horizontal Cabling."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that power supply is available to control units and operator workstation.

3.2 INSTALLATION

- A. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.

- B. Connect and configure equipment and software to achieve sequence of operation specified.
- C. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches (1220 mm) above the floor.
 - 1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.
- D. Install automatic dampers according to Division 23 Section "Air Duct Accessories."
- E. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.
- F. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."
- G. Install refrigerant instrument wells, valves, and other accessories according to Division 23 Section "Refrigerant Piping."
- H. Install duct volume-control dampers according to Division 23 Sections specifying air ducts.
- I. Install electronic and fiber-optic cables according to Division 27 Section "Communications Horizontal Cabling."

3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

- A. Install raceways, boxes, and cabinets according to Division 26 Section "Raceway and Boxes for Electrical Systems."
- B. Install building wire and cable according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- C. Install signal and communication cable according to Division 27 Section "Communications Horizontal Cabling."
 - 1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
 - 2. Install exposed cable in raceway.
 - 3. Install concealed cable in raceway.
 - 4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
 - 5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
 - 6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
 - 7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
- D. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.
- E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including connections. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
 - 2. Test and adjust controls and safeties.
 - 3. Test each point through its full operating range to verify that safety and operating control set points are as required.
 - 4. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
 - 5. Test each system for compliance with sequence of operation.
 - 6. Test software and hardware interlocks.
- C. DDC Verification:
 - 1. Verify that instruments are installed before calibration, testing, and loop checks.
 - 2. Check instruments for proper location and accessibility.
 - 3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
 - 4. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.
 - 5. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
 - 6. Check temperature instruments and material and length of sensing elements.
 - 7. Check air-operated dampers. Verify that pressure gages are provided and that proper blade alignment, either parallel or opposed, has been provided.
 - 8. Check DDC system as follows:
 - a. Verify that DDC controller power supply is from emergency power supply, if applicable.
 - b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
 - c. Verify that spare I/O capacity has been provided.
 - d. Verify that DDC controllers are protected from power supply surges.
- D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.5 ADJUSTING

- A. Calibrating and Adjusting:
 - 1. Calibrate instruments.
 - 2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
 - 3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
 - 4. Control System Inputs and Outputs:
 - a. Check digital inputs using jumper wire.
 - b. Check digital outputs using ohmmeter to test for contact making or breaking.
 - c. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.
 - 5. Pressure:
 - a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.

- b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.
 - 6. Temperature:
 - a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
 - b. Calibrate temperature switches to make or break contacts.
 - 7. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
 - 8. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
 - 9. Provide diagnostic and test instruments for calibration and adjustment of system.
 - 10. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.
- B. Adjust initial temperature and humidity set points.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 23 09 93

SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes control sequences for HVAC systems, subsystems, and equipment.
- B. Related Sections include the following:
 - 1. Division 23 Section "Instrumentation and Control for HVAC" for control equipment and devices and for submittal requirements.

1.3 DEFINITIONS

- A. DDC: Direct digital control.
- B. VAV: Variable air volume.

1.4 VAV ROOFTOP UNITS

- A. Factory fabricated medium pressure, cooling only, rooftop unit serving DDC VAV boxes (through medium pressure main ductwork) with filters, draw-thru cooling coil, supply fans with variable frequency drives (VFD), relief fans with VFDs, relief and outside air dampers with integrated economizer operation, isolation dampers, and air flow monitors on all fans and outside air intake.
 - 1. Unit shall be started and stopped from the BAS or from a hand-off-automatic switch at the VFD. The VFD shall ramp up the fan, the normally closed O.A. damper shall open to minimum set-point and the unit's controls shall be activated. The unit's controls shall be deactivated, fan stopped, and O.A. damper shall close when the unit is stopped. The controls to be activated and deactivated when the unit is started and stopped do not include terminal boxes and other local controls which shall remain active even when the unit is stopped.
 - 2. The compressors shall be staged to maintain a constant supply air temperature from the temperature transmitter in the supply fan discharge air stream. Temperature transmitter shall be set to maintain 54 degrees F (adjustable).
 - 3. A static pressure sensor located 2/3 down in the main duct shall control the supply fan variable frequency drive to maintain minimum system static pressure. Provide a high static pressure safety limit switch in the fan discharge, which shall stop the fan and indicate an alarm condition when the limit is exceeded. This high static pressure safety limit switch shall be manual reset type.
 - 4. Provide a freeze-stat upstream of the cooling coil. Freezestat activation shall initiate all shutdown features noted above for deactivating unit as well as send alarm to BAS.
 - 5. All duct smoke detectors shall be furnished by Division 16 and installed by Division 15. Smoke detectors downstream of R.A. sound attenuators are furnished and installed by Division 16. When any smoke detector in a return duct of an air handling unit system senses smoke, unit shall shut down.
 - 6. Provide CO² sensor above ceiling near return air inlet for modulating outside air damper. During occupied hours, allow outside air damper to modulate from 50% of the minimum

setpoint up to 150% of the minimum setpoint to maintain CO2 setpoint of 900 ppm (adjustable).

- B. Rooftop unit's factory sensors and controls shall determine if economizer operation is available and modulate O.A. damper open. BAS shall monitor status of economizer. When in economizer operation, the unit's relief fans shall ramp up to prevent excessive positive pressure in building. Economizer operation shall be able to be disabled through the Operator's Workstation.
 - 1. Provide space static pressure sensor (relative to the outdoors) near the entry doors for an exterior space, or near the middle of the occupied space for interior zones.
 - 2. Economizer shall be integrated to maximize the energy efficiency of the unit. (i.e. compressors shall be allowed to run during economizer cycle if required to maintain duct temperature or humidity setpoints).
- C. Provide dirty filter alarm if static pressure across filters exceeds manufacturers recommended limits (adjustable).
- D. Monitor all available points through the factory communication module, including, but not limited to system diagnostics.

1.5 CONSTANT VOLUME SPLIT SYSTEMS

- A. Factory fabricated low pressure cooling/heating unit. Supply fans shall run continuously during occupied periods. Stage compressors and/or electric heat in unit to maintain space temperature via the temperature sensor. Temperature sensor shall match sensor used on all VAV air terminals.
- B. Provide dirty filter alarm if static pressure across filters exceeds manufacturers recommended limits (adjustable).
- C. Monitor all available points through the factory communication module, including, but not limited to system diagnostics.
- D. Coordination of Air-Handling Unit Sequences: Ensure that preheat, mixed-air, heating-coil, and cooling-coil controls have common inputs and do not overlap in function.
- E. Operator Station Display: Indicate the following on operator workstation display terminal:
 - 1. DDC system graphic.
 - 2. DDC system on-off indication.
 - 3. DDC system occupied/unoccupied mode.
 - 4. Outdoor-air-temperature indication.
 - 5. Supply-fan on-off indication.
 - 6. Supply-fan-discharge static-pressure indication.
 - 7. Supply-fan-discharge static-pressure set point.
 - 8. Supply-fan airflow rate.
 - 9. Supply-fan speed.
 - 10. Return-fan on-off indication.
 - 11. Return-air static-pressure indication.
 - 12. Return-air static-pressure set point.
 - 13. Return-fan airflow rate.
 - 14. Return-fan speed.
 - 15. Building static-pressure indication.
 - 16. Building static-pressure set point.
 - 17. Mixed-air-temperature indication.
 - 18. Mixed-air-temperature set point.
 - 19. Mixed-air damper position.

20. Filter air-pressure-drop indication.
21. Filter low-air-pressure set point.
22. Filter high-air-pressure set point.
23. Fan-discharge air-temperature indication.
24. Fan-discharge air-temperature set point.
25. Cooling-coil air-temperature indication.
26. Cooling-coil air-temperature set point.
27. Room temperature indication.
28. Room temperature set point.

1.6 TERMINAL UNIT OPERATING SEQUENCE

- A. Electric
 1. Room Temperature:
 - a. Input Device: Room thermostat.
- B. Cabinet Unit Heater, Electric: Room thermostat cycles fan and sequences stages of heating.
- C. Unit Heater, Electric: Room thermostat cycles fan and sequences stages of heating.
- D. Heating Coils, Electric: Room thermostat [cycles coils] [sequences stages of heating].
- E. Constant-Volume Terminal Air Units
 1. VAV and VAV w/heat boxes shall be DDC. DDC space sensors shall have override buttons controlling HVAC zone.
 2. VAV Boxes: The controller shall monitor the space temperature from a room space temperature sensor and modulate the normally open damper to maintain the setpoint (adjustable).
 3. VAV Boxes w/heat: The controller shall monitor the space temperature from a room space temperature sensor and modulate the normally open damper from 100% to minimum position (as scheduled) and then stage heat in sequence.
- F. VAV Terminal Air Units with Coils:
 1. VAV and VAV w/heat boxes shall be DDC. DDC space sensors shall have override buttons controlling HVAC zone.
 2. VAV Boxes: The controller shall monitor the space temperature from a room space temperature sensor and modulate the normally open damper to maintain the setpoint (adjustable).
- G. VAV Boxes w/heat: The controller shall monitor the space temperature from a room space temperature sensor and modulate the normally open damper from 100% to minimum position (as scheduled) and then stage heat in sequence.
- H. Constant Volume Split-Systems:
 1. Factory fabricated low pressure cooling/heating unit. Supply fans shall run continuously during occupied periods. Stage compressors and/or electric heat in unit to maintain space temperature via the temperature sensor. Temperature sensor shall match sensor used on all VAV air terminals.
 2. Provide dirty filter alarm if static pressure across filters exceeds manufacturers recommended limits (adjustable).
 3. Monitor all available points through the factory communication module, including, but not limited to system diagnostics.

1.7 VENTILATION SEQUENCES

- A. Toilet Exhaust Fans
 - 1. Toilet exhaust fans shall be started and stopped at the BAS or by hand-off-automatic switch in starter. Roof top fans shall have backdraft damper provided with fans which shall close when fan is off and open when fan is running. Fan shall run when any rooftop unit is running and shall be off when all rooftop units are off.
- B. High Temperature Alarms
 - 1. Provide high temperature alarms in all electrical rooms, elevator machine room, and server rooms on each floor.
- C. Water Detection Spot Detector
 - 1. Provide water detection spot detector in each elevator pit and alarm if water is detected.
- D. Monitor Status Fire Alarm System
 - 1. Provide monitor status fire alarm system.
- E. Lighting Zones
 - 1. Division 16 shall provide lighting control panels. EMS shall send time of day signal, occupied, and unoccupied signals to panels. Lighting control panels shall be provided with all logic necessary to control lighting zones.
- F. Communication Interface Module
 - 1. Provide communication interface module with the main electrical switchboard communication module and retrieve all data available. Monitor amps/KW/Phase Rotation/Voltage on each sub-meter installed at the main electrical switchboard.
- G. Monitor TVSS at main electrical switchgear.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION

SECTION 23 31 13

METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Single-wall rectangular ducts and fittings.
 - 2. Double-wall rectangular ducts and fittings.
 - 3. Single-wall round ducts and fittings.
 - 4. Double-wall round ducts and fittings.
 - 5. Sheet metal materials.
 - 6. Duct liner.
 - 7. Sealants and gaskets.
 - 8. Hangers and supports.
 - 9. Seismic-restraint devices.
- B. Related Sections:
 - 1. Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
 - 2. Division 23 Section "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 PERFORMANCE REQUIREMENTS

- A. Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.
- B. Structural Performance: Duct hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."
- C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2010.

1.4 SUBMITTALS

- A. LEED Submittals:
 - 1. Product Data for Prerequisite EQ 1: Documentation indicating that duct systems comply with ASHRAE 62.1-2010, Section 5 - "Systems and Equipment."
 - 2. Product Data for Prerequisite EA 2: Documentation indicating that duct systems comply with ASHRAE/IESNA 90.1-2010, Section 6.4.4 - "HVAC System Construction and Insulation."
 - 3. Leakage Test Report for Prerequisite EA 2: Documentation of work performed for compliance with ASHRAE/IESNA 90.1-2010, Section 6.4.4.2.2 - "Duct Leakage Tests."

4. Duct-Cleaning Test Report for Prerequisite EQ 1: Documentation of work performed for compliance with ASHRAE 62.1-2010, Section 7.2.4 - "Ventilation System Start-Up."
 5. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.
- B. Shop Drawings:
1. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
 2. Elevation of top of ducts.
 3. Dimensions of main duct runs from building grid lines.
 4. Reinforcement and spacing.
 5. Seam and joint construction.
 6. Penetrations through fire-rated and other partitions.
 7. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.

1.5 QUALITY ASSURANCE

- A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2010, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."
- B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2010, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 DOUBLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. Rectangular Ducts: Fabricate ducts with indicated dimensions for the inner duct.
- B. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

- C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- E. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
 - 1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F (0.039 W/m x K) at 75 deg F (24 deg C) mean temperature.
 - 2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
 - 3. Coat insulation with antimicrobial coating.
- F. Inner Duct: Minimum 0.028-inch (0.7-mm) solid sheet steel.
- G. Formed-on Transverse Joints (Flanges): Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- H. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SINGLE-WALL ROUND DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials

involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.4 DOUBLE-WALL ROUND DUCTS AND FITTINGS

- A. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.
 - 1. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 2. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 3. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- B. Inner Duct: Minimum 0.028-inch (0.7-mm) solid sheet steel.
- C. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
 - 1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F (0.039 W/m x K) at 75 deg F (24 deg C) mean temperature.
 - 2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
 - 3. Coat insulation with antimicrobial coating.
 - 4. Cover insulation with polyester film complying with UL 181, Class 1.

2.5 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.6 DUCT LINER

- A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
 - 1. Maximum Thermal Conductivity:
 - a. Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F (0.039 W/m x K) at 75 deg F (24 deg C) mean temperature.
 - b. Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F (0.033 W/m x K) at 75 deg F (24 deg C) mean temperature.
 - 2. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.

- a. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Insulation Pins and Washers:
 - 1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- (2.6-mm-) length to suit depth of insulation indicated with integral 1-1/2-inch (38-mm) galvanized carbon-steel washer.
 - 2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.
- C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-19, "Flexible Duct Liner Installation."

2.7 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

2.8 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1 (Table 4-1M), "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.
- F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- H. Trapeze and Riser Supports:
 - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 - 2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
 - 3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

2.9 SEISMIC-RESTRAINT DEVICES

- A. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.
- B. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.

- C. Restraint Cables: ASTM A 603, galvanized-steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; and with an automatic-locking and clamping device or double-cable clips.
- D. Hanger Rod Stiffener: Reinforcing steel angle clamped to hanger rod.
- E. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- D. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- E. Install ducts with a clearance of 1 inch (25 mm), plus allowance for insulation thickness.
- F. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures and directly over any electrical panel or transformer.
- G. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches (38 mm).
- H. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers.
- I. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."

3.2 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 ADDITIONAL INSTALLATION REQUIREMENTS FOR COMMERCIAL KITCHEN HOOD EXHAUST DUCT

- A. Install commercial kitchen hood exhaust ducts without dips and traps that may hold grease, and sloped a minimum of 2 percent to drain grease back to the hood.
- B. Install fire-rated access panel assemblies at each change in direction and at maximum intervals of 20 feet (6 m) in horizontal ducts, and at every floor for vertical ducts, or as indicated on Drawings. Locate access panel on top or sides of duct a minimum of 1-1/2 inches (38 mm) from bottom of duct.
- C. Do not penetrate fire-rated assemblies except as allowed by applicable building codes and authorities having jurisdiction.

3.4 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

3.5 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Where practical, install concrete inserts before placing concrete.
 - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches (100 mm) thick.
 - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) thick.
 - 5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1 (Table 4-1M), "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches (610 mm) of each elbow and within 48 inches (1200 mm) of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet (5 m).

- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.6 SEISMIC-RESTRAINT-DEVICE INSTALLATION

- A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."
- B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.
- C. Install cables so they do not bend across edges of adjacent equipment or building structure.
- D. Install cable restraints on ducts that are suspended with vibration isolators.

3.7 FIELD QUALITY CONTROL

- A. Leakage Tests:
 - 1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
 - 2. Test the following systems:
 - a. Ducts with a Pressure Class Higher Than 3-Inch wg (750 Pa): Test representative duct sections totaling no less than 25 percent of total installed duct area for each designated pressure class.
 - 3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
 - 4. Test for leaks before applying external insulation.
 - 5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
 - 6. Give seven days' advance notice for testing.
- B. Duct System Cleanliness Tests:
 - 1. Visually inspect duct system to ensure that no visible contaminants are present.
 - 2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
 - a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

3.8 DUCT CLEANING

- A. Clean new and existing duct system(s) before testing, adjusting, and balancing.
- B. Use service openings for entry and inspection.
 - 1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Division 23 Section "Air Duct Accessories" for access panels and doors.
 - 2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
 - 3. Remove and reinstall ceiling to gain access during the cleaning process.

- C. Particulate Collection and Odor Control:
 - 1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
 - 2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.
- D. Clean the following components by removing surface contaminants and deposits:
 - 1. Air outlets and inlets (registers, grilles, and diffusers).
 - 2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
 - 3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
 - 4. Coils and related components.
 - 5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
 - 6. Supply-air ducts, dampers, actuators, and turning vanes.
 - 7. Dedicated exhaust and ventilation components and makeup air systems.
- E. Mechanical Cleaning Methodology:
 - 1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
 - 2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
 - 3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
 - 4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
 - 5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
 - 6. Provide drainage and cleanup for wash-down procedures.
 - 7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.9 DUCT SCHEDULE

- A. Supply Ducts:
 - 1. Ducts Connected to Constant-Volume Units, Furnaces and Air Terminal Units:
 - a. Pressure Class: Positive 2-inch wg (500 Pa).
 - b. Minimum SMACNA Seal Class: A.
 - 2. Ducts Connected to Variable-Air-Volume Units:
 - a. Pressure Class: Positive 3-inch wg (750 Pa), 4-inch wg (1000 Pa).
 - b. Minimum SMACNA Seal Class: A.
 - 3. Ducts Connected to Supply Fans, and Other Equipment Not Listed:
 - a. Pressure Class: Positive 2-inch wg (500 Pa).
 - b. Minimum SMACNA Seal Class: A.
- B. Return Ducts:
 - 1. All Return Ducts:
 - a. Pressure Class: Positive or negative 2-inch wg (500 Pa).

- b. Minimum SMACNA Seal Class: B.
- C. Exhaust Ducts:
- 1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
 - a. Pressure Class: Negative 2-inch wg (500 Pa).
 - b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
 - 2. Ducts Connected to Commercial Kitchen Hoods: Comply with NFPA 96.
 - a. Exposed to View: Type 304, stainless-steel sheet.
 - b. Concealed: 16 gauge black steel.
 - c. Welded seams and joints.
 - d. Pressure Class: Positive or negative 2-inch wg (500 Pa).
 - e. Minimum SMACNA Seal Class: Welded seams, joints, and penetrations.
 - f. SMACNA Leakage Class: 3.
 - 3. Ducts Connected to Dishwasher Hoods:
 - a. Type 304, stainless-steel sheet.
 - b. Exposed to View: No. 4 finish.
 - c. Concealed: No. 2D finish.
 - d. Welded seams and flanged joints with watertight EPDM gaskets.
 - e. Pressure Class: Positive or negative 2-inch wg (500 Pa).
 - f. Minimum SMACNA Seal Class: Welded seams, joints, and penetrations.
 - g. SMACNA Leakage Class: 3.
 - 4. Ducts Connected to Fans Exhausting Laboratory and Process (ASHRAE 62.1, Class 3 and 4) Air:
 - a. Type 316, stainless-steel sheet.
 - 1) Exposed to View: No. 4 finish.
 - 2) Concealed: No. 2D finish.
 - b. Pressure Class: Positive or negative 3-inch wg (750 Pa).
 - c. Minimum SMACNA Seal Class: Welded seams, joints, and penetrations.
 - d. SMACNA Leakage Class: 3.
- D. Liner:
- 1. Supply Air Ducts: Fibrous glass, Type I, 1 inch (25 mm) thick.
 - 2. Return Air Ducts: Fibrous glass, Type I, 1 inch (25 mm) thick.
 - 3. Exhaust Air Ducts: Fibrous glass, Type I, 1 inch (25 mm) thick.
 - 4. Supply Fan Plenums: Fibrous glass, Type II, 1 inch (25 mm) thick.
 - 5. Transfer Ducts: Fibrous glass, Type I, 1/2 inch (25 mm) thick.
- E. Double-Wall Duct Interstitial Insulation:
- 1. Supply Air Ducts: 1 inch (25 mm) thick.
 - 2. Return Air Ducts: 1 inch (25 mm) thick.
 - 3. Exhaust Air Ducts: 1 inch (25 mm) thick.
- F. Elbow Configuration:
- 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."
 - a. Low Pressure (2" and Below)
 - 1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
 - 2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
 - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
 - b. Medium Pressure (3" and Higher):
 - 1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.

G. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-6, "Branch Connections."
 - a. Rectangular Main to Rectangular Branch: 45-degree entry.
 - b. Rectangular Main to Round Branch: Spin in.
2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees." Saddle taps are permitted in existing duct.
 - a. Velocity 1000 fpm (5 m/s) or Lower: 90-degree tap.
 - b. Velocity 1000 or higher (5 to 7.6 m/s): Conical tap.

END OF SECTION

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SECTION 23 34 23

HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Centrifugal roof ventilators.
 - 2. In-line centrifugal fans.

1.3 PERFORMANCE REQUIREMENTS

- A. Project Altitude: Base fan-performance ratings on actual Project site elevations.
- B. Operating Limits: Classify according to AMCA 99.

1.4 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
 - 1. Certified fan performance curves with system operating conditions indicated.
 - 2. Certified fan sound-power ratings.
 - 3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - 4. Material thickness and finishes, including color charts.
 - 5. Dampers, including housings, linkages, and operators.
 - 6. Roof curbs.
 - 7. Fan speed controllers.
- B. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.
- C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.
- D. UL Standard: Power ventilators shall comply with UL 705.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.

- B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.
- C. Lift and support units with manufacturer's designated lifting or supporting points.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Belts: One set(s) for each belt-driven unit.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL ROOF VENTILATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Greenheck.
 - 2. Loren Cook Company.
- B. Description: Direct- or belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.
- C. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.
 - 1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains.
 - 2. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.
- D. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
- E. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:
 - 1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 - 2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
 - 3. Pulleys: Cast-iron, adjustable-pitch motor pulley.
 - 4. Fan and motor isolated from exhaust airstream.
- F. Accessories:
 - 1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
 - 2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
 - 3. Bird Screens: Removable, 1/2-inch (13-mm) mesh, aluminum or brass wire.
 - 4. Backdraft Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
 - 5. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
- G. Roof Curbs: 12" High Galvanized steel; mitered and welded corners; 1-1/2-inch- (40-mm-) thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch (40-mm) wood nailer. Size as required to suit roof opening and fan base.

2.2 IN-LINE CENTRIFUGAL FANS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Greenheck.
 - 2. Loren Cook Company.
- B. Description: In-line centrifugal fans consisting of housing, wheel, outlet guide vanes, fan shaft, bearings, motor and disconnect switch, drive assembly, mounting brackets, and accessories.
- C. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.
- D. Direct-Driven Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.
- E. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.
- F. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.

2.3 MOTORS

- A. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.4 SOURCE QUALITY CONTROL

- A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
- B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install power ventilators level and plumb.
- B. Support units using elastomeric mounts, restrained elastomeric mounts, spring isolators or restrained spring isolators having a static deflection of 1 inch (25 mm). Vibration- and seismic-control devices are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
 - 1. Secure vibration and seismic controls to concrete bases using anchor bolts cast in concrete base.
- C. Secure roof-mounting fans to roof curbs with cadmium-plated hardware. Refer to Division 07 Section "Roof Accessories" for installation of roof curbs.
- D. Ceiling Units: Suspend units from structure; use steel wire or metal straps.

- E. Install units with clearances for service and maintenance.
- F. Label units according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

- A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Air Duct Accessories."
- B. Install ducts adjacent to power ventilators to allow service and maintenance.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Verify that shipping, blocking, and bracing are removed.
 - 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 - 3. Verify that cleaning and adjusting are complete.
 - 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
 - 5. Adjust belt tension.
 - 6. Adjust damper linkages for proper damper operation.
 - 7. Verify lubrication for bearings and other moving parts.
 - 8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
 - 9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
 - 10. Shut unit down and reconnect automatic temperature-control operators.
 - 11. Remove and replace malfunctioning units and retest as specified above.
- B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.

- D. Replace fan and motor pulleys as required to achieve design airflow.
- E. Lubricate bearings.

END OF SECTION

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SECTION 23 36 00

AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Single-duct air terminal units.
 - 2. Fan-powered air terminal units.

1.3 PERFORMANCE REQUIREMENTS

1.4 SUBMITTALS

- A. Product Data: For each type of the following products, including rated capacities, furnished specialties, sound-power ratings, and accessories.
 - 1. Air terminal units.
 - 2. Liners and adhesives.
 - 3. Sealants and gaskets.
- B. LEED Submittal:
 - 1. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with ASHRAE 62.1-2010, Section 5 - "Systems and Equipment."
- C. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Instructions for resetting minimum and maximum air volumes.
 - 2. Instructions for adjusting software set points.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2010, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

1.6 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fan-Powered-Unit Filters: Furnish one spare filter for each filter installed.

PART 2 - PRODUCTS

2.1 FAN-POWERED AIR TERMINAL UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Nailor Industries Inc.
 - 2. Price Industries.
 - 3. Titus.
 - 4. Carrier.
- B. Configuration: Volume-damper assembly and fan in series (or parallel, per schedule on Drawings) arrangement inside unit casing with control components inside a protective metal shroud.
- C. Outside Casing: 0.034-inch (0.85-mm) steel.
 - 1. Casing Lining: Adhesive attached, 1/2-inch- (13-mm-) thick, closed cell foam insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
 - 2. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket and quarter-turn latches.
 - 3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2010.
 - 4. Unit shall be supplied with an integral induced air attenuator for noise attenuation.
- D. Volume Damper: Galvanized steel with flow-sensing ring and peripheral gasket and self-lubricating bearings.
 - 1. Maximum Damper Leakage: ARI 880 rated, 3 percent of nominal airflow at 3-inch wg (750-Pa) inlet static pressure.
 - 2. Damper Position: Normally open.
- E. Velocity Sensors: Multipoint array with velocity sensors in air inlets. Provide external total and static pressure connections (capped barbed tees) in the tubing for connection by TAB contractor.
- F. Motor:
 - 1. Provide ECM fan motors with field adjustable digitally controlled fan speed controller.
 - 2. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 - 3. Electrical Characteristics: Voltage shall be 480/3/0 volt for heat and 277/1/60 volt for fan.
- G. Filters: Minimum arrestance according to ASHRAE 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
 - 1. Material: Pleated cotton-polyester media having 90 percent arrestance and 7 MERV.
 - 2. Thickness: 1 inch (25 mm).
- H. Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and secondary manual, reset thermal cutouts. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware.
 - 1. Stage(s) 0 – 7 kW, 1 stage; 7.5 kW -12.00 – 2 stages; 15 kW and larger – 3 stages.
 - 2. Access door interlocked disconnect switch.

3. Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable.)
 4. Fan interlock contacts.
 5. Fuses in terminal box for overcurrent protection (for coils more than 48 A).
 6. Pneumatic-electric switches and relays.
 7. Magnetic contactor for each step of control.
- I. Controls:
1. Electric actuators, DDC controllers, and transducers shall be furnished by EMS contractor (See Division 230900). All controls shall be delivered to air terminal manufacturer.
 2. Air terminal manufacturer shall factory mount all devices and ship complete units to job site.
 3. Air terminal manufacturer shall provide a 120/24 volt transformer sized for fan powered terminal and five (5) extra DDC controllers.
 4. Provide toggle switch and 4x4 electrical box for transformer, securely fastened to unit.
 5. Terminal unit manufacturer shall provide a flow cross in inlets and extend tubing from flow cross to controls provided by Section 23 09 00.

2.2 SINGLE-DUCT AIR TERMINAL UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Nailor Industries Inc.
 2. Price Industries.
 3. Titus.
 4. Carrier.
- B. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.
- C. Casing: 0.034-inch (0.85-mm) steel.
1. Casing Lining:
 - a. Casing Lining: Adhesive attached, 1/2-inch- (13-mm-) thick, closed cell foam insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
 2. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
 3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2010.
- D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
1. Maximum Damper Leakage: ARI 880 rated, 3 percent of nominal airflow at 3-inch wg (750-Pa) inlet static pressure.
 2. Damper Position: Normally open.
- E. Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and secondary manual, reset thermal cutouts. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware.
1. Access door interlocked disconnect switch.
 2. Airflow switch for proof of airflow.
 3. Fuses in terminal box for overcurrent protection (for coils more than 48 A).
 4. Magnetic contactor for each step of control (for three-phase coils).

- F. Controls:
 - 1. Electric actuators, DDC controllers, and transducers shall be furnished by EMS contractor (See division 230900). All controls shall be delivered to air terminal manufacturer.
 - 2. Air terminal manufacturer shall factory mount all devices and ship complete units to job sites.
 - 3. Terminal unit manufacturer shall provide a flow cross in inlet and extend tubing from flow cross to controls provided by Section 23 09 00.

2.3 SOURCE QUALITY CONTROL

- A. Factory Tests: Test assembled air terminal units according to ARI 880.
 - 1. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, and ARI certification seal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."
- B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."

3.3 CONNECTIONS

- A. Install piping adjacent to air terminal unit to allow service and maintenance.
- B. Make connections to air terminal unit inlets with flexible ductwork complying with requirements in Division 23 Section "Air Duct Accessories."

3.4 IDENTIFICATION

- A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Division 23 Section "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

3.5 STARTUP SERVICE

- A. Perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
 - 3. Verify that controls and control enclosure are accessible.
 - 4. Verify that control connections are complete.
 - 5. Verify that nameplate and identification tag are visible.
 - 6. Verify that controls respond to inputs as specified.

END OF SECTION

SECTION 26 05 00

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Electrical equipment coordination and installation.
 - 2. Sleeves for raceways and cables.
 - 3. Sleeve seals.
 - 4. Grout.
 - 5. Common electrical installation requirements.

1.3 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.4 SUBMITTALS

- A. Product Data: For sleeve seals.

1.5 COORDINATION

- A. Coordinate arrangement, mounting, and support of electrical equipment:
 - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 - 3. To allow right of way for piping and conduit installed at required slope.
 - 4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. 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."
- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."."
- E. In order to make the submittal review process more efficient for all parties, all MEP submittal data shall be reviewed on a designated "Submittal Review Day." The "Submittal Review Day" will consist of having the Engineer, General Contractor, Mechanical Contractor, Plumbing Contractor, and Electrical Contractor review the submittals together, in the same room. The Architect and owner's representative(s) will be invited to attend the "Submittal Review Day." Key Manufacturer's Representatives shall attend the review or be available by phone for

immediate response to questions and/or comments. All submittals will be reviewed and stamped by the Engineer the same day. The Contractor is responsible for setting time and place for this review and inviting all required parties. All parties will be given a minimum of seven (7) days notice.

PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Sleeves for Rectangular Openings: Galvanized sheet steel.
 - 1. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
 - b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 SLEEVE SEALS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. Pipeline Seal and Insulator, Inc.
 - 2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
 - 3. Pressure Plates: Stainless steel. Include two for each sealing element.
 - 4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

- D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- E. Right of Way: Give to piping systems installed at a required slope.

3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- E. Cut sleeves to length for mounting flush with both surfaces of walls.
- F. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.
- G. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable, unless indicated otherwise.
- H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
 - 1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
- I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."
- J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."
- K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.3 SLEEVE-SEAL INSTALLATION

- A. Install to seal exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 FIRESTOPPING

- A. 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."

END OF SECTION

SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes methods and materials for grounding systems and equipment, plus the following special applications:
 - 1. Overhead-lines grounding.
 - 2. Underground distribution grounding.
 - 3. Common ground bonding with lightning protection system.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in Part 3 "Field Quality Control" Article, including the following:
 - 1. Test wells.
 - 2. Ground rods.
 - 3. Ground rings.
 - 4. Grounding arrangements and connections for separately derived systems.
 - 5. Grounding for sensitive electronic equipment.
- C. Qualification Data: For testing agency and testing agency's field supervisor.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For grounding to include the following in emergency, operation, and maintenance manuals:
 - 1. Instructions for periodic testing and inspection of grounding features at grounding connections for separately derived systems based on NETA MTS, NFPA 70B.
 - a. Tests shall be to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.
 - b. Include recommended testing intervals.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association to supervise on-site testing specified in Part 3.

- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

- A. Insulated Conductors: Copper or tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Stranded Conductors: ASTM B 8.
 - 3. Tinned Conductors: ASTM B 33.
 - 4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
 - 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 - 6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
 - 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
- C. Bare Grounding Conductor and Conductor Protector for Wood Poles:
 - 1. No. 4 AWG minimum, soft-drawn copper.
 - 2. Conductor Protector: Half-round PVC or wood molding. If wood, use pressure-treated fir or cypress or cedar.
- D. Grounding Bus: Rectangular bars of annealed copper, 1/4 by 4 inches (6 by 100 mm) in cross section, unless otherwise indicated; with insulators.

2.2 CONNECTORS

- A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
 - 1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet (19 mm by 3 m) in diameter.
- B. Chemical-Enhanced Grounding Electrodes: Copper tube, straight or L-shaped, charged with nonhazardous electrolytic chemical salts.
 - 1. Termination: Factory-attached No. 4/0 AWG bare conductor at least 48 inches (1200 mm) long.
 - 2. Backfill Material: Electrode manufacturer's recommended material.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 10 AWG and smaller, and stranded conductors for No. 8 AWG and larger, unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2/0 AWG minimum.
 - 1. Bury at least 24 inches (600 mm) below grade.
 - 2. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.
- C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- D. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Install bus on insulated spacers 1 inch minimum, from wall 6 inches above finished floor, unless otherwise indicated.
- E. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods: Bolted connectors.
 - 4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.
- B. Pad-Mounted Transformers and Switches: For all Owner furnished equipment or where required by the utility company. Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches (150 mm) from the foundation.

3.3 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - 1. Feeders and branch circuits.
 - 2. Lighting circuits.
 - 3. Receptacle circuits.
 - 4. Single-phase motor and appliance branch circuits.
 - 5. Three-phase motor and appliance branch circuits.
 - 6. Flexible raceway runs.
 - 7. Armored and metal-clad cable runs.

8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
 9. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.
- C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- D. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- E. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.
- F. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.
- G. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch (6-by-50-by-300-mm) grounding bus.
 2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
- H. Metal Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.4 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Common Ground Bonding with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
- C. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade, unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
 2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Division 26 Section "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches (300 mm) deep, with cover.
1. Test Wells: Install at least one test well for each service, unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.
- E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
 3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.
- F. 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, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- G. 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.
- H. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet (18 m) apart.
- I. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70, using a minimum of 20 feet (6 m) of bare copper conductor not smaller than No. 4 AWG.
1. If concrete foundation is less than 20 feet (6 m) long, coil excess conductor within base of foundation.
 2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to grounding electrode external to concrete.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

- B. Perform the following tests and inspections and prepare test reports:
1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at individual ground rods. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method according to IEEE 81.
 3. Prepare dimensioned drawings locating each test well, ground rod and ground rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
- C. Report measured ground resistances that exceed the following values:
1. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 10 ohms.
 2. Power and Lighting Equipment or System with Capacity 500 to 1000 kVA: 5 ohms.
 3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
 4. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).
 5. Substations and Pad-Mounted Equipment: 5 ohms.
- D. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION

SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.

1.3 DEFINITIONS

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

1.4 PERFORMANCE REQUIREMENTS

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

1.5 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel slotted support systems.
 - 2. Nonmetallic slotted support systems.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze hangers. Include Product Data for components.
 - 2. Steel slotted channel systems. Include Product Data for components.
 - 3. Nonmetallic slotted channel systems. Include Product Data for components.
 - 4. Equipment supports.
- C. Welding certificates.

1.6 QUALITY ASSURANCE

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

1.7 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. ERICO International Corporation.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut; Tyco International, Ltd.
 - 2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 - 3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 - 4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 - 5. Channel Dimensions: Selected for applicable load criteria.
- B. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch- (14-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c., in at least 1 surface.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. Fabco Plastics Wholesale Limited.
 - d. Seasafe, Inc.
 - 2. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
 - 3. Fitting and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.
 - 4. Rated Strength: Selected to suit applicable load criteria.
- C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- D. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

- E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - 1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used. Not approved for light weight concrete or slabs less than six (6) inches thick.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Hilti Inc.
 - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC.
 - 4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
 - 2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti Inc.
 - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 5) MKT Fastening, LLC.
 - 3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 - 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 - 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 - 6. Toggle Bolts: All-steel springhead type.
 - 7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by scheduled in NECA 1, where its Table 1 lists maximum spacings less than stated in NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with two-bolt conduit clamps.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: Conduits or raceways may not be supported by openings through structure members.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Expansion anchor fasteners.
 - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
 - 6. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
 - 7. To Light Steel: Sheet metal screws.
 - 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) 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 (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete."
- C. Anchor equipment to concrete base.
 - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).
- B. Touchup: Comply with requirements in Division 09 painting Sections Section "High-Performance Coatings" for 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 A 780.

END OF SECTION

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SECTION 26 05 33

RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
- B. Related Sections include the following:
 - 1. Division 26 Section "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. ENT: Electrical nonmetallic tubing.
- C. EPDM: Ethylene-propylene-diene terpolymer rubber.
- D. FMC: Flexible metal conduit.
- E. IMC: Intermediate metal conduit.
- F. LFMC: Liquidtight flexible metal conduit.
- G. LFNC: Liquidtight flexible nonmetallic conduit.
- H. NBR: Acrylonitrile-butadiene rubber.
- I. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Custom enclosures and cabinets, where applicable.
 - 2. For handholes and boxes for underground wiring, including the following:
 - a. Duct entry provisions, including locations and duct sizes.
 - b. Frame and cover design.
 - c. Grounding details.
 - d. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
 - e. Joint details.
 - 3. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

- 4. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Qualification Data: For professional engineer and testing agency.
- D. Source quality-control test reports.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Alflex Inc.
 - 3. Allied Tube & Conduit; a Tyco International Ltd. Co.
 - 4. Anamet Electrical, Inc.; Anaconda Metal Hose.
 - 5. Electri-Flex Co.
 - 6. Manhattan/CDT/Cole-Flex.
 - 7. Maverick Tube Corporation.
 - 8. O-Z Gedney; a unit of General Signal.
 - 9. Wheatland Tube Company.
- B. Rigid Steel Conduit: ANSI C80.1.
- C. Aluminum Rigid Conduit: ANSI C80.5.
- D. IMC: ANSI C80.6.
- E. PVC-Coated Steel Conduit:
 - 1. Comply with NEMA RN 1.
 - 2. Coating Thickness: 0.040 inch (1 mm), minimum.
- F. EMT: ANSI C80.3.
- G. FMC: Zinc-coated steel.
- H. LFMC: Flexible steel conduit with PVC jacket.
- I. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
 - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
 - 2. Fittings for EMT: Steel, compression type.
 - 3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.

- J. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 NONMETALLIC CONDUIT AND TUBING

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Anamet Electrical, Inc.; Anaconda Metal Hose.
 - 3. Arnco Corporation.
 - 4. CANTEX Inc.
 - 5. CertainTeed Corp.; Pipe & Plastics Group.
 - 6. Condux International, Inc.
 - 7. ElecSYS, Inc.
 - 8. Electri-Flex Co.
 - 9. Lamson & Sessions; Carlon Electrical Products.
 - 10. Manhattan/CDT/Cole-Flex.
 - 11. RACO; a Hubbell Company.
 - 12. Thomas & Betts Corporation.
- B. ENT: NEMA TC 13.
- C. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.
- D. LFNC: UL 1660.
- E. Fittings for ENT and RNC: NEMA TC 3; match to conduit or tubing type and material.
- F. Fittings for LFNC: UL 514B.

2.3 OPTICAL FIBER/COMMUNICATIONS CABLE RACEWAY AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Arnco Corporation.
 - 2. Endot Industries Inc.
 - 3. IPEX Inc.
 - 4. Lamson & Sessions; Carlon Electrical Products.
- B. Description: Comply with UL 2024; flexible type, approved for plenum installation.

2.4 METAL WIREWAYS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper B-Line, Inc.
 - 2. Hoffman.
 - 3. Square D; Schneider Electric.
- B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, unless otherwise indicated.

- C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Wireway Covers: Hinged type.
- E. Finish: Manufacturer's standard enamel finish.

2.5 NONMETALLIC WIREWAYS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Hoffman.
 - 2. Lamson & Sessions; Carlon Electrical Products.
- B. Description: Fiberglass polyester, extruded and fabricated to size and shape indicated, with no holes or knockouts. Cover is gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections are flanged, with stainless-steel screws and oil-resistant gaskets.
- C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

2.6 SURFACE RACEWAYS

- A. Surface Metal Raceways: Galvanized steel with snap-on covers. Manufacturer's standard enamel finish in color selected by Architect.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Thomas & Betts Corporation.
 - b. Walker Systems, Inc.; Wiremold Company (The).
 - c. Wiremold Company (The); Electrical Sales Division.
- B. Surface Nonmetallic Raceways: Two-piece construction, manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Butler Manufacturing Company; Walker Division.
 - b. Enduro Systems, Inc.; Composite Products Division.
 - c. Hubbell Incorporated; Wiring Device-Kellems Division.
 - d. Lamson & Sessions; Carlon Electrical Products.
 - e. Panduit Corp.
 - f. Walker Systems, Inc.; Wiremold Company (The).
 - g. Wiremold Company (The); Electrical Sales Division.

2.7 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
 - 2. EGS/Appleton Electric.
 - 3. Erickson Electrical Equipment Company.
 - 4. Hoffman.
 - 5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.

6. O-Z/Gedney; a unit of General Signal.
 7. RACO; a Hubbell Company.
 8. Robroy Industries, Inc.; Enclosure Division.
 9. Scott Fetzer Co.; Adalet Division.
 10. Spring City Electrical Manufacturing Company.
 11. Thomas & Betts Corporation.
 12. Walker Systems, Inc.; Wiremold Company (The).
 13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.
- B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
- C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, aluminum, Type FD, with gasketed cover.
- D. Nonmetallic Outlet and Device Boxes: NEMA OS 2.
- E. Metal Floor Boxes: Cast or sheet metal, fully adjustable, rectangular.
- F. Nonmetallic Floor Boxes: Nonadjustable, round.
- G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- H. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.
- I. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 2. Nonmetallic Enclosures: Plastic, finished inside with radio-frequency-resistant paint.
- J. Cabinets:
1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 2. Hinged door in front cover with flush latch and concealed hinge.
 3. Key latch to match panelboards.
 4. Metal barriers to separate wiring of different systems and voltage.
 5. Accessory feet where required for freestanding equipment.

2.8 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

- A. Description: Comply with SCTE 77.
1. Color of Frame and Cover: Gray.
 2. Configuration: Units shall be designed for flush burial and have integral closed bottom, unless otherwise indicated.
 3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
 4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 5. Cover Legend: Molded lettering, "ELECTRIC." "TELEPHONE." as indicated for each service.
 6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
 7. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.
- B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass or a combination of the two. Not approved for areas subject to vehicle traffic.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
 - a. Armorcast Products Company.
 - b. Carson Industries LLC.
 - c. CDR Systems Corporation.
 - d. NewBasis.

2.9 SLEEVES FOR RACEWAYS

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch (1.3- or 3.5-mm) thickness as indicated and of length to suit application.
- C. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

2.10 SLEEVE SEALS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
 1. Advance Products & Systems, Inc.
 2. Calpico, Inc.
 3. Metraflex Co.
 4. Pipeline Seal and Insulator, Inc.
- C. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.
 1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
 2. Pressure Plates: Stainless steel. Include two for each sealing element.
 3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.11 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

- A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
 1. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
 2. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:

1. Exposed Conduit: Rigid steel conduit.
 2. Concealed Conduit, Aboveground: Rigid steel conduit IMC.
 3. Underground Conduit: RNC, Type EPC- 80-PVC, direct buried.
 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
 6. Application of Handholes and Boxes for Underground Wiring:
 - a. Handholes and Pull Boxes in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete, SCTE 77, Tier 15 structural load rating.
 - b. Handholes and Pull Boxes in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Polymer-concrete units, SCTE 77, Tier 8 structural load rating.
 - c. Handholes and Pull Boxes Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf (13 345-N) vertical loading.
- B. Comply with the following indoor applications, unless otherwise indicated:
1. Exposed, Not Subject to Physical Damage: RNC.
 2. Exposed, Not Subject to Severe Physical Damage: EMT.
 3. Exposed and Subject to Severe Physical Damage: Rigid steel conduit. Includes raceways in the following locations:
 - a. Loading dock.
 - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - c. Mechanical rooms.
 4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
 6. Damp or Wet Locations: Rigid steel conduit IMC.
 7. Raceways for Optical Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical fiber/communications cable raceway.
 8. Raceways for Optical Fiber or Communications Cable Risers in Vertical Shafts: Riser-type, optical fiber/communications cable raceway.
 9. Raceways for Concealed General Purpose Distribution of Optical Fiber or Communications Cable: General-use, optical fiber/communications cable raceway.
 10. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, nonmetallic in damp or wet locations.
- C. Minimum Raceway Size: 3/4-inch (21-mm) trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
 2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.
- E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.
- F. Do not install aluminum conduits in contact with concrete.

3.2 INSTALLATION

- A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.
- B. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Complete raceway installation before starting conductor installation.
- D. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."
- E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.
- F. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
- H. Raceways Embedded in Slabs:
 - 1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
 - 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 - 3. Change from ENT to RNC, Type EPC-40-PVC, rigid steel conduit, or IMC before rising above the floor.
- I. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- J. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.
- K. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 36 inches (900 mm) of slack at each end of pull wire.
- L. Raceways for Optical Fiber and Communications Cable: Install raceways, metallic and nonmetallic, rigid and flexible, as follows:
 - 1. 3/4-Inch (19-mm) Trade Size and Smaller: Install raceways in maximum lengths of 50 feet (15 m).
 - 2. 1-Inch (25-mm) Trade Size and Larger: Install raceways in maximum lengths of 75 feet (23 m).
 - 3. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.
- M. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 2. Where otherwise required by NFPA 70.
- N. Expansion-Joint Fittings for RNC: Install in each run of aboveground conduit that is located where environmental temperature change may exceed 30 deg F (17 deg C), and that has straight-run length that exceeds 25 feet (7.6 m).
1. Install expansion-joint fittings for each of the following locations, and provide type and quantity of fittings that accommodate temperature change listed for location:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
 - c. Indoor Spaces: Connected with the Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
 - d. Attics: 135 deg F (75 deg C) temperature change.
 2. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change.
 3. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at the time of installation.
- O. Flexible Conduit Connections: Use maximum of 72 inches (1830 mm) of flexible conduit for equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
1. Use LFMC in damp or wet locations subject to severe physical damage.
 2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.
- P. 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.
- Q. Set metal floor boxes level and flush with finished floor surface.
- R. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

- A. Direct-Buried Conduit:
1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 31 Section "Earth Moving" for pipe less than 6 inches (150 mm) in nominal diameter.
 2. Install backfill as specified in Division 31 Section "Earth Moving."
 3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."
 4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
 - b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of equipment

pad or foundation. Install insulated grounding bushings on terminations at equipment.

5. Warning Planks: Bury warning planks approximately 12 inches (300 mm) above direct-buried conduits, placing them 24 inches (600 mm) o.c. Align planks along the width and along the centerline of conduit.

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch (25 mm) above finished grade.
- D. Install handholes and boxes with bottom below the frost line, below grade.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.
- F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Rectangular Sleeve Minimum Metal Thickness:
 1. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side greater than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
 2. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches (1270 mm) and 1 or more sides equal to, or greater than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).
- E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- F. Cut sleeves to length for mounting flush with both surfaces of walls.
- G. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.

- H. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway unless sleeve seal is to be installed.
- I. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.
- J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
- K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with firestop materials. Comply with Division 07 Section "Penetration Firestopping."
- L. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.
- M. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- N. Underground, Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway and sleeve for installing mechanical sleeve seals.

3.6 SLEEVE-SEAL INSTALLATION

- A. Install to seal underground, exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position raceway in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.7 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.8 PROTECTION

- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

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SECTION 26 05 43

UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1.3 DEFINITION

- A. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Duct-bank materials, including separators and miscellaneous components.
 - 2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
 - 3. Accessories for handholes, boxes, and other utility structures.
 - 4. Warning tape.
 - 5. Warning planks.
- B. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Include plans, elevations, sections, details, attachments to other work, and accessories, including the following:
 - 1. Duct entry provisions, including locations and duct sizes.
 - 2. Reinforcement details.
 - 3. Frame and cover design.
 - 4. Grounding details.
 - 5. Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
 - 6. Joint details.
- C. Shop Drawings for Factory-Fabricated Handholes and Boxes Other Than Precast Concrete: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:
 - 1. Duct entry provisions, including locations and duct sizes.
 - 2. Cover design.
 - 3. Grounding details.
 - 4. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
- D. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.
 - 1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
 - 2. Drawings shall be signed and sealed by a qualified professional engineer.

- E. Product Certificates: For concrete and steel used in precast concrete handholes, as required by ASTM C 858.
- F. Qualification Data: For professional engineer and testing agency.
- G. Source quality-control test reports.
- H. Field quality-control test reports.

1.5 QUALITY ASSURANCE

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

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 COORDINATION

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

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- B. Furnish cable-support stanchions, arms, insulators, and associated fasteners in quantities equal to 5 percent of quantity of each item installed.

PART 2 - PRODUCTS

2.1 CONDUIT

- A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.
- B. RNC: NEMA TC 2, Type EPC-80-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.2 NONMETALLIC DUCTS AND DUCT ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:
 - 1. ARNCO Corp.
 - 2. Beck Manufacturing.
 - 3. Cantex, Inc.
 - 4. CertainTeed Corp.; Pipe & Plastics Group.
 - 5. Condux International, Inc.
 - 6. ElecSys, Inc.
 - 7. Electri-Flex Company.
 - 8. IPEX Inc.
 - 9. Lamson & Sessions; Carlon Electrical Products.
 - 10. Manhattan/CDT; a division of Cable Design Technologies.
 - 11. Spiraduct/AFC Cable Systems, Inc.
- C. Underground Plastic Utilities Duct: NEMA TC 6 & 8, Type EB-20-PVC, ASTM F 512, UL 651A, with matching fittings by the same manufacturer as the duct, complying with NEMA TC 9.
- D. Underground Plastic Utilities Duct: NEMA TC 6 & 8, Type DB-60-PVC and Type DB-120-PVC, ASTM F 512, with matching fittings by the same manufacturer as the duct, complying with NEMA TC 9.
- E. Duct Accessories:
 - 1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
 - 2. Warning Tape: Underground-line warning tape specified in Division 26 Section "Identification for Electrical Systems."
 - 3. Concrete Warning Planks: Nominal 12 by 24 by 3 inches (300 by 600 by 76 mm) in size, manufactured from 6000-psi (41-MPa) concrete.
 - a. Color: Red dye added to concrete during batching.
 - b. Mark each plank with "ELECTRIC" in 2-inch- (50-mm-) high, 3/8-inch- (10-mm-) deep letters.

2.3 PRECAST CONCRETE HANDHOLES AND BOXES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Carder Concrete Products.
 - 2. Christy Concrete Products.
 - 3. Elmhurst-Chicago Stone Co.
 - 4. Oldcastle Precast Group.
 - 5. Riverton Concrete Products; a division of Cretex Companies, Inc.
 - 6. Utility Concrete Products, LLC.
 - 7. Utility Vault Co.
 - 8. Wausau Tile, Inc.
- C. Comply with ASTM C 858 for design and manufacturing processes.

- D. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.
1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
 2. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
 3. Frame and Cover: Weatherproof steel frame, with hinged steel access door assembly with tamper-resistant, captive, cover-securing bolts.
 - a. Cover Hinges: Concealed, with hold-open ratchet assembly.
 - b. Cover Handle: Recessed.
 4. Frame and Cover: Weatherproof aluminum frame with hinged aluminum access door assembly with tamper-resistant, captive, cover-securing bolts.
 - a. Cover Hinges: Concealed, with hold-open ratchet assembly.
 - b. Cover Handle: Recessed.
 5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 6. Cover Legend: Molded lettering, "ELECTRIC." "TELEPHONE."
 7. Configuration: Units shall be designed for flush burial and have integral closed bottom, unless otherwise indicated.
 8. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
 - a. Extension shall provide increased depth of 12 inches (300 mm).
 - b. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.
 9. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches (300 mm) vertically and horizontally to accommodate alignment variations.
 - a. Windows shall be located no less than 6 inches (150 mm) from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
 - b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
 - c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.
 10. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
 - a. Type and size shall match fittings to duct or conduit to be terminated.
 - b. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.
 11. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.4 HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

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

8. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have factory-installed inserts for cable racks and pulling-in irons.
- B. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 2. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:
 - a. Armorcast Products Company.
 - b. Carson Industries LLC.
 - c. CDR Systems Corporation.
 - d. NewBasis.

2.5 SOURCE QUALITY CONTROL

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

PART 3 - EXECUTION

3.1 UNDERGROUND DUCT APPLICATION

- A. Ducts for Electrical Cables Over 600 V: RNC, NEMA Type EPC-80 -PVC, in concrete-encased duct bank, unless otherwise indicated.
- B. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-80-PVC, in direct-buried duct bank, unless otherwise indicated.
- C. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-80-PVC, in direct-buried duct bank, unless otherwise indicated.
- D. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated.
- E. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40-PVC, installed in concrete-encased duct bank, unless otherwise indicated.
- F. Underground Ducts for Telephone, Communications, or Data Circuits: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank, unless otherwise indicated.
- G. Underground Ducts for Telephone, Communications, or Data Circuits: RNC, NEMA Type EB-20-PVC, in concrete-encased duct bank, unless otherwise indicated.
- H. Underground Ducts Crossing Paved Paths, Walks, and Driveways, Roadways: RNC, NEMA Type EPC-40-PVC, encased in reinforced concrete.

3.2 UNDERGROUND ENCLOSURE APPLICATION

- A. Handholes and Boxes for 600 V and Less, Including Telephone, Communications, and Data Wiring:
 - 1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-10 structural load rating.
 - 2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20 structural load rating.
 - 3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-10 structural load rating.
 - 4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf (13 345-N) vertical loading.

3.3 EARTHWORK

- A. Excavation and Backfill: Comply with Division 31 Section "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
- C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 32 Sections "Turf and Grasses" and "Plants."
- D. Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 01 Section "Cutting and Patching."

3.4 DUCT INSTALLATION

- A. Slope: Pitch ducts a minimum slope of 1:300 down handholes and away from buildings and equipment.
- B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches (1220 mm), both horizontally and vertically, at other locations, unless otherwise indicated.
- C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.
- D. Duct Entrances to Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches (250 mm) o.c. for 5-inch (125-mm) ducts, and vary proportionately for other duct sizes.
 - 1. Begin change from regular spacing to end-bell spacing 10 feet (3 m) from the end bell without reducing duct line slope and without forming a trap in the line.
 - 2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to handhole.
 - 3. Grout end bells into structure walls from both sides to provide watertight entrances.
- E. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet (3 m) outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit

transition. Install conduit penetrations of building walls as specified in Division 26 Section "Common Work Results for Electrical."

- F. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig (1.03-MPa) hydrostatic pressure.
- G. Pulling Cord: Install 100-lbf- (445-N-) test nylon cord in ducts, including spares.
- H. Concrete-Encased Ducts: Support ducts on duct separators.
 - 1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 feet (6 m) of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches (150 mm) between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
 - 2. Concreting Sequence: Pour each run of envelope between other terminations in one continuous operation.
 - a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
 - b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch (19-mm) reinforcing rod dowels extending 18 inches (450 mm) into concrete on both sides of joint near corners of envelope.
 - 3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.
 - 4. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
 - 5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
 - 6. Minimum Space between Ducts: 3 inches (75 mm) between ducts and exterior envelope wall, 2 inches (50 mm) between ducts for like services, and 4 inches (100 mm) between power and signal ducts.
 - 7. Depth: Install top of duct bank at least 24 inches (600 mm) below finished grade in areas not subject to deliberate traffic, and at least 30 inches (750 mm) below finished grade in deliberate traffic paths for vehicles, unless otherwise indicated.
 - 8. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
 - b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of base. Install insulated grounding bushings on terminations at equipment.
 - 9. Warning Tape: Bury warning tape approximately 12 inches (300 mm) above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches (75 mm) of the centerline of duct bank. Provide an additional warning tape for each 12-inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional tapes 12 inches (300 mm) apart, horizontally.

- I. Direct-Buried Duct Banks:
 1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
 2. Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 feet (6 m) of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches (150 mm) between tiers.
 3. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Division 31 Section "Earth Moving" for pipes less than 6 inches (150 mm) in nominal diameter.
 4. Install backfill as specified in Division 31 Section "Earth Moving."
 5. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand-place backfill to 4 inches (100 mm) over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."
 6. Install ducts with a minimum of 3 inches (75 mm) between ducts for like services and 6 inches (150 mm) between power and signal ducts.
 7. Depth: Install top of duct bank at least 36 inches (900 mm) below finished grade, unless otherwise indicated.
 8. Set elevation of bottom of duct bank below the frost line.
 9. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
 - b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
 10. Warning Planks: Bury warning planks approximately 12 inches (300 mm) above direct-buried ducts and duct banks, placing them 24 inches (600 mm) o.c. Align planks along the width and along the centerline of duct bank. Provide an additional plank for each 12-inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional planks 12 inches (300 mm) apart, horizontally.

3.5 INSTALLATION OF CONCRETE HANDHOLES AND BOXES

- A. Precast Concrete Handhole Installation:
 1. Comply with ASTM C 891, unless otherwise indicated.
 2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
 3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch (25-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.
- B. Elevations:
 1. Install handholes with bottom below the frost line, below grade.
 2. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.
 3. Where indicated, cast handhole cover frame integrally with handhole structure.

- C. Waterproofing: Apply waterproofing to exterior surfaces of handholes after concrete has cured at least three days. Waterproofing materials and installation are specified in Division 07 Section "Elastomeric Sheet Waterproofing." After ducts have been connected and grouted, and before backfilling, waterproof joints and connections and touch up abrasions and scars.
- D. Dampproofing: Apply dampproofing to exterior surfaces of handholes after concrete has cured at least three days. Dampproofing materials and installation are specified in Division 07 Section "Bituminous Dampproofing." After ducts have been connected and grouted, and before backfilling, dampproof joints and connections and touch up abrasions and scars.
- E. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.
- F. Field-Installed Bolting Anchors in Concrete Handholes: Do not drill deeper than 2 inches (50 mm) for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

3.6 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.7-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas and trafficways, set so cover surface will be flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.
- D. Install handholes and boxes with bottom below the frost line, below grade.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.
- F. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
- G. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.
 - 1. Concrete: 3000 psi (20 kPa), 28-day strength, complying with Division 03 Section "Cast-in-Place Concrete," with a troweled finish.
 - 2. Dimensions: 10 inches wide by 12 inches deep (250 mm wide by 300 mm deep).

3.7 GROUNDING

- A. Ground underground ducts and utility structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.8 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
 - 1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
 - 2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
 - 3. Test handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.9 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

END OF SECTION

SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Identification for raceways.
 - 2. Identification of power and control cables.
 - 3. Identification for conductors.
 - 4. Underground-line warning tape.
 - 5. Warning labels and signs.
 - 6. Instruction signs.
 - 7. Equipment identification labels.
 - 8. Miscellaneous identification products.

1.3 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.
- B. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.
- C. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.4 QUALITY ASSURANCE

- A. Comply with ANSI A13.1 and IEEE C2.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.5 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 POWER RACEWAY IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.
- B. Colors for Raceways Carrying Circuits at 600 V or Less:
 - 1. Black letters on an orange field.
 - 2. Legend: Indicate voltage and system or service type.
- C. Colors for Raceways Carrying Circuits at More Than 600 V:
 - 1. Black letters on an orange field.
 - 2. Legend: "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch- (75-mm-) high letters on 20-inch (500-mm) centers.
- D. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- E. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- F. Snap-Around, Color-Coding Bands for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- G. Tape and Stencil for Raceways Carrying Circuits More Than 600 V: 4-inch- (100-mm-) wide black stripes on 10-inch (250-mm) centers diagonally over orange background that extends full length of raceway or duct and is 12 inches (300 mm) wide. Stop stripes at legends.
- H. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (50 by 50 by 1.3 mm), with stamped legend, punched for use with self-locking cable tie fastener.
- I. Write-On Tags: Polyester tag, 0.010 inch (0.25 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
 - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
 - 2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.2 ARMORED AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Colors for Raceways Carrying Circuits at 600 V and Less:
 - 1. Black letters on an orange field.
 - 2. Legend: Indicate voltage and system or service type.

- C. Colors for Raceways Carrying Circuits at More Than 600 V:
 - 1. Black letters on an orange field.
 - 2. Legend: "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch- (75-mm-) high letters on 20-inch (500-mm) centers.
- D. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- E. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches (50 mm) wide; compounded for outdoor use.

2.3 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- C. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (50 by 50 by 1.3 mm), with stamped legend, punched for use with self-locking cable tie fastener.
- D. Write-On Tags: Polyester tag, 0.010 inch (0.25 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
 - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
 - 2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.
- E. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- F. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.4 CONDUCTOR IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.
- B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- C. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- D. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

- E. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- F. Write-On Tags: Polyester tag, 0.010 inch (0.25 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
 - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
 - 2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.5 FLOOR MARKING TAPE

- A. 2-inch- (50-mm-) wide, 5-mil (0.125-mm) pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.6 UNDERGROUND-LINE WARNING TAPE

- A. Tape:
 - 1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
 - 2. Printing on tape shall be permanent and shall not be damaged by burial operations.
 - 3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.
- B. Color and Printing:
 - 1. Comply with ANSI Z535.1 through ANSI Z535.5.
 - 2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE,.
 - 3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE,.
- C. Tag: Type I:
 - 1. Pigmented polyolefin, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
 - 2. Thickness: 4 mils (0.1 mm).
 - 3. Weight: 18.5 lb/1000 sq. ft. (9.0 kg/100 sq. m).
 - 4. 3-Inch (75-mm) Tensile According to ASTM D 882: 30 lbf (133.4 N), and 2500 psi (17.2 MPa).

2.7 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.
- C. Baked-Enamel Warning Signs:
 - 1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
 - 2. 1/4-inch (6.4-mm) grommets in corners for mounting.
 - 3. Nominal size, 7 by 10 inches (180 by 250 mm).

- D. Metal-Backed, Butyrate Warning Signs:
 - 1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application.
 - 2. 1/4-inch (6.4-mm) grommets in corners for mounting.
 - 3. Nominal size, 10 by 14 inches (250 by 360 mm).
- E. Warning label and sign shall include, but are not limited to, the following legends:
 - 1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD."
 - 2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."

2.8 INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. inches (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.
 - 1. Engraved legend with white letters on black face.
 - 2. Punched or drilled for mechanical fasteners.
 - 3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.
- B. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm).
- C. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.

2.9 EQUIPMENT IDENTIFICATION LABELS

- A. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm).
- B. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.
- C. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).
- D. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).
- E. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch (25 mm).

2.10 CABLE TIES

- A. General-Purpose Cable Ties: Fungus inert, self extinguishing, one piece, self locking, Type 6/6 nylon.
 - 1. Minimum Width: 3/16 inch (5 mm).
 - 2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).
 - 3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).

4. Color: Black except where used for color-coding.
- B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self extinguishing, one piece, self locking, Type 6/6 nylon.
1. Minimum Width: 3/16 inch (5 mm).
 2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).
 3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
 4. Color: Black.
- C. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.
1. Minimum Width: 3/16 inch (5 mm).
 2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 7000 psi (48.2 MPa).
 3. UL 94 Flame Rating: 94V-0.
 4. Temperature Range: Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C).
 5. Color: Black.

2.11 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- F. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.
- G. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.
- H. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
1. Outdoors: UV-stabilized nylon.

2. In Spaces Handling Environmental Air: Plenum rated.

- I. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches (150 to 200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches (400 mm) overall.
- J. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

- A. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:
 - 1. Emergency Power.
 - 2. Power.
 - 3. UPS.
- B. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
 - 1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service feeder and branch-circuit conductors.
 - a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
 - b. Colors for 208/120-V Circuits:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - c. Colors for 480/277-V Circuits:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.
 - d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- C. Power-Circuit Conductor Identification, More than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use nonmetallic plastic tag holder with adhesive-backed phase tags, and a separate tag with the circuit designation.
- D. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.
- E. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.
- F. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
 - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 - 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.

3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.
- G. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
1. Limit use of underground-line warning tape to direct-buried cables.
 2. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- H. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- I. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.
1. Comply with 29 CFR 1910.145.
 2. Identify system voltage with black letters on an orange background.
 3. Apply to exterior of door, cover, or other access.
 4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
 - a. Power transfer switches.
 - b. Controls with external control power connections.
- J. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
- K. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- (10-mm-) high letters for emergency instructions at equipment used for power transfer.
- L. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
1. Labeling Instructions:
 - a. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high.
 - b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
 - c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
 - d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
 2. Equipment to Be Labeled:
 - a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be engraved, laminated acrylic or melamine label.
 - b. Enclosures and electrical cabinets.
 - c. Access doors and panels for concealed electrical items.
 - d. Switchgear.
 - e. Switchboards.

- f. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
- g. Substations.
- h. Emergency system boxes and enclosures.
- i. Motor-control centers.
- j. Enclosed switches.
- k. Enclosed circuit breakers.
- l. Enclosed controllers.
- m. Variable-speed controllers.
- n. Push-button stations.
- o. Power transfer equipment.
- p. Contactors.
- q. Remote-controlled switches, dimmer modules, and control devices.
- r. Power-generating units.
- s. Monitoring and control equipment.
- t. UPS equipment.

END OF SECTION

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SECTION 26 05 73

OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes computer-based, fault-current and overcurrent protective device coordination studies. Protective devices shall be set based on results of the protective device coordination study.

1.3 SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.
- C. Qualification Data: For coordination-study specialist.
- D. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. Submittals shall be in digital form.
 - 1. Coordination-study input data, including completed computer program input data sheets.
 - 2. Study and Equipment Evaluation Reports.
 - 3. Coordination-Study Report.

1.4 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Computer Software Developers: Subject to compliance with requirements, provide products by one of the following:

- B. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:
 - 1. CGI CYME.
 - 2. EDSA Micro Corporation.
 - 3. ESA Inc.
 - 4. Operation Technology, Inc.
 - 5. SKM Systems Analysis, Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

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

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 POWER SYSTEM DATA

- A. Gather and tabulate the following input data to support coordination study:
 - 1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 - 2. Impedance of utility service entrance.
 - 3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
 - a. Circuit-breaker and fuse-current ratings and types.
 - b. Relays and associated power and current transformer ratings and ratios.
 - c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
 - d. Generator kilovolt amperes, size, voltage, and source impedance.
 - e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
 - f. Busway ampacity and impedance.

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

3.3 FAULT-CURRENT STUDY

- A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:
 - 1. Main distribution panel.
 - 2. Distribution panelboard.
 - 3. Branch circuit panelboard.
- B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.
- C. Calculate momentary and interrupting duties on the basis of maximum available fault current.
- D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 141, IEEE 241 and IEEE 242.
 - 1. Transformers:
 - a. ANSI C57.12.10.
 - b. ANSI C57.12.22.
 - c. ANSI C57.12.40.
 - d. IEEE C57.12.00.
 - e. IEEE C57.96.
 - 2. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
 - 3. Low-Voltage Fuses: IEEE C37.46.
- E. Study Report:
 - 1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.
- F. Equipment Evaluation Report:

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

3.4 COORDINATION STUDY

- A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.
 1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
 2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.
 3. Calculate the maximum and minimum ground-fault currents.
- B. Comply with IEEE 141, IEEE 241, IEEE 242 recommendations for fault currents and time intervals.
- C. Transformer Primary Overcurrent Protective Devices:
 1. Device shall not operate in response to the following:
 - a. Inrush current when first energized.
 - b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
 - c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
 2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.
- D. Motors served by voltages more than 600 V shall be protected according to IEEE 620.
- E. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.
- F. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
 1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
 - a. Device tag.
 - b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
 - c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
 - d. Fuse-current rating and type.
 - e. Ground-fault relay-pickup and time-delay settings.
 2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
 - a. Device tag.
 - b. Voltage and current ratio for curves.

- c. Three-phase and single-phase damage points for each transformer.
 - d. No damage, melting, and clearing curves for fuses.
 - e. Cable damage curves.
 - f. Transformer inrush points.
 - g. Maximum fault-current cutoff point.
- G. Completed data sheets for setting of overcurrent protective devices.

END OF SECTION

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SECTION 26 09 23

LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following lighting control devices:
 - 1. Indoor occupancy sensors.
 - 2. Lighting contactors.
 - 3. Emergency shunt relays.
- B. Related Sections include the following:
 - 1. Division 26 Section "Wiring Devices" for wall-box dimmers, wall-switch occupancy sensors, and manual light switches.

1.3 DEFINITIONS

- A. LED: Light-emitting diode.
- B. PIR: Passive infrared.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show installation details for occupancy and light-level sensors.
 - 1. Interconnection diagrams showing field-installed wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.6 COORDINATION

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 OUTDOOR PHOTOELECTRIC SWITCHES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:
 - 1. Area Lighting Research, Inc.; Tyco Electronics.
 - 2. Grasslin Controls Corporation; a GE Industrial Systems Company.
 - 3. Intermatic, Inc.
 - 4. Lithonia Lighting; Acuity Lighting Group, Inc.
 - 5. Novitas, Inc.
 - 6. Paragon Electric Co.; Invensys Climate Controls.
 - 7. Square D; Schneider Electric.
 - 8. TORK.
 - 9. Touch-Plate, Inc.
 - 10. Watt Stopper (The).
- D. Description: Solid state, with SPST dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.
 - 1. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lx), with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of photocell to prevent fixed light sources from causing turn-off.
 - 2. Time Delay: 15-second minimum, to prevent false operation.
 - 3. Surge Protection: Metal-oxide varistor, complying with IEEE C62.41.1, IEEE C62.41.2, and IEEE 62.45 for Category A1 locations.
 - 4. Mounting: Twist lock complying with IEEE C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

2.2 INDOOR PHOTOELECTRIC SWITCHES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:
 - 1. Allen-Bradley/Rockwell Automation.
 - 2. Area Lighting Research, Inc.; Tyco Electronics.
 - 3. Eaton Electrical Inc; Cutler-Hammer Products.
 - 4. Grasslin Controls Corporation; a GE Industrial Systems Company.
 - 5. Intermatic, Inc.
 - 6. Lithonia Lighting; Acuity Lighting Group, Inc.
 - 7. MicroLite Lighting Control Systems.
 - 8. Novitas, Inc.
 - 9. Paragon Electric Co.; Invensys Climate Controls.

10. Square D; Schneider Electric.
 11. TORK.
 12. Touch-Plate, Inc.
 13. Watt Stopper (The).
- D. Ceiling-Mounted Photoelectric Switch: Solid-state, light-level sensor unit, with separate relay unit, to detect changes in lighting levels that are perceived by the eye. Cadmium sulfide photoresistors are not acceptable.
1. Sensor Output: Contacts rated to operate the associated relay, complying with UL 773A. Sensor shall be powered from the relay unit.
 2. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
 3. Light-Level Monitoring Range: 10 to 200 fc (108 to 2152 lx), with an adjustment for turn-on and turn-off levels within that range.
 4. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling, with deadband adjustment.
 5. Indicator: Two LEDs to indicate the beginning of on-off cycles.
- E. Skylight Photoelectric Sensors: Solid-state, light-level sensor; housed in a threaded, plastic fitting for mounting under skylight, facing up at skylight; with separate relay unit, to detect changes in lighting levels that are perceived by the eye. Cadmium sulfide photoresistors are not acceptable.
1. Sensor Output: Contacts rated to operate the associated relay, complying with UL 773A. Sensor shall be powered from the relay unit.
 2. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
 3. Light-Level Monitoring Range: 1000 to 10,000 fc (10 800 to 108 000 lx), with an adjustment for turn-on and turn-off levels within that range.
 4. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling, with deadband adjustment.
 5. Indicator: Two LEDs to indicate the beginning of on-off cycles.

2.3 INDOOR OCCUPANCY SENSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:
1. Hubbell Lighting.
 2. Leviton Mfg. Company Inc.
 3. Lithonia Lighting; Acuity Lighting Group, Inc.
 4. Novitas, Inc.
 5. RAB Lighting, Inc.
 6. Sensor Switch, Inc.
 7. TORK.
 8. Watt Stopper (The).
 9. Square D; Schneider Electric.
- C. General Description: Wall- or ceiling-mounting, solid-state units with a separate relay unit.
1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.

2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
 3. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
 4. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
 6. Bypass Switch: Override the on function in case of sensor failure.
 7. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lx); keep lighting off when selected lighting level is present.
- D. PIR Type: Ceiling mounting; detect occupancy by sensing a combination of heat and movement in area of coverage.
1. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm).
 2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
 3. Detection Coverage (Corridor): Detect occupancy within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling.
- E. Ultrasonic Type: Ceiling mounting; detect occupancy by sensing a change in pattern of reflected ultrasonic energy in area of coverage.
1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
 2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. (56 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
 4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. (186 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
 5. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling in a corridor not wider than 14 feet (4.3 m).
- F. Dual-Technology Type: Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on-off functions shall be selectable in the field by operating controls on unit.
1. Sensitivity Adjustment: Separate for each sensing technology.
 2. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.

2.4 LIGHTING CONTACTORS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:
 - 1. Allen-Bradley/Rockwell Automation.
 - 2. ASCO Power Technologies, LP; a division of Emerson Electric Co.
 - 3. Eaton Electrical Inc.; Cutler-Hammer Products.
 - 4. GE Industrial Systems; Total Lighting Control.
 - 5. Grasslin Controls Corporation; a GE Industrial Systems Company.
 - 6. Hubbell Lighting.
 - 7. Lithonia Lighting; Acuity Lighting Group, Inc.
 - 8. MicroLite Lighting Control Systems.
 - 9. Square D; Schneider Electric.
 - 10. TORK.
 - 11. Touch-Plate, Inc.
 - 12. Watt Stopper (The).
- D. Description: Electrically operated and mechanically held, combination type with nonfused disconnect, complying with NEMA ICS 2 and UL 508.
 - 1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
 - 2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
 - 3. Enclosure: Comply with NEMA 250.
 - 4. Provide with control and pilot devices matching the NEMA type specified for the enclosure.
- E. BAS Interface: Provide hardware interface to enable the BAS to monitor and control lighting contactors.
 - 1. Monitoring: On-off status.
 - 2. Control: On-off operation.

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

- A. 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 written instructions.

3.2 CONTACTOR INSTALLATION

- A. 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.

3.3 WIRING INSTALLATION

- A. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 1/2 inch (13 mm).
- B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION

- A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."
 - 1. Identify controlled circuits in lighting contactors.
 - 2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.
- B. Label time switches and contactors with a unique designation.

3.5 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
 - 2. Operational Test: Verify operation of each lighting control device, and adjust time delays.
- B. Lighting control devices that fail tests and inspections are defective work.

3.6 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.7 DEMONSTRATION

- A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control system specified in Division 26 Section "Network Lighting Controls."
- B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 26 22 00

LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1.3 SUBMITTALS

- A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Qualification Data: For testing agency.
- D. Source quality-control test reports.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.
- C. Source Limitations: Obtain each transformer type through one source from a single manufacturer.

- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

1.5 DELIVERY, STORAGE, AND HANDLING

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

1.6 COORDINATION

- A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ACME Electric Corporation; Power Distribution Products Division.
 - 2. Challenger Electrical Equipment Corp.; a division of Eaton Corp.
 - 3. Controlled Power Company.
 - 4. Eaton Electrical Inc.; Cutler-Hammer Products.
 - 5. General Electric Company.
 - 6. Hammond Co.; Matra Electric, Inc.
 - 7. Magnetek Power Electronics Group.
 - 8. Micron Industries Corp.
 - 9. Myers Power Products, Inc.
 - 10. Siemens Energy & Automation, Inc.
 - 11. Sola/Hevi-Duty.
 - 12. Square D; Schneider Electric.

2.2 GENERAL TRANSFORMER REQUIREMENTS

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

2.3 DISTRIBUTION TRANSFORMERS

- A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

- B. Provide transformers that are constructed to withstand seismic forces specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- C. Cores: One leg per phase.
- D. Enclosure: Ventilated, NEMA 250, Type 2.
 - 1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
- E. Enclosure: Ventilated, NEMA 250 and Type 3R stainless steel.
 - 1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
- F. Transformer Enclosure Finish: Comply with NEMA 250.
 - 1. Finish Color: Gray.
- G. Taps for Transformers Smaller Than 3 kVA: None.
- H. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.
- I. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.
- J. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.
- K. Energy Efficiency for Transformers Rated 15 kVA and Larger:
 - 1. Complying with NEMA TP 1, Class 1 efficiency levels.
 - 2. Tested according to NEMA TP 2.
- L. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.
 - 1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
 - 2. Indicate value of K-factor on transformer nameplate.
- M. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
 - 1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
 - 2. Include special terminal for grounding the shield.
 - 3. Shield Effectiveness:
 - a. Capacitance between Primary and Secondary Windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.
 - b. Common-Mode Noise Attenuation: Minimum of minus 120 dBA at 0.5 to 1.5 kHz; minimum of minus 65 dBA at 1.5 to 100 kHz.
 - c. Normal-Mode Noise Attenuation: Minimum of minus 52 dBA at 1.5 to 10 kHz.
- N. Wall Brackets: Manufacturer's standard brackets.
- O. Fungus Proofing: Permanent fungicidal treatment for coil and core.

2.4 IDENTIFICATION DEVICES

- A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

2.5 SOURCE QUALITY CONTROL

- A. Test and inspect transformers according to IEEE C57.12.91.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.
- B. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions.

3.3 CONNECTIONS

- A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

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

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Tests and Inspections:
 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- E. Remove and replace units that do not pass tests or inspections and retest as specified above.
- F. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.
 1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
 2. Perform 2 follow-up infrared scans of transformers, one at 4 months and the other at 11 months after Substantial Completion.
 3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.
- G. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

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

3.6 CLEANING

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

END OF SECTION

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SECTION 26 24 16

PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Distribution panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.
 - 3. Load centers.
 - 4. Electronic-grade panelboards.

1.3 DEFINITIONS

- A. TVSS: Transient voltage surge suppressor.

1.4 SUBMITTALS

- A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Detail enclosure types and details for types other than NEMA 250, Type 1.
 - 3. Detail bus configuration, current, and voltage ratings.
 - 4. Short-circuit current rating of panelboards and overcurrent protective devices.
 - 5. Include evidence of NRTL listing for series rating of installed devices.
 - 6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 7. Include wiring diagrams for power, signal, and control wiring.
 - 8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device.
- C. Field Quality-Control Reports:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- D. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

- E. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - 2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. Comply with NEMA PB 1.
- F. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Handle and prepare panelboards for installation according to NECA 407, NEMA PB 1.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations:
 - 1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
 - 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) or more than plus 104 deg F (plus 40 deg C).
 - b. Altitude: Not exceeding 6600 feet (2000 m).
- B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
 - 1. Ambient temperatures within limits specified.
 - 2. Altitude not exceeding 6600 feet (2000 m).

1.8 COORDINATION

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

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

- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.9 WARRANTY

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

1.10 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Keys: Two spares for each type of panelboard cabinet lock.
 - 2. 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.
 - 3. 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.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- B. Enclosures: Flush- and surface-mounted cabinets.
 - 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - b. Outdoor Locations: NEMA 250, Type 3R.
 - 2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
 - 3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
 - 4. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
 - 5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
 - 6. Finishes:
 - a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Galvanized steel.
 - c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.
 - 7. Directory Card: Inside panelboard door, mounted in transparent card holder.
- C. Phase, Neutral, and Ground Buses:
 - 1. Material: Tin-plated aluminum.

2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
 3. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
 4. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.
 5. Split Bus: Vertical buses divided into individual vertical sections.
- D. Conductor Connectors: Suitable for use with conductor material and sizes.
1. Material: Tin-plated aluminum.
 2. Main and Neutral Lugs: Mechanical type.
 3. Ground Lugs and Bus-Configured Terminators: Compression type.
 4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 5. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
 6. Gutter-Tap Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
 7. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.
- E. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.
- F. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- G. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 DISTRIBUTION PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 3. Siemens Energy & Automation, Inc.
 4. Square D; a brand of Schneider Electric.
- C. Panelboards: NEMA PB 1, power and feeder distribution type.
- D. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
1. For doors more than 36 inches (914 mm) high, provide two latches, keyed alike.
- E. Mains: Circuit breaker Lugs only. As scheduled on the Drawings.
- F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
- G. Branch Overcurrent Protective Devices: Circuit breakers.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- C. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- D. Mains: Circuit breaker or lugs only. As scheduled on the Drawings.
- E. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- F. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.4 LOAD CENTERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- C. Load Centers: Comply with UL 67.
- D. Mains: Circuit breaker. As scheduled on the Drawings.
- E. Branch Overcurrent Protective Devices: Plug-in circuit breakers, replaceable without disturbing adjacent units.
- F. Conductor Connectors: Mechanical type for main, neutral, and ground lugs and buses.

2.5 ELECTRONIC-GRADE PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
 - 1. Current Technology; a subsidiary of Danahar Corporation.
 - 2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 3. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 4. Liebert Corporation.
 - 5. Siemens Energy & Automation, Inc.
 - 6. Square D; a brand of Schneider Electric.

- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
- D. Main Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.
- E. Branch Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.
- F. Buses:
 - 1. Copper phase and neutral buses; 200 percent capacity neutral bus and lugs.
 - 2. Copper equipment and isolated ground buses.

2.6 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- C. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with series-connected rating to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 150 A and larger.
 - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 - 3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t response. (Main breaker)
 - 4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
 - 5. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
 - 6. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
 - 7. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
 - 8. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - e. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring and Control."

- f. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
 - g. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.
- D. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
 - 1. Fuses, and Spare-Fuse Cabinet: Comply with requirements specified in Division 26 Section "Fuses."
 - 2. Fused Switch Features and Accessories: Standard ampere ratings and number of poles.
 - 3. Auxiliary Contacts: Two normally open and normally closed contact(s) that operate with switch handle operation.

2.7 ACCESSORY COMPONENTS AND FEATURES

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

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receive, inspect, handle, and store panelboards according to NECA 407, NEMA PB 1.1.
- B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
- C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install panelboards and accessories according to NECA 407, NEMA PB 1.1.
- B. Equipment Mounting: Install panelboards on concrete bases, 4-inch (100-mm) nominal thickness. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-Place Concrete."
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
 - 2. For panelboards, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to panelboards.
 - 5. Attach panelboard to the vertical finished or structural surface behind the panelboard.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- D. Mount top of trim 90 inches (2286 mm) above finished floor unless otherwise indicated.

- E. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- F. Install overcurrent protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit-breaker trip ranges.
- G. Install filler plates in unused spaces.
- H. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
- I. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- E. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 3. Perform the following infrared scan tests and inspections and prepare reports:

- a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
 - c. Instruments and Equipment:
 - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- F. Panelboards will be considered defective if they do not pass tests and inspections.
- G. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

- A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."
- C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
- 1. Measure as directed during period of normal system loading.
 - 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
 - 3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
 - 4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

END OF SECTION

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SECTION 26 27 26

WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
 - 2. Twist-locking receptacles.
 - 3. Receptacles with integral surge suppression units.
 - 4. Wall-box motion sensors.
 - 5. Isolated-ground receptacles.
 - 6. Snap switches and wall-box dimmers.
 - 7. Solid-state fan speed controls.
 - 8. Communications outlets.
 - 9. Pendant cord-connector devices.
 - 10. Cord and plug sets.
 - 11. Floor service outlets, poke-through assemblies, service poles, and multioutlet assemblies.
- B. Related Sections include the following:
 - 1. Division 27 Section "Communications Horizontal Cabling" for workstation outlets.

1.3 DEFINITIONS

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

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
- C. Samples: One for each type of device and wall plate specified, in each color specified.
- D. Field quality-control test reports.

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

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.

1.6 COORDINATION

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

1.7 EXTRA MATERIALS

- A. Furnish extra materials described in subparagraphs below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Floor Service Outlet Assemblies: One for every 10, but no fewer than one.
 - 2. Poke-Through, Fire-Rated Closure Plugs: One for every five floor service outlets installed, but no fewer than two.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
 - 1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
 - 2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
 - 3. Leviton Mfg. Company Inc. (Leviton).
 - 4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 STRAIGHT BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 5351 (single), 5352 (duplex).
 - b. Hubbell; HBL5351 (single), CR5352 (duplex).
 - c. Leviton; 5891 (single), 5352 (duplex).
 - d. Pass & Seymour; 5381 (single), 5352 (duplex).
- B. Isolated-Ground, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; CR 5253IG.
 - b. Leviton; 5362-IG.
 - c. Pass & Seymour; IG6300.
3. Description: Straight blade; equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.3 GFCI RECEPTACLES

- A. General Description: Straight blade, feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.

2.4 TVSS RECEPTACLES

- A. Isolated-Ground, Duplex Convenience Receptacles:
 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; IG5362BLS.
 - b. Hubbell; IG5362SA.
 - c. Leviton; 5380-IG.
 3. Description: Straight blade, 125 V, 20 A; NEMA WD 6 configuration 5-20R. Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.5 SNAP SWITCHES

- A. Comply with NEMA WD 1 and UL 20.
- B. Switches, 120/277 V, 20 A:
 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).
 - b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
 - c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
 - d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).
- C. Pilot Light Switches, 20 A:
 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 2221PL for 120 V and 277 V.
 - b. Hubbell; HPL1221PL for 120 V and 277 V.
 - c. Leviton; 1221-PLR for 120 V, 1221-7PLR for 277 V.
 - d. Pass & Seymour; PS20AC1-PLR for 120 V.
 3. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."

- D. Key-Operated Switches, 120/277 V, 20 A:
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 2221L.
 - b. Hubbell; HBL1221L.
 - c. Leviton; 1221-2L.
 - d. Pass & Seymour; PS20AC1-L.
 - 3. Description: Single pole, with factory-supplied key in lieu of switch handle.
- E. Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors.
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 1995.
 - b. Hubbell; HBL1557.
 - c. Leviton; 1257.
 - d. Pass & Seymour; 1251.
- F. Key-Operated, Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 1995L.
 - b. Hubbell; HBL1557L.
 - c. Leviton; 1257L.
 - d. Pass & Seymour; 1251L.

2.6 WALL-BOX DIMMERS

- A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.
- B. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472.
- C. Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.
 - 1. 600 W; dimmers shall require no derating when ganged with other devices.
- D. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.

2.7 OCCUPANCY SENSORS

- A. Wall-Switch Sensors:
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 6111 for 120 V, 6117 for 277 V.
 - b. Hubbell; WS1277.

- c. Leviton; ODS 10-ID.
 - d. Pass & Seymour; WS3000.
 - e. Watt Stopper (The); WS-200.
 - 3. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 180-degree field of view, with a minimum coverage area of 900 sq. ft. (84 sq. m).
- B. Wall-Switch Sensors:
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; AT120 for 120 V, AT277 for 277 V.
 - b. Leviton; ODS 15-ID.
 - 3. Description: Adaptive-technology type, 120/277 V, adjustable time delay up to 20 minutes, 180-degree field of view, with a minimum coverage area of 900 sq. ft. (84 sq. m).
- C. Long-Range Wall-Switch Sensors:
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; ATP1600WRP.
 - b. Leviton; ODWWV-IRW.
 - c. Pass & Seymour; WA1001.
 - d. Watt Stopper (The); CX-100.
 - 3. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 110-degree field of view, with a minimum coverage area of 1200 sq. ft. (111 sq. m).
- D. Long-Range Wall-Switch Sensors:
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; ATD1600WRP.
 - b. Leviton; ODW12-MRW.
 - c. Watt Stopper (The); DT-200.
 - 3. Description: Dual technology, with both passive-infrared- and ultrasonic-type sensing, 120/277 V, adjustable time delay up to 30 minutes, 110-degree field of view, and a minimum coverage area of 1200 sq. ft. (111 sq. m).
- E. Wide-Range Wall-Switch Sensors:
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; ATP120HBRP.
 - b. Leviton; ODWHB-IRW.
 - c. Pass & Seymour; HS1001.
 - d. Watt Stopper (The); CX-100-3.
 - 3. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 150-degree field of view, with a minimum coverage area of 1200 sq. ft. (111 sq. m).

2.8 WALL PLATES

- A. Single and combination types to match corresponding wiring devices.
 - 1. Plate-Securing Screws: Metal with head color to match plate finish.
 - 2. Material for Finished Spaces: Smooth, high-impact thermoplastic.
 - 3. Material for Unfinished Spaces: Galvanized steel.

- 4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in "wet locations."
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant, die-cast aluminum with lockable cover.

2.9 FLOOR SERVICE FITTINGS

- A. Type: Modular, flush-type, dual-service units suitable for wiring method used.
- B. Compartments: Barrier separates power from voice and data communication cabling.
- C. Service Plate: Round, with satin finish.
- D. Power Receptacle: NEMA WD 6 configuration 5-20R, gray finish, unless otherwise indicated.
- E. Voice and Data Communication Outlet: Blank cover with bushed cable opening.

2.10 POKE-THROUGH ASSEMBLIES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Hubbell Incorporated; Wiring Device-Kellems.
 - 2. Pass & Seymour/Legrand; Wiring Devices & Accessories.
 - 3. Square D/ Schneider Electric.
 - 4. Thomas & Betts Corporation.
 - 5. Wiremold Company (The).
- C. Description: Factory-fabricated and -wired assembly of below-floor junction box with multichanneled, through-floor raceway/firestop unit and detachable matching floor service outlet assembly.
 - 1. Service Outlet Assembly: Flush type as described on the Drawings.
 - 2. Size: Selected to fit nominal 4-inch (100-mm) cored holes in floor and matched to floor thickness.
 - 3. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
 - 4. Closure Plug: Arranged to close unused 4-inch (100-mm) cored openings and reestablish fire rating of floor.
 - 5. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors and a minimum of four, 4-pair, Category 5e voice and data communication cables.

2.11 MULTIOUTLET ASSEMBLIES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Hubbell Incorporated; Wiring Device-Kellems.
 - 2. Wiremold Company (The).
- C. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.

- D. Raceway Material: Metal, with manufacturer's standard finish.
- E. Wire: No. 12 AWG.

2.12 FINISHES

- A. Color: Wiring device catalog numbers in Section Text do not designate device color.
 - 1. Wiring Devices Connected to Normal Power System: White, unless otherwise indicated or required by NFPA 70 or device listing.
 - 2. Wiring Devices Connected to Emergency Power System: Red.
 - 3. TVSS Devices: Blue.
 - 4. Isolated-Ground Receptacles: Orange.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.
- B. Coordination with Other Trades:
 - 1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
 - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 - 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 - 4. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
 - 1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
 - 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
 - 3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
 - 4. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtailling existing conductors is permitted provided the outlet box is large enough.
- D. Device Installation:
 - 1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
 - 2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
 - 3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
 - 4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
 - 5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.

6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
 7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
 8. Tighten unused terminal screws on the device.
 9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.
- E. Receptacle Orientation:
1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.
 2. Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade at the top.
- F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.
- G. Dimmers:
1. Install dimmers within terms of their listing.
 2. Verify that dimmers used for fan speed control are listed for that application.
 3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.
- H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.
- I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

- A. Comply with Division 26 Section "Identification for Electrical Systems."
1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
1. Test Instruments: Use instruments that comply with UL 1436.
 2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.
- B. Tests for Convenience Receptacles:
1. Line Voltage: Acceptable range is 105 to 132 V.
 2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.

5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

END OF SECTION

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SECTION 26 28 13

FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Cartridge fuses rated 600-V ac and less for use in control circuits, enclosed switches, enclosed controllers.
 - 2. Spare-fuse cabinets.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
 - 1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
 - a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
 - b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
 - 2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
 - 3. Current-limitation curves for fuses with current-limiting characteristics.
 - 4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
 - 5. Coordination charts and tables and related data.
 - 6. Fuse sizes for elevator feeders and elevator disconnect switches.
- B. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Ambient temperature adjustment information.
 - 2. Current-limitation curves for fuses with current-limiting characteristics.
 - 3. Coordination charts and tables and related data.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70.

- E. Comply with UL 248-11 for plug fuses.

1.5 PROJECT CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.6 COORDINATION

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

1.7 EXTRA MATERIALS

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

2.2 CARTRIDGE FUSES

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

2.3 SPARE-FUSE CABINET

- A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.
 - 1. Size: Adequate for storage of spare fuses specified with [15] <Insert number> percent spare capacity minimum.
 - 2. Finish: Gray, baked enamel.
 - 3. Identification: "SPARE FUSES" in 1-1/2-inch- (38-mm-) high letters on exterior of door.
 - 4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

- A. Cartridge Fuses:
 - 1. Feeders: Class RK5, time delay.
 - 2. Motor Branch Circuits: Class RK5, time delay.
 - 3. Other Branch Circuits: Class J, fast acting.
 - 4. Control Circuits: Class CC, fast acting.

3.3 INSTALLATION

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

3.4 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION

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SECTION 26 28 16

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1.3 DEFINITIONS

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

1.4 SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
 - 1. Enclosure types and details for types other than NEMA 250, Type 1.
 - 2. Current and voltage ratings.
 - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
 - 4. Include evidence of NRTL listing for series rating of installed devices.
 - 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
 - 6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.
- B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Wiring Diagrams: For power, signal, and control wiring.
- C. Qualification Data: For qualified testing agency.
- D. Field quality-control reports.
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.

3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- E. Manufacturer's field service report.
- F. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
 2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- B. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
 2. Altitude: Not exceeding 6600 feet (2010 m).

1.7 COORDINATION

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

1.8 EXTRA MATERIALS

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

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. Type GD, General Duty, Single Throw, 240-V ac, 800 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with cartridge fuse interiors to accommodate specified fuses, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- C. Type HD, Heavy Duty, Single Throw, 240 or 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- D. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 - 5. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
 - 6. Hookstick Handle: Allows use of a hookstick to operate the handle.
 - 7. Lugs: Mechanical type, suitable for number, size, and conductor material.
 - 8. Service-Rated Switches: Labeled for use as service equipment.

2.2 NONFUSIBLE SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. Type GD, General Duty, Single Throw, 600 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- C. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- D. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.

2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
4. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
5. Hookstick Handle: Allows use of a hookstick to operate the handle.
6. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.3 SHUNT TRIP SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:
 1. Cooper Bussmann, Inc.
 2. Ferraz Shawmut, Inc.
 3. Littelfuse, Inc.
- B. General Requirements: Comply with ASME A17.1, UL 50, and UL 98, with 200-kA interrupting and short-circuit current rating when fitted with Class J fuses.
- C. Switches: Three-pole, horsepower rated, with integral shunt trip mechanism and Class J fuse block; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.
- D. Control Circuit: 120-V ac; obtained from integral control power transformer, with primary and secondary fuses, with a control power source of enough capacity to operate shunt trip, connected pilot, and indicating and control devices.
- E. Accessories:
 1. Oiltight key switch for key-to-test function.
 2. Oiltight green ON pilot light.
 3. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.
 4. Form C alarm contacts that change state when switch is tripped.
 5. Three-pole, double-throw, fire-safety and alarm relay; 24-V dc coil voltage.
 6. Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.

2.4 MOLDED-CASE CIRCUIT BREAKERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:
 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 3. Siemens Energy & Automation, Inc.
 4. Square D; a brand of Schneider Electric.
- B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
- D. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

- E. Features and Accessories:
 - 1. Standard frame sizes, trip ratings, and number of poles.
 - 2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
 - 3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.

2.5 MOLDED-CASE SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. General Requirements: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.
- C. Features and Accessories:
 - 1. Standard frame sizes and number of poles.
 - 2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.

2.6 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
 - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 - 2. Outdoor Locations: NEMA 250, Type 3R.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. Install fuses in fusible devices.
- E. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- E. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 3. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
 - c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- F. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- G. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

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

- B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study".

END OF SECTION

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SECTION 26 43 13

TRANSIENT-VOLTAGE SUPPRESSION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes field-mounted TVSS for low-voltage (120 to 600 V) power distribution and control equipment.
- B. Related Sections:
 - 1. Division 26 Section "Switchboards" for factory-installed TVSS.
 - 2. Division 26 Section "Panelboards" for factory-installed TVSS.
 - 3. Division 26 Section "Wiring Devices" for devices with integral TVSS.

1.3 DEFINITIONS

- A. ATS: Acceptance Testing Specifications.
- B. SVR: Suppressed voltage rating.
- C. TVSS: Transient voltage surge suppressor(s), both singular and plural; also, transient voltage surge suppression.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating weights, electrical characteristics, furnished specialties, and accessories.
- B. Qualification Data: For qualified testing agency.
- C. Product Certificates: For TVSS devices, from manufacturer.
- D. Field quality-control reports.
- E. Operation and Maintenance Data: For TVSS devices to include in emergency, operation, and maintenance manuals.
- F. Warranties: Sample of special warranties.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency, and marked for intended location and application.

- C. Comply with IEEE C62.41.2 and test devices according to IEEE C62.45.
- D. Comply with NEMA LS 1.
- E. Comply with UL 1283 and UL 1449.
- F. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

- A. Service Conditions: Rate TVSS devices for continuous operation under the following conditions unless otherwise indicated:
 - 1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.
 - 2. Operating Temperature: 30 to 120 deg F (0 to 50 deg C).
 - 3. Humidity: 0 to 85 percent, noncondensing.
 - 4. Altitude: Less than 20,000 feet (6090 m) above sea level.

1.7 COORDINATION

- A. Coordinate location of field-mounted TVSS devices to allow adequate clearances for maintenance.
- B. Coordinate TVSS devices with Division 26 Section "Electrical Power Monitoring and Control."

1.8 WARRANTY

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

1.9 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Replaceable Protection Modules: One of each size and type installed.

PART 2 - PRODUCTS

2.1 SERVICE ENTRANCE SUPPRESSORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
 - 1. ABB USA.
 - 2. AC Data Solutions.
 - 3. Advanced Protection Technologies Inc. (APT).
 - 4. Atlantic Scientific.
 - 5. Current Technology Inc.; Danaher Power Solutions.
 - 6. Danaher Power Solutions; United Power Products.
 - 7. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 8. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 9. Intermatic, Inc.
 - 10. LEA International.
 - 11. Leviton Mfg. Company Inc.

12. Liebert Corporation; a division of Emerson Network Power.
 13. Northern Technologies, Inc.; a division of Emerson Network Power.
 14. Siemens Energy & Automation, Inc.
 15. Square D; a brand of Schneider Electric.
 16. Surge Suppression Incorporated.
- B. Surge Protection Devices:
1. Non-modular.
 2. LED indicator lights for power and protection status.
 3. Audible alarm, with silencing switch, to indicate when protection has failed.
 4. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
- C. Surge Protection Devices:
1. Comply with UL 1449.
 2. Modular design (with field-replaceable modules).
 3. Fuses, rated at 200-kA interrupting capacity.
 4. Fabrication using bolted compression lugs for internal wiring.
 5. Integral disconnect switch.
 6. Redundant suppression circuits.
 7. Redundant replaceable modules.
 8. Arrangement with copper bus bars and for bolted connections to phase buses, neutral bus, and ground bus.
 9. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
 10. LED indicator lights for power and protection status.
 11. Audible alarm, with silencing switch, to indicate when protection has failed.
 12. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
 13. Six-digit transient-event counter set to totalize transient surges.
- D. Peak Single-Impulse Surge Current Rating: 240 kA per mode/480 kA per phase.
- E. Minimum single impulse current ratings, using 8-by-20-mic.sec waveform described in IEEE C62.41.2
1. Line to Neutral: 70,000 A.
 2. Line to Ground: 70,000 A.
 3. Neutral to Ground: 50,000 A.
- F. Protection modes and UL 1449 SVR for grounded wye circuits with 480Y/277 V, 3-phase, 4-wire circuits shall be as follows:
1. Line to Neutral: 800 V for 480Y/277 V.
 2. Line to Ground: 800 V for 480Y/277 V.
 3. Neutral to Ground: 800 V for 480Y/277 V.
- G. Protection modes and UL 1449 SVR for 240/120 V, single-phase, 3-wire circuits shall be as follows:
1. Line to Neutral: 400 V.
 2. Line to Ground: 400 V.
 3. Neutral to Ground: 400 V.
- H. Protection modes and UL 1449 SVR for 240/120-V, 3-phase, 4-wire circuits with high leg shall be as follows:

1. Line to Neutral: 400 V, 800 V from high leg.
 2. Line to Ground: 400 V.
 3. Neutral to Ground: 400 V.
- I. Protection modes and UL 1449 SVR for 240 V, 480 V, or 600 V, 3-phase, 3-wire, delta circuits shall be as follows:
1. Line to Line: 2000 V for 480 V.
 2. Line to Ground: 2000 V for 480 V.

2.2 PANELBOARD SUPPRESSORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
1. ABB USA.
 2. AC Data Solutions.
 3. Advanced Protection Technologies Inc. (APT).
 4. Atlantic Scientific.
 5. Current Technology Inc.; Danaher Power Solutions.
 6. Danaher Power Solutions; United Power Products.
 7. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 8. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 9. Intermatic, Inc.
 10. LEA International.
 11. Leviton Mfg. Company Inc.
 12. Liebert Corporation; a division of Emerson Network Power.
 13. Northern Technologies, Inc.; a division of Emerson Network Power.
 14. Siemens Energy & Automation, Inc.
 15. Square D; a brand of Schneider Electric.
 16. Surge Suppression Incorporated.
- B. Surge Protection Devices:
1. Non-modular.
 2. LED indicator lights for power and protection status.
 3. Audible alarm, with silencing switch, to indicate when protection has failed.
 4. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
- C. Surge Protection Devices:
1. Comply with UL 1449.
 2. Modular design (with field-replaceable modules).
 3. Short-circuit current rating complying with UL 1449, and matching or exceeding the panelboard short-circuit rating and redundant suppression circuits; with individually fused metal-oxide varistors.
 4. Fuses, rated at 200-kA interrupting capacity.
 5. Fabrication using bolted compression lugs for internal wiring.
 6. Integral disconnect switch.
 7. Redundant suppression circuits.
 8. Redundant replaceable modules.
 9. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
 10. LED indicator lights for power and protection status.
 11. Audible alarm, with silencing switch, to indicate when protection has failed.
 12. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge

- diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
13. Four-digit transient-event counter set to totalize transient surges.
- D. Peak Single-Impulse Surge Current Rating: 80 kA per mode/160 kA per phase.
- E. Minimum single impulse current ratings, using 8-by-20-mic.sec waveform described in IEEE C62.41.2:
1. Line to Neutral: 70,000 A.
 2. Line to Ground: 70,000 A.
 3. Neutral to Ground: 50,000 A.
- F. Protection modes and UL 1449 SVR for grounded wye circuits with 208Y/120 V, 3-phase, 4-wire circuits shall be as follows:
1. Line to Neutral: 400 V for 208Y/120 V.
 2. Line to Ground: 400 V for 208Y/120 V.
 3. Neutral to Ground: 400 V for 208Y/120 V.
- G. Protection modes and UL 1449 SVR for 240/120-V, single-phase, 3-wire circuits shall be as follows:
1. Line to Neutral: 400 V.
 2. Line to Ground: 400 V.
 3. Neutral to Ground: 400 V.
- H. Protection modes and UL 1449 SVR for 240/120-V, 3-phase, 4-wire circuits with high leg shall be as follows:
1. Line to Neutral: 400 V, 800 V from high leg.
 2. Line to Ground: 400 V.
 3. Neutral to Ground: 400 V.
- I. Protection modes and UL 1449 SVR for 240 V, 480 V, or 600 V, 3-phase, 3-wire, delta circuits shall be as follows:
1. Line to Line: 1000 V for 240 V.
 2. Line to Ground: 800 V for 240 V.

2.3 ENCLOSURES

- A. Indoor Enclosures: NEMA 250 Type 1.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install TVSS devices at service entrance on load side, with ground lead bonded to service entrance ground.
- B. Install TVSS devices for panelboards and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.
1. Provide multiple, 100-A circuit breaker as a dedicated disconnecting means for TVSS unless otherwise indicated.

3.2 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
 - 1. Verify that electrical wiring installation complies with manufacturer's written installation requirements.
- C. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, "Surge Arresters, Low-Voltage Surge Protection Devices" Section. Certify compliance with test parameters.
 - 2. After installing TVSS devices but before electrical circuitry has been energized, test for compliance with requirements.
 - 3. Complete startup checks according to manufacturer's written instructions.
- E. TVSS device will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

3.3 STARTUP SERVICE

- A. Do not energize or connect service entrance equipment, panelboards, control terminals, data terminals to their sources until TVSS devices are installed and connected.
- B. Do not perform insulation resistance tests of the distribution wiring equipment with the TVSS installed. Disconnect before conducting insulation resistance tests, and reconnect immediately after the testing is over.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to maintain TVSS devices.

END OF SECTION

SECTION 26 51 00

INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Interior lighting fixtures, lamps, and ballasts.
 - 2. Emergency lighting units.
 - 3. Exit signs.
 - 4. Lighting fixture supports.
 - 5. Retrofit kits for fluorescent lighting fixtures.
- B. Related Sections include the following:
 - 1. Division 26 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
 - 2. Division 26 Section "Wiring Devices" for manual wall-box dimmers for incandescent lamps.

1.3 DEFINITIONS

- A. BF: Ballast factor.
- B. CRI: Color-rendering index.
- C. CU: Coefficient of utilization.
- D. HID: High-intensity discharge.
- E. LER: Luminaire efficacy rating.
- F. Luminaire: Complete lighting fixture, including ballast housing if provided.
- G. RCR: Room cavity ratio.

1.4 SUBMITTALS

- A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
 - 1. Physical description of lighting fixture including dimensions.
 - 2. Emergency lighting units including battery and charger.
 - 3. Ballast.
 - 4. Energy-efficiency data.
 - 5. Life, output, and energy-efficiency data for lamps.
 - 6. Photometric data, in IESNA format, based on laboratory tests of each lighting fixture type, outfitted with lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.

- a. For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by the manufacturer.
 - b. Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program (NVLAP) for Energy Efficient Lighting Products.
- B. Shop Drawings: Show details of nonstandard or custom lighting fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories.
 1. Wiring Diagrams: Power and control wiring.
- C. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 1. Lighting fixtures.
 2. Suspended ceiling components.
 3. Structural members to which suspension systems for lighting fixtures will be attached.
 4. Other items in finished ceiling including the following:
 - a. Air outlets and inlets.
 - b. Speakers.
 - c. Sprinklers.
 - d. Smoke and fire detectors.
 - e. Occupancy sensors.
 - f. Access panels.
 5. Perimeter moldings.
- D. Samples for Verification: Interior lighting fixtures designated for sample submission in Interior Lighting Fixture Schedule. Each sample shall include the following:
 1. Lamps: Specified units installed.
 2. Accessories: Cords and plugs.
- E. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, signed by product manufacturer.
- F. Qualification Data: For agencies providing photometric data for lighting fixtures.
- G. Field quality-control test reports.
- H. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.
- I. Warranties: Special warranties specified in this Section.

1.5 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 1910.7.

- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with NFPA 70.
- E. FMG Compliance: Lighting fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FMG.
- F. Mockups: Provide interior lighting fixtures for room or module mockups, complete with power and control connections.
 - 1. Obtain Architect's approval of fixtures for mockups before starting installations.
 - 2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 - 3. Approved fixtures in mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 COORDINATION

- A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.7 WARRANTY

- A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Emergency Lighting Unit Batteries: 10 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.
 - 2. Warranty Period for Emergency Fluorescent Ballast and Self-Powered Exit Sign Batteries: Seven years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining six years.
- B. Special Warranty for Ballasts: Manufacturer's standard form in which ballast manufacturer agrees to repair or replace ballasts that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Electronic Ballasts: Five years from date of Substantial Completion.
 - 2. Warranty Period for Electromagnetic Ballasts: Three years from date of Substantial Completion.
- C. Special Warranty for T5 and T8 Fluorescent Lamps: Manufacturer's standard form, made out to Owner and signed by lamp manufacturer agreeing to replace lamps that fail in materials or workmanship, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
 - 1. Warranty Period: One year(s) from date of Substantial Completion.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.

2. Plastic Diffusers and Lenses: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
3. Battery and Charger Data: One for each emergency lighting unit.
4. Ballasts: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
5. Globes and Guards: 1 for every 20 of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
- B. In Interior Lighting Fixture Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:
 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
 3. Basis-of-Design Product: The design for each lighting fixture is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified.

2.2 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

- A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
- B. Incandescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5A.
- C. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
- D. HID Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5B.
- E. Metal Parts: Free of burrs and sharp corners and edges.
- F. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.
- G. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- H. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
 1. White Surfaces: 85 percent.
 2. Specular Surfaces: 83 percent.
 3. Diffusing Specular Surfaces: 75 percent.
 4. Laminated Silver Metallized Film: 90 percent.
- I. Plastic Diffusers, Covers, and Globes:

1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - a. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless different thickness is indicated.
 - b. UV stabilized.
 2. Glass: Annealed crystal glass, unless otherwise indicated.
- J. Electromagnetic-Interference Filters: Factory installed to suppress conducted electromagnetic-interference as required by MIL-STD-461E. Fabricate lighting fixtures with one filter on each ballast indicated to require a filter.

2.3 BALLASTS FOR LINEAR FLUORESCENT LAMPS

- A. Electronic Ballasts: Comply with ANSI C82.11; instant-start type, unless otherwise indicated, and designed for type and quantity of lamps served. Ballasts shall be designed for full light output unless dimmer or bi-level control is indicated.
1. Sound Rating: A.
 2. Total Harmonic Distortion Rating: Less than 10 percent.
 3. Transient Voltage Protection: IEEE C62.41, Category A or better.
 4. Operating Frequency: 20 kHz or higher.
 5. Lamp Current Crest Factor: 1.7 or less.
 6. BF: 0.85 or higher.
 7. Power Factor: 0.95 or higher.
 8. Parallel Lamp Circuits: Multiple lamp ballasts shall comply with ANSI C 82.11 and shall be connected to maintain full light output on surviving lamps if one or more lamps fail.
- B. Electronic Programmed-Start Ballasts for T5 and T5HO Lamps: Comply with ANSI C82.11 and the following:
1. Lamp end-of-life detection and shutdown circuit for T5 diameter lamps.
 2. Automatic lamp starting after lamp replacement.
 3. Sound Rating: A.
 4. Total Harmonic Distortion Rating: Less than 20 percent.
 5. Transient Voltage Protection: IEEE C62.41, Category A or better.
 6. Operating Frequency: 20 kHz or higher.
 7. Lamp Current Crest Factor: 1.7 or less.
 8. BF: 0.95 or higher, unless otherwise indicated.
 9. Power Factor: 0.95 or higher.
- C. Electromagnetic Ballasts: Comply with ANSI C82.1; energy saving, high-power factor, Class P, and having automatic-reset thermal protection.
1. Ballast Manufacturer Certification: Indicated by label.
- D. Single Ballasts for Multiple Lighting Fixtures: Factory-wired with ballast arrangements and bundled extension wiring to suit final installation conditions without modification or rewiring in the field.
- E. Ballasts for Low-Temperature Environments:
1. Temperatures 0 Deg F (Minus 17 Deg C) and Higher: Electronic type rated for 0 deg F (minus 17 deg C) starting and operating temperature with indicated lamp types.
 2. Temperatures Minus 20 Deg F (Minus 29 Deg C) and Higher: Electromagnetic type designed for use with indicated lamp types.
- F. Ballasts for Low Electromagnetic-Interference Environments: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for consumer equipment.

- G. Ballasts for Dimmer-Controlled Lighting Fixtures: Electronic type.
 - 1. Dimming Range: 100 to 5 percent of rated lamp lumens.
 - 2. Ballast Input Watts: Can be reduced to 20 percent of normal.
 - 3. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.
- H. Ballasts for Bi-Level Controlled Lighting Fixtures: Electronic type.
 - 1. Operating Modes: Ballast circuit and leads provide for remote control of the light output of the associated lamp between high- and low-level and off.
 - a. High-Level Operation: 100 percent of rated lamp lumens.
 - b. Low-Level Operation: 30 percent of rated lamp lumens.
 - 2. Ballast shall provide equal current to each lamp in each operating mode.
 - 3. Compatibility: Certified by manufacturer for use with specific bi-level control system and lamp type indicated.

2.4 BALLASTS FOR COMPACT FLUORESCENT LAMPS

- A. Description: Electronic programmed rapid-start type, complying with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated:
 - 1. Lamp end-of-life detection and shutdown circuit.
 - 2. Automatic lamp starting after lamp replacement.
 - 3. Sound Rating: A.
 - 4. Total Harmonic Distortion Rating: Less than 20 percent.
 - 5. Transient Voltage Protection: IEEE C62.41, Category A or better.
 - 6. Operating Frequency: 20 kHz or higher.
 - 7. Lamp Current Crest Factor: 1.7 or less.
 - 8. BF: 0.95 or higher, unless otherwise indicated.
 - 9. Power Factor: 0.95 or higher.
 - 10. Interference: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.
 - 11. Ballast Case Temperature: 75 deg C, maximum.
- B. Ballasts for Dimmer-Controlled Lighting Fixtures: Electronic type.
 - 1. Dimming Range: 100 to 5 percent of rated lamp lumens.
 - 2. Ballast Input Watts: Can be reduced to 20 percent of normal.
 - 3. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.

2.5 EMERGENCY FLUORESCENT POWER UNIT

- A. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with ballast. Comply with UL 924.
 - 1. Emergency Connection: Operate 1 fluorescent lamp(s) continuously at an output of 1100 lumens each. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
 - 2. Night-Light Connection: Operate one fluorescent lamp continuously.
 - 3. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.
 - a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 - 4. Battery: Sealed, maintenance-free, nickel-cadmium type.
 - 5. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.

6. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
 7. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.
- B. External Type: Self-contained, modular, battery-inverter unit, suitable for powering one or more fluorescent lamps, remote mounted from lighting fixture. Comply with UL 924.
1. Emergency Connection: Operate one fluorescent lamp continuously. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
 2. Night-Light Connection: Operate one fluorescent lamp in a remote fixture continuously.
 3. Battery: Sealed, maintenance-free, nickel-cadmium type.
 4. Charger: Fully automatic, solid-state, constant-current type.
 5. Housing: NEMA 250, Type 1 enclosure.
 6. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 7. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 8. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
 9. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

2.6 EXIT SIGNS

- A. Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
1. Lamps for AC Operation: Fluorescent, 2 for each fixture, 20,000 hours of rated lamp life.
 2. Lamps for AC Operation: LEDs, 70,000 hours minimum rated lamp life.
 3. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
 - a. Battery: Sealed, maintenance-free, nickel-cadmium type.
 - b. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 - f. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
 - g. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

2.7 FLUORESCENT LAMPS

- A. Low-Mercury Lamps: Comply with EPA's toxicity characteristic leaching procedure test; shall yield less than 0.2 mg of mercury per liter when tested according to NEMA LL 1.
- B. T8 rapid-start low-mercury lamps, rated 32 W maximum, nominal length of 48 inches (1220 mm), 2800 initial lumens (minimum), CRI 75 (minimum), color temperature 3500 K, and average rated life 20,000 hours, unless otherwise indicated.
- C. T8 rapid-start low-mercury lamps, rated 17 W maximum, nominal length of 24 inches (610 mm), 1300 initial lumens (minimum), CRI 75 (minimum), color temperature 3500 K, and average rated life of 20,000 hours, unless otherwise indicated.
- D. T5 rapid-start low-mercury lamps, rated 28 W maximum, nominal length of 45.2 inches (1150 mm), 2900 initial lumens (minimum), CRI 85 (minimum), color temperature 3000 K, and average rated life of 20,000 hours, unless otherwise indicated.
- E. T5HO rapid-start, high-output low-mercury lamps, rated 54 W maximum, nominal length of 45.2 inches (1150 mm), 5000 initial lumens (minimum), CRI 85 (minimum), color temperature 4100 K, and average rated life of 20,000 hours, unless otherwise indicated.
- F. Compact Fluorescent Lamps: 4-Pin, low mercury, CRI 80 (minimum), color temperature 3500 K, average rated life of 10,000 hours at 3 hours operation per start, and suitable for use with dimming ballasts, unless otherwise indicated.
 - 1. 13 W: T4, double or triple tube, rated 900 initial lumens (minimum).
 - 2. 18 W: T4, double or triple tube, rated 1200 initial lumens (minimum).
 - 3. 26 W: T4, double or triple tube, rated 1800 initial lumens (minimum).
 - 4. 32 W: T4, triple tube, rated 2400 initial lumens (minimum).
 - 5. 42 W: T4, triple tube, rated 3200 initial lumens (minimum).
 - 6. 55 W: T4, triple tube, rated 4300 initial lumens (minimum).

2.8 LIGHTING FIXTURE SUPPORT COMPONENTS

- A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
- C. Twin-Stem Hangers: Two, 1/2-inch (13-mm) steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
- D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).
- E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage (2.68 mm).
- F. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.
- G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.
- B. Support for Lighting Fixtures in or on Grid-Type Suspended Ceilings: Use grid as a support element.
 - 1. Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 6 inches (150 mm) from lighting fixture corners.
 - 2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
 - 3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch (20-mm) metal channels spanning and secured to ceiling tees.
 - 4. Install at least one independent support rod or wire from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.
- C. Suspended Lighting Fixture Support:
 - 1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
 - 2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
 - 3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
- D. Adjust aimable lighting fixtures to provide required light intensities.
- E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.2 FIELD QUALITY CONTROL

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

END OF SECTION

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SECTION 26 56 00

EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Exterior luminaires with lamps and ballasts.
 - 2. Luminaire-mounted photoelectric relays.
 - 3. Poles and accessories.
 - 4. Luminaire lowering devices.
- B. Related Sections include the following:
 - 1. Division 26 Section "Interior Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.

1.3 DEFINITIONS

- A. CRI: Color-rendering index.
- B. HID: High-intensity discharge.
- C. Luminaire: Complete lighting fixture, including ballast housing if provided.
- D. Pole: Luminaire support structure, including tower used for large area illumination.
- E. Standard: Same definition as "Pole" above.

1.4 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. 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. 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. Ballasts, including energy-efficiency data.
 - 8. Lamps, including life, output, and energy-efficiency data.

9. Materials, dimensions, and finishes of poles.
 10. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
 11. Anchor bolts for poles.
 12. Manufactured pole foundations.
- B. Shop Drawings:
1. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
 2. Design calculations, certified by a qualified professional engineer, indicating strength of screw foundations and soil conditions on which they are based.
 3. Wiring Diagrams: Power and control wiring.
- C. Samples for Verification: For products designated for sample submission in Exterior Lighting Device Schedule. Each sample shall include lamps and ballasts.
- D. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4 and that load imposed by luminaire has been included in design.
- E. Qualification Data: For agencies providing photometric data for lighting fixtures.
- F. Field quality-control test reports.
- G. Operation and Maintenance Data: For luminaires and poles to include in emergency, operation, and maintenance manuals.
- H. Warranty: Special warranty specified in this Section.

1.5 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 1910.7.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with IEEE C2, "National Electrical Safety Code."
- E. Comply with NFPA 70.

1.6 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 (300 mm) above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

- C. Handle wood poles so they will not be damaged. Do not use pointed tools that can indent pole surface more than 1/4 inch (6 mm) deep. Do not apply tools to section of pole to be installed below ground line.
- D. Retain factory-applied pole wrappings on fiberglass and laminated wood poles until right before pole installation. Handle poles with web fabric straps.
- E. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.7 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 Lamps: Replace lamps and fuses that fail within 12 months from date of Substantial Completion; furnish replacement lamps and fuses that fail within the second 12 months from date of Substantial Completion.
 - 5. 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.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 2. Glass and Plastic Lenses, Covers, and Other Optical Parts: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 3. Ballasts: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 4. Globes and Guards: 10 for every 20 of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
- B. In Exterior Lighting Device Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

3. Basis of Design Product: The design of each item of exterior luminaire and its support is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified.

2.2 LUMINAIRES, GENERAL REQUIREMENTS

- A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
- B. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.
- C. Metal Parts: Free of burrs and sharp corners and edges.
- D. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.
- E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
- F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.
- G. Exposed Hardware Material: Stainless steel.
- H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
- I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.
- J. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
 1. White Surfaces: 85 percent.
 2. Specular Surfaces: 83 percent.
 3. Diffusing Specular Surfaces: 75 percent.
- K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- L. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.
- M. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
 2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

- a. Color: As selected from manufacturer's standard catalog of colors.
 - b. Color: Match Architect's sample of manufacturer's standard color.
 - c. Color: As selected by Architect from manufacturer's full range.
- N. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
 2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
 3. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
 4. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.

2.3 LUMINAIRE-MOUNTED PHOTOELECTRIC RELAYS

- A. Comply with UL 773 or UL 773A.
- B. Contact Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 to 3 fc (16 to 32 lx) and off at 4.5 to 10 fc (48 to 108 lx) with 15-second minimum time delay.
1. Relay with locking-type receptacle shall comply with NEMA C136.10.
 2. Adjustable window slide for adjusting on-off set points.

2.4 FLUORESCENT BALLASTS AND LAMPS

- A. Low-Temperature Ballast Capability: Rated by its manufacturer for reliable starting and operation of indicated lamp(s) at temperatures 0 deg F (minus 18 deg C) and higher.
- B. Ballast Characteristics:
1. Power Factor: 90 percent, minimum.
 2. Sound Rating: A.
 3. Total Harmonic Distortion Rating: Less than 10 percent.
 4. Electromagnetic Ballasts: Comply with ANSI C82.1, energy-saving, high power factor, Class P, automatic-reset thermal protection.
 5. Case Temperature for Compact Lamp Ballasts: 65 deg C, maximum.
 6. Transient-Voltage Protection: Comply with IEEE C62.41 Category A or better.
- C. Low-Temperature Lamp Capability: Rated for reliable starting and operation with ballast provided at temperatures 0 deg F (minus 18 deg C) and higher.
- D. Fluorescent Lamps: Low-mercury type. Comply with the EPA's toxicity characteristic leaching procedure test; shall yield less than 0.2 mg of mercury per liter when tested according to NEMA LL 1.

2.5 POLES AND SUPPORT COMPONENTS, GENERAL REQUIREMENTS

- A. Structural Characteristics: Comply with AASHTO LTS-4.

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 Part 1 "Structural Analysis Criteria for Pole Selection" Article, with a gust factor of 1.3.
 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 stainless-steel items are indicated.
 3. Anchor-Bolt Template: Plywood or steel.
- D. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."
- E. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123M; and with top-plate and mounting bolts to match pole base flange and strength required to support pole, luminaire, and accessories.
- F. Breakaway Supports: Frangible breakaway supports, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-4.

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.

3.2 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRES

- A. Install on concrete base with top 4 inches (100 mm) 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 Division 03 Section "Cast-in-Place Concrete."

3.3 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 Division 26 Section "Raceway and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.4 GROUNDING

- A. Ground metal poles and support structures according to Division 26 Section "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 Division 26 Section "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.

3.5 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."
 - 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.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain luminaire lowering devices. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

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SECTION 28 31 11

DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Fire-alarm control unit.
 - 2. Manual fire-alarm boxes.
 - 3. System smoke detectors.
 - 4. Nonsystem smoke detectors.
 - 5. Heat detectors.
 - 6. Notification appliances.
 - 7. Firefighters' two-way telephone communication service.
 - 8. Magnetic door holders.
 - 9. Remote annunciator.
 - 10. Addressable interface device.
 - 11. Digital alarm communicator transmitter.
 - 12. Radio alarm transmitter.
 - 13. System printer.

1.3 DEFINITIONS

- A. LED: Light-emitting diode.
- B. NICET: National Institute for Certification in Engineering Technologies.

1.4 SYSTEM DESCRIPTION

- A. Noncoded, UL-certified addressable system, with multiplexed signal transmission, dedicated to fire-alarm service only.
- B. Noncoded addressable system, with automatic sensitivity control of certain smoke detectors and multiplexed signal transmission, dedicated to fire-alarm service only.

1.5 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Fire-alarm control unit and raceways shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

1.6 SUBMITTALS

- A. General Submittal Requirements:
 - 1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
 - 2. Shop Drawings shall be prepared by persons with the following qualifications:
 - a. Trained and certified by manufacturer in fire-alarm system design.
 - b. NICET-certified fire-alarm technician, Level III minimum.

- c. Licensed or certified by authorities having jurisdiction.
- B. Product Data: For each type of product indicated.
- C. Shop Drawings: For fire-alarm system. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.
 - 2. Include voltage drop calculations for notification appliance circuits.
 - 3. Include battery-size calculations.
 - 4. Include performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
 - 5. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale and coordinating installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.
 - 6. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.
- D. Delegated-Design Submittal: For smoke and heat detectors indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Drawings showing the location of each smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the detector.
 - 2. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72.
- E. Qualification Data: For qualified Installer.
- F. Field quality-control reports.
- G. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
 - 2. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.
 - 3. Record copy of site-specific software.
 - 4. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:
 - a. Frequency of testing of installed components.
 - b. Frequency of inspection of installed components.
 - c. Requirements and recommendations related to results of maintenance.
 - d. Manufacturer's user training manuals.
 - 5. Manufacturer's required maintenance related to system warranty requirements.
 - 6. Abbreviated operating instructions for mounting at fire-alarm control unit.
 - 7. Copy of NFPA 25.
- H. Software and Firmware Operational Documentation:
 - 1. Software operating and upgrade manuals.
 - 2. Program Software Backup: On magnetic media or compact disk, complete with data files.
 - 3. Device address list.

4. Printout of software application and graphic screens.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
- B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level III technician.
- C. Source Limitations for Fire-Alarm System and Components: Obtain fire-alarm system from single source from single manufacturer. Components shall be compatible with, and operate as, an extension of existing system.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. NFPA Certification: Obtain certification according to NFPA 72 by an NRTL.
- F. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.
- G. NFPA Certification: Obtain certification according to NFPA 72 in the form of a placard by an FMG-approved alarm company.
- H. NFPA Certification: Obtain certification according to NFPA 72.

1.8 SOFTWARE SERVICE AGREEMENT

- A. Comply with UL 864.
- B. Technical Support: Beginning with Substantial Completion, provide software support for two years.
- C. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
 1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

1.9 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no fewer than 1 unit.
 2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than 1 unit.
 3. Smoke Detectors, Fire Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than 1 unit of each type.
 4. Detector Bases: Quantity equal to 2 percent of amount of each type installed, but no fewer than 1 unit of each type.
 5. Keys and Tools: One extra set for access to locked and tamperproofed components.
 6. Audible and Visual Notification Appliances: One of each type installed.
 7. Fuses: Two of each type installed in the system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:
1. Amseco - a Potter brand; Potter Electric Signal Company.
 2. Bosch Security Systems.
 3. Commercial Products Group/CPG Life Safety Signals.
 4. Faraday; Siemens Building Technologies, Inc.
 5. Federal Signal Corporation.
 6. Fire Control Instruments, Inc.; a Honeywell company.
 7. Fire Lite Alarms; a Honeywell company.
 8. Gamewell; a Honeywell company.
 9. GE Infrastructure; a unit of General Electric Company.
 10. Gentex Corporation.
 11. Harrington Signal, Inc.
 12. NOTIFIER; a Honeywell company.
 13. Siemens Building Technologies, Inc.; Fire Safety Division.
 14. Silent Knight; a Honeywell company.
 15. SimplexGrinnell LP; a Tyco International company.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

- A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:
1. Manual stations.
 2. Heat detectors.
 3. Flame detectors.
 4. Smoke detectors.
 5. Duct smoke detectors.
 6. Verified automatic alarm operation of smoke detectors.
 7. Automatic sprinkler system water flow.
 8. Heat detectors in elevator shaft and pit.
 9. Fire-extinguishing system operation.
 10. Fire standpipe system.
- B. Fire-alarm signal shall initiate the following actions:
1. Continuously operate alarm notification appliances.
 2. Identify alarm at fire-alarm control unit and remote annunciators.
 3. Transmit an alarm signal to the remote alarm receiving station.
 4. Unlock electric door locks in designated egress paths.
 5. Release fire and smoke doors held open by magnetic door holders.
 6. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
 7. Activate smoke-control system (smoke management) at firefighter smoke-control system panel.
 8. Activate stairwell and elevator-shaft pressurization systems.
 9. Close smoke dampers in air ducts of designated air-conditioning duct systems.
 10. Recall elevators to primary or alternate recall floors.
 11. Activate emergency lighting control.
 12. Activate emergency shutoffs for gas and fuel supplies.
 13. Record events in the system memory.
 14. Record events by the system printer.
- C. Supervisory signal initiation shall be by one or more of the following devices and actions:
1. Valve supervisory switch.
 2. Low-air-pressure switch of a dry-pipe sprinkler system.

3. Elevator shunt-trip supervision.
- D. System trouble signal initiation shall be by one or more of the following devices and actions:
 1. Open circuits, shorts, and grounds in designated circuits.
 2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
 3. Loss of primary power at fire-alarm control unit.
 4. Ground or a single break in fire-alarm control unit internal circuits.
 5. Abnormal ac voltage at fire-alarm control unit.
 6. Break in standby battery circuitry.
 7. Failure of battery charging.
 8. Abnormal position of any switch at fire-alarm control unit or annunciator.
 9. Low-air-pressure switch operation on a dry-pipe or preaction sprinkler system.
- E. System Trouble and Supervisory Signal Actions: Initiate notification appliance and annunciate at fire-alarm control unit and remote annunciators. Record the event on system printer.

2.3 FIRE-ALARM CONTROL UNIT

- A. General Requirements for Fire-Alarm Control Unit:
 1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864 and listed and labeled by an NRTL.
 - a. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.
 - b. Include a real-time clock for time annotation of events on the event recorder and printer.
 2. Addressable initiation devices that communicate device identity and status.
 - a. Smoke sensors shall additionally communicate sensitivity setting and allow for adjustment of sensitivity at fire-alarm control unit.
 - b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.
 3. Addressable control circuits for operation of mechanical equipment.
- B. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
 1. Annunciator and Display: Liquid-crystal type, 3 line(s) of 40 characters, minimum.
 2. Keypad: Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.
- C. Circuits:
 1. Initiating Device, Notification Appliance, and Signaling Line Circuits: NFPA 72, Class A.
 - a. Initiating Device Circuits.
 - b. Notification Appliance Circuits: Style Z.
 - c. Signaling Line Circuits.
 - d. Install no more than 50 addressable devices on each signaling line circuit.
 2. Initiating Device, Notification Appliance, and Signaling Line Circuits: NFPA 72, Class B.
 - a. Initiating Device Circuits.
 - b. Notification Appliance Circuits.
 - c. Signaling Line Circuits.
 - d. Install no more than 50 addressable devices on each signaling line circuit.
 3. Serial Interfaces: Two RS-232 ports for printers.

- D. Stairwell Pressurization: Provide an output signal using an addressable relay to start the stairwell pressurization system. Signal shall remain on until alarm conditions are cleared and fire-alarm system is reset. Signal shall not stop in response to alarm acknowledge or signal silence commands.
 - 1. Pressurization starts when any alarm is received at fire-alarm control unit.
 - 2. Alarm signals from smoke detectors at pressurization air supplies have a higher priority than other alarm signals that start the system.
- E. Smoke-Alarm Verification:
 - 1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.
 - 2. Activate an NRTL-listed and -approved "alarm-verification" sequence at fire-alarm control unit and detector.
 - 3. Record events by the system printer.
 - 4. Sound general alarm if the alarm is verified.
 - 5. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.
- F. Elevator Recall:
 - 1. Smoke detectors at the following locations shall initiate automatic elevator recall. Alarm-initiating devices, except those listed, shall not start elevator recall.
 - a. Elevator lobby detectors except the lobby detector on the designated floor.
 - b. Smoke detector in elevator machine room.
 - c. Smoke detectors in elevator hoistway.
 - 2. Elevator lobby detectors located on the designated recall floors shall be programmed to move the cars to the alternate recall floor.
 - 3. Water-flow alarm connected to sprinkler in an elevator shaft and elevator machine room shall shut down elevators associated with the location without time delay.
 - a. Water-flow switch associated with the sprinkler in the elevator pit may have a delay to allow elevators to move to the designated floor.
- G. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke barrier walls shall be connected to fire-alarm system.
- H. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and print out the final adjusted values on system printer.
- I. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.
- J. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.
- K. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory signals, supervisory and digital alarm communicator transmitters shall be powered by 24-V dc source.
 - 1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

- L. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
 - 1. Batteries: Sealed lead calcium.
- M. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.4 MANUAL FIRE-ALARM BOXES

- A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
 - 1. Station Reset: Key- or wrench-operated switch.
 - 2. Indoor Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.
 - 3. Weatherproof Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.

2.5 SYSTEM SMOKE DETECTORS

- A. General Requirements for System Smoke Detectors:
 - 1. Comply with UL 268; operating at 24-V dc, nominal.
 - 2. Detectors shall be two-wire type.
 - 3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
 - 4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
 - 5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
 - 6. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status.
 - 7. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.
 - a. Rate-of-rise temperature characteristic shall be selectable at fire-alarm control unit for 15 or 20 deg F (8 or 11 deg C) per minute.
 - b. Fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg F (57 or 68 deg C).
 - c. Provide multiple levels of detection sensitivity for each sensor.
- B. Photoelectric Smoke Detectors:
 - 1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
 - 2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).

- C. Duct Smoke Detectors: Photoelectric type complying with UL 268A.
 - 1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
 - 2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).
 - 3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector.
 - 4. Each sensor shall have multiple levels of detection sensitivity.
 - 5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
 - 6. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

2.6 HEAT DETECTORS

- A. General Requirements for Heat Detectors: Comply with UL 521.
- B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F (57 deg C) or a rate of rise that exceeds 15 deg F (8 deg C) per minute unless otherwise indicated.
 - 1. Mounting: Adapter plate for outlet box mounting.
 - 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
- C. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 deg F (88 deg C).
 - 1. Mounting: Adapter plate for outlet box mounting.
 - 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.7 NOTIFICATION APPLIANCES

- A. General Requirements for Notification Appliances: Individually addressed, connected to a signaling line circuit, equipped for mounting as indicated and with screw terminals for system connections.
- B. General Requirements for Notification Appliances: Connected to notification appliance signal circuits, zoned as indicated, equipped for mounting as indicated and with screw terminals for system connections.
 - 1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated and with screw terminals for system connections.
- C. Chimes, Low-Level Output: Vibrating type, 75-dBA minimum rated output.
- D. Chimes, High-Level Output: Vibrating type, 81-dBA minimum rated output.
- E. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet (3 m) from the horn, using the coded signal prescribed in UL 464 test protocol.

- F. Visible Notification Appliances: Xenon strobe lights comply with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- (25-mm-) high letters on the lens.
 - 1. Rated Light Output:
 - a. 15/30/75/110 cd, selectable in the field.
 - 2. Mounting: Wall mounted unless otherwise indicated.
 - 3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
 - 4. Flashing shall be in a temporal pattern, synchronized with other units.
 - 5. Strobe Leads: Factory connected to screw terminals.
 - 6. Mounting Faceplate: Factory finished, white.

2.8 MAGNETIC DOOR HOLDERS

- A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.
 - 1. Electromagnet: Requires no more than 3 W to develop 25-lbf (111-N) holding force.
 - 2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
 - 3. Rating: 24-V ac or dc.
 - 4. Rating: 120-V ac.
- B. Material and Finish: Match door hardware.

2.9 REMOTE ANNUNCIATOR

- A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.
 - 1. Mounting: Flush cabinet, NEMA 250, Type 1.
- B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.10 ADDRESSABLE INTERFACE DEVICE

- A. Description: Microelectronic monitor module, NRTL listed for use in providing a system address for alarm-initiating devices for wired applications with normally open contacts.

2.11 DIGITAL ALARM COMMUNICATOR TRANSMITTER

- A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632 and be listed and labeled by an NRTL.
- B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture one telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.
- C. Local functions and display at the digital alarm communicator transmitter shall include the following:

1. Verification that both telephone lines are available.
 2. Programming device.
 3. LED display.
 4. Manual test report function and manual transmission clear indication.
 5. Communications failure with the central station or fire-alarm control unit.
- D. Digital data transmission shall include the following:
1. Address of the alarm-initiating device.
 2. Address of the supervisory signal.
 3. Address of the trouble-initiating device.
 4. Loss of ac supply or loss of power.
 5. Low battery.
 6. Abnormal test signal.
 7. Communication bus failure.
- E. Secondary Power: Integral rechargeable battery and automatic charger.
- F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.12 SYSTEM PRINTER

- A. Printer shall be listed and labeled by an NRTL as an integral part of fire-alarm system.

2.13 DEVICE GUARDS

- A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.
1. Factory fabricated and furnished by manufacturer of device.
 2. Finish: Paint of color to match the protected device.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

- A. Comply with NFPA 72 for installation of fire-alarm equipment.
- B. Equipment Mounting: Install fire-alarm control unit on concrete base with tops of cabinets not more than 72 inches (1830 mm) above the finished floor. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-Place Concrete."
1. Install seismic bracing. Comply with requirements in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
 3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
- C. Smoke- or Heat-Detector Spacing:
1. Comply with NFPA 72, "Smoke-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for smoke-detector spacing.
 2. Comply with NFPA 72, "Heat-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for heat-detector spacing.

3. Smooth ceiling spacing shall not exceed 30 feet (9 m).
 4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Appendix A or Appendix B in NFPA 72.
 5. HVAC: Locate detectors not closer than 3 feet (1 m) from air-supply diffuser or return-air opening.
 6. Lighting Fixtures: Locate detectors not closer than 12 inches (300 mm) from any part of a lighting fixture.
- D. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct.
- E. Heat Detectors in Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location.
- F. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within a dwelling or suite, they shall be connected so that the operation of any smoke alarm causes the alarm in all smoke alarms to sound.
- G. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.
- H. Audible Alarm-Indicating Devices: Install not less than 6 inches (150 mm) below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.
- I. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches (150 mm) below the ceiling.
- J. Device Location-Indicating Lights: Locate in public space near the device they monitor.
- K. Fire-Alarm Control Unit: Surface mounted, with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.
- L. Annunciator: Install with top of panel not more than 72 inches (1830 mm) above the finished floor.
- M. Antenna for Radio Alarm Transmitter: Mount to building structure where indicated. Use mounting arrangement and substrate connection that will resist 100-mph (160-km/h) wind load with a gust factor of 1.3 without damage.

3.2 CONNECTIONS

- A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Division 08 Section "Door Hardware." Connect hardware and devices to fire-alarm system.
1. Verify that hardware and devices are NRTL listed for use with fire-alarm system in this Section before making connections.
- B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 3 feet (1 m) from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
1. Alarm-initiating connection to smoke-control system (smoke management) at firefighter smoke-control system panel.

2. Alarm-initiating connection to stairwell and elevator-shaft pressurization systems.
3. Smoke dampers in air ducts of designated air-conditioning duct systems.
4. Alarm-initiating connection to elevator recall system and components.
5. Alarm-initiating connection to activate emergency lighting control.
6. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
7. Supervisory connections at valve supervisory switches.
8. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
9. Supervisory connections at elevator shunt trip breaker.
10. Supervisory connections at fire-pump power failure including a dead-phase or phase-reversal condition.
11. Supervisory connections at fire-pump engine control panel.

3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- B. Install framed instructions in a location visible from fire-alarm control unit.

3.4 GROUNDING

- A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

3.5 FIELD QUALITY CONTROL

- A. Field tests shall be witnessed by authorities having jurisdiction.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Tests and Inspections:
 1. Visual Inspection: Conduct visual inspection prior to testing.
 - a. Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter.
 - b. Comply with "Visual Inspection Frequencies" Table in the "Inspection" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
 2. System Testing: Comply with "Test Methods" Table in the "Testing" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
 3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
 4. Test audible appliances for the private operating mode according to manufacturer's written instructions.
 5. Test visible appliances for the public operating mode according to manufacturer's written instructions.

6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
- E. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
- F. Fire-alarm system will be considered defective if it does not pass tests and inspections.
- G. Prepare test and inspection reports.
- H. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.
- I. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION

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SECTION 31 10 00

SITE CLEARING

PART 1 - GENERAL

1.01 RELATED CONDITIONS

- A. Provisions established within the 00 72 00 General Conditions and 00 73 00 Supplementary Conditions, Division 1 - General Requirements, and the Drawings are collectively applicable to this Section.

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Protection of existing trees.
 - 2. Removal of trees and other vegetation.
 - 3. Topsoil stripping.
 - 4. Clearing and grubbing.
 - 5. Removing above-grade improvements.
 - 6. Removing below-grade improvements.

1.03 PROJECT CONDITIONS.

- A. Traffic: Conduct site clearing operations to ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities. Do not close or obstruct streets, walks or other occupied or used facilities without permission from authorities having jurisdiction.
- B. Protection of Existing Improvements: Provide protection necessary to prevent damage to existing improvements indicated to remain in place.
 - 1. Protect improvements on adjoining properties and on Owner's property.
 - 2. Restore damaged improvements to their original condition, as acceptable to property owners.
- C. Protection of Existing Trees and Vegetation: Protect existing trees and other vegetation indicated to remain in place, against unnecessary cutting, breaking or skinning of roots, skinning or bruising of bark, smothering of trees by stockpiling construction materials or excavated materials within drip line, excess foot or vehicular traffic, or parking of vehicles within drip line. Provide temporary guards to protect trees and vegetation to be left standing.
 - 1. Water trees and other vegetation to remain within limits of contract work as required to maintain their health during course of construction operations.
 - 2. Provide protection for roots over 1-1/2" diameter that are cut during construction operations. Coat cut faces with an emulsified asphalt, or other acceptable coating, formulated for use on damaged plant tissues. Temporarily cover exposed roots with wet burlap to prevent roots from drying out; cover with earth as soon as possible.
 - 3. Repair or replace trees and vegetation indicated to remain which are damaged by construction operations, in a manner acceptable to Architect. Employ a licensed arborist to repair damages to trees and shrubs.

PART 2 – PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 SITE CLEARING

- A. General: Remove trees, shrubs, grass and other vegetation, improvements, or obstructions as required to permit installation of new construction. Remove similar items elsewhere on site or premises as specifically indicated. "Removal" includes digging out and off-site disposing of

stumps and roots.

1. Cut minor roots and branches of trees indicated to remain in a clean and careful manner, where such roots and branches obstruct installation of new construction.
- B. Topsoil: Topsoil is defined as friable clay surface soil found in a depth of not less than 4". Satisfactory topsoil is reasonably free of subsoil, clay lumps, stones, and other objects over 2" in diameter, and without weeds, roots, and other objectionable material.
 1. Strip topsoil to whatever depths encountered in a manner to prevent intermingling with underlying subsoil or other objectionable material.
 - a. Remove heavy growths of grass from areas before stripping.
 - b. Where existing trees are indicated to remain, leave existing topsoil in place within drip lines to prevent damage to root system.
 2. Stockpile topsoil in storage piles in areas indicated or directed. Construct storage piles to provide free drainage of surface water. Cover storage piles, if required, to prevent wind erosion.
 3. Dispose of unsuitable or excess topsoil same as specified for disposal of waste material.
- C. Clearing and Grubbing: Clear site of trees, shrubs and other vegetation, except for those indicated to be left standing.
 1. Completely remove stumps, roots, and other debris protruding through ground surface.
 2. Use only hand methods for grubbing inside drip line of trees indicated to remain.
 3. Fill depressions caused by clearing and grubbing operations with satisfactory soil material, unless further excavation or earthwork is indicated.
 4. Place fill material in horizontal layers not exceeding 6" loose depth, and thoroughly compact to a density equal to adjacent original ground.
- D. Removal of Improvements: Remove existing above-grade and below-grade improvements as indicated and as necessary to facilitate new construction.
 1. Abandonment or removal of certain underground pipe or conduits may be indicated.

3.02 DISPOSAL OF WASTE MATERIALS

- A. Burning on Owner's Property: Burning is not permitted on Owner's property.
- B. Removal from Owner's Property; Remove waste materials and unsuitable or excess topsoil from Owner's property.

END OF SECTION

SECTION 31 22 00

GRADING

PART 1 - GENERAL

1.01 RELATED REQUIREMENTS

- A. Comply with Conditions of the Contract, Division 1 - General Requirements, and referenced documents.
- B. Related Conditions: Provisions established within the 00 72 00 General Conditions and 00 73 00 Supplementary Conditions, Division 1 - General Requirements, and the Drawings are collectively applicable to this Section.
- C. Obtain copies of the Geotechnical Report for this project and comply with specific recommendations for subgrade preparation and site drainage described therein.

1.02 GENERAL DESCRIPTION OF WORK INCLUDED

- A. Coordinate work of this Section with work of other sections as required to properly execute work and as necessary to maintain satisfactory progress of work of other Sections.
- B. Excavate materials to required subgrades as noted on plan by civil engineer.
- C. Removal of existing below grade improvements that occur within excavations.
- D. Filling, backfilling, compaction, and rough grading of site to required subgrades.
- E. Providing off-site suitable fill materials.
- F. Dewatering, until permanent drainage system is operational.
- G. Disposal of excess and unsuitable excavated materials.
- H. Providing adequate dust control measures as necessary to maintain streets in clean condition from excavation site to disposal location.
- I. Providing adequate protective measures for public, workmen, adjacent streets, buildings and utilities.
- J. Lime stabilization for pavement, as specified in the Geotechnical Report, if required.

1.03 REFERENCES

- A. American Society for Testing and Materials: (Latest Editions)
 - 1. ASTM C 33, Concrete Aggregates.
 - 2. ASTM D698, Moisture-Density Relations of Soils and Soil- Aggregate Mixtures, Using 5.5-lb. (2.5 kg.) Rammer and 12-in. (304.8-mm) Drop.
 - 3. ASTM D 1556, Density of Soil in Place by the Sand- Cone Method.
 - 4. ASTM D2167, Density of Soil in Place by the Rubber-Balloon Method.
 - 5. ASTM D 2922, Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth.)
 - 6. ASTM D 3017, Moisture Control of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth.)

1.04 REGULATORY REQUIREMENTS

- A. Comply with rules, regulations, laws, and ordinances of authorities having jurisdiction.
- B. Notify Department of Public Works - Field Operations, Director of Traffic Control, and Police Department. Make necessary arrangements and obtain their approval of routes used by hauling equipment. Obtain required permits for traffic control during hauling operations.

1.05 QUALITY ASSURANCE

A. Testing Laboratory Services:

1. A soil testing and inspecting service is to be engaged for quality control testing during fill and backfill operations. The Contractor shall provide the Testing Laboratory with a copy of the Geotechnical Report prepared for this project to be used as a reference.
2. Submit soil materials proposed for backfill to laboratory for testing.
 - a. Laboratory will determine suitability of materials to be used.
 - b. Laboratory will submit test results and recommendations.
3. Advise testing laboratory two days in advance of operations.
4. Tests will be executed immediately prior to covering of compacted areas.
5. When tests indicate compaction does not meet requirements, remove fill and backfill completely, dry out or moisten as necessary and recompact.
 - a. Retest recompact areas.
 - b. Repeat until tests indicate compliance with specified requirements.
 - c. Provide reworking and retesting at no additional compensation.
6. Permissible Tolerations: Finish excavations, fills, and grade within a tolerance of 0.05 foot above or 0.10 foot below required grades. Do not leave depressions in graded areas.

1.06 SUBMITTALS

- A. Product Data: Submit manufacturer's descriptive literature and recommended installation instructions for filter fabric, and drainage matting.
- B. Samples: Submit minimum, 10 lb., samples of each type of fill material to be used. Forward samples to testing laboratory, packed tightly in containers to prevent contamination.
- C. Test Reports: If recent test results are available for proposed fill materials, submit to testing laboratory in lieu of samples. Test results are to clearly indicate types of materials and composition, hardness, compatibility and suitability for proposed usage.
- D. Laboratory Test Reports for following:
 1. Test reports on borrow material.
 2. Field density reports.
 3. One optimum moisture-maximum density curve for each type soil encountered.
 4. Materials certificate stating materials acceptable for fill and backfill.

1.07 SUBSURFACE INVESTIGATION

- A. Owner and Architect make no representation regarding character and extent of soil data or other surface or subsurface data and conditions which may be encountered during work and no guarantee as to accuracy or validity of interpretation of such data or conditions is made or intended.

1.08 PROTECTION

- A. Provide, erect, and maintain all lights, barricades, warning signs, and guards as necessary.
- B. Provide adequate protective measures to protect existing adjacent construction, including buildings, streets, walks, utility lines, the public and workmen.
- C. Protect all reference points, bench marks, and monuments from dislocation, damage, or being destroyed.
- D. Survey adjacent structures and improvements, establishing exact relocations at fixed points to act as bench marks. Clearly identify bench marks and record existing elevations. Locate datum level used to establish bench mark elevations sufficiently distant so as to be not affected by movement resulting from excavation operations.
- E. During excavation, resurvey bench marks, employing a Registered Professional Land Surveyor. Maintain accurate log of surveyed elevations for comparison with original elevations.

- F. Exercise care during excavations as excessive withdrawal of ground water and lowering of ground water table may adversely affect stability and integrity of existing buildings and structures in vicinity or induce settlement in them through loss of ground (soil or earth), or settlement due to lowering of ground water under them.
- G. Damage to buildings, structures, utilities, sidewalks, pavements, and other facilities in vicinity resulting from these operations will be Contractor's responsibility; provide whatever measures as necessary to prevent damages from occurring.
- H. Keep adjacent streets and hauling routes free from soils and debris deposited thereon as results of this work. Clean debris as necessary.
- I. Repair or replace work damaged or destroyed while performing work of this Section.

1.09 PROTECTION OF EXCAVATIONS

- A. Protect excavations to prevent cave-ins or loose dirt from falling into excavations and to ensure against damage to existing streets, paving buildings, other structures, and utility lines when excavation and grading work occurs adjacent to or below same.
- B. Protect bottom of excavations and soil around and beneath foundations from frost and water.
- C. Grade around excavation to prevent surface water runoff into excavated area.
- D. Provide dewatering system as necessary to keep excavations dry at all times until permanent pumping and discharge systems are fully operational.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Controlled Backfill and Engineered Fill: Free-draining granular material with less than 3% passing a No. 200 sieve and less than 30% passing No. 40 sieve, non plastic. All granular backfill shall be approved by the testing laboratory.
- B. Filter Fabric: Permeable polypropylene or polyester construction, not less than 4.0 oz/sq.yd., 140N or 700X Drainage Fabric by Mirafi, Inc., Type T-140-N Stabilenka by American Enka Company, Typar Style 3401 by Dupont, or approved equivalent.
- C. Drainage Matting:
 - 1. High-impact polystyrene waffle-like core with filter fabric bonded on one side, and core perforated in areas of foundation weeps; Miradrain by Mirafi Inc., Charlotte, North Carolina, or Eljen Prefabricated Drainage Structures by Eljen Development Corporation, Storrs, Connecticut or approved equivalent
 - 2. Compression-resistant open nylon matting with filter fabric bonded on one side, Type 9120 Enkadrain by American Enka Company, Enka, North Carolina.
- D. Topsoil: Fertile, friable, natural loam surface soil free of subsoil, clay lumps, brush, weeds, roots, stones and other litter.

PART 3 - EXECUTION

3.01 PREPARATION AND LAYOUT

- A. Work shall be laid out by a Registered Professional Land Surveyor. Establish extent of site grading by area and elevation; designate and identify datum elevation. Set required lines and levels.
- B. Verify elevations, dimensions, and actual conditions at site. Refer discrepancies to Architect for interpretation or necessary modifications.
- C. Maintain bench mark, monuments, and other reference points.

3.02 UTILITIES

- A. Before starting site grading, establish location and extent of underground utilities occurring in work area.
- B. Notify utility companies to remove and relocate lines which are in way of site grading.
- C. Remove abandoned utility service lines from areas of site grading; cap, plug or seal such lines and identify their location and grade.
- D. On Project Record Documents accurately locate and record abandoned and active utility lines rerouted or extended.

3.03 PUMPING AND DRAINAGE

- A. Provide adequate provisions for prompt removal of water accumulating in excavations, including temporary sumps, well points, pumps, drain lines, and other equipment or appurtenances as necessary.
- B. Keep excavations free from water at all times and prevent water from interfering with progress or quality of work.
- C. Drain site to temporary sumps and silt settling basins, and remove accumulated water by pumping to storm sewers. Excavate in sequence that will provide drainage to sumps at all times.
- D. When pumping water from excavated areas, take special precautions to avoid undermining of contiguous property by withdrawal of sand, soil, or any other supporting materials from areas below surfaces of such property.

3.04 EXCAVATION

- A. Excavate subsoil in accordance with lines and levels required for construction of site work.
- B. Remove existing foundation, foundation mats, footings, catch basins, manholes, underground piping, abandoned utilities, and other below grade improvements that occur within excavated areas.

3.05 BACKFILLING

- A. Ensure areas are free from debris, snow, ice and water, and that ground surfaces are not in frozen condition.
- B. Backfill areas to grades, contours, levels, and elevations indicated.
- C. Backfill systematically and as early as possible to allow maximum time for natural settlement and compaction.
- D. Place fill materials in horizontal layers not exceeding 9" loose depth and uniformly compact. Use a method so as not to disturb or damage building drainage systems and waterproofing systems.
- E. Maintain optimum moisture content of backfill materials to attain specified compaction density. Moisten materials as necessary.
- F. Settlement or washing that occurs in backfilled areas prior to acceptance of work shall be repaired and grades re-established to required elevations and slopes.

3.06 RECONDITIONING SUBGRADE

- A. Prior to beginning paving operations, any vegetation should be removed to a depth of at least 6".
- B. The exposed surface should then be scarified to a minimum depth of 6" and recompact to a minimum of 95% of the maximum dry density as determined by ASTM D 698 (Standard Proctor Test) at a moisture content between the optimum moisture value and 4% above optimum, unless otherwise specified in the Geotechnical Report.

- C. In the event that additional fill is necessary to bring parking areas to grade, it should be placed in less than 8" loose lifts and compacted as indicated above.
- D. The subgrade should be in a moist condition at the time concrete is deposited thereon.
- E. Using coarse sand (sand cushion) as a leveling material is not allowed.

3.07 GRADING

- A. Establishment of grades: The Contractor shall be responsible for establishment of all grades by means of grade stakes placed at pavement corners at all abrupt changes of grade and elsewhere as required.
- B. Grading: Grade to elevations required by drawings. Remove soft and unstable material which will not readily compact when rolled or tamped. Fill resulting depressions with stable material and roll until required compaction is obtained. At intermediate points for which finish grades are not indicated, finish grades shall be of uniform level or slope between points for which elevations are given. Make certain that finish grades slope away from buildings in all directions to assure positive drainage as specified in the Geotechnical Report.

3.08 SURPLUS MATERIALS

- A. Remove excavated and excess materials from site. Legally dispose of off construction site.

3.09 FIELD QUALITY CONTROL

- A. Testing of compacted fill materials will be performed by testing laboratory. Refer to Division 1. Testing will be performed to least encumber performance of work.
- B. Coordinate provisions for and sequence of testing with Testing Laboratory. Notify testing laboratory and allow sufficient time to perform density tests.
- C. Testing Laboratory will establish moisture density relationships of soils in accordance with ASTM D 698, D 3017, or D 3017.
- D. Testing Laboratory will perform in-place density test in accordance with ASTM D 1556, D 2167, D 2922, or other acceptable density tests.
- E. If, during progress of work, tests indicate that compacted materials do not meet specified requirements, remove defective work, replace and retest.
- F. Ensure compacted fills are tested before proceeding with placement of surface materials.

3.10 CLEANING

- A. Clean debris caused by excavation and backfill work. Keep premises and adjacent streets clean and neat.
- B. Leave stockpile areas completely free of excess fill materials.

END OF SECTION

SECTION 31 25 00

EROSION & SEDIMENTATION CONTROLS

PART 1 GENERAL

1.01 RELATED CONDITIONS

- A. Provisions established within the 00 72 00 General Conditions and 00 73 00 Supplementary Conditions, Division 1 - General Requirements, and the Drawings are collectively applicable to this Section.

1.02 DESCRIPTION OF WORK

- A. This section will consist of the completion and implementation of a Storm Water Pollution Prevention Plan (SWPPP).

PART 2 PRODUCTS

2.01 MATERIALS

- A. All materials shall be as specified or meeting the specifications as outlined in the North Central Texas Council of Governments Manual – “Storm Water Quality Best Management Practices for Construction Activities and the Standard Specifications for Public Works Construction.”
- B. All procedures and materials used for erosion control shall be approved by the City.

PART 3 EXECUTION

3.01 GENERAL

- A. It shall be the contractor's responsibility to use whatever means are necessary to control and limit silt and sediment leaving this site. Specifically, the contractor shall protect all public street, alleys, streams, storm drain systems and inlets from erosion deposits. The contractor shall comply with storm water pollution prevention management practices per the City and Texas Commissions on Environmental Quality.
- B. Prior to commencing any construction, perimeter silt fence shall be installed at the locations shown on the plans and a stabilized construction entrance will be constructed per the Erosion Control and Storm Water Pollution Prevention Plans as applicable.

3.02 INSTALLATION

- A. Grasses used to vegetate the site must be suitable for use under local climate and soil conditions. In general, hydro seeding or sodding bermuda grass is acceptable during the summer months (May 1 to August 30). Winter rye or fescue grass may be planted during times other than the summer months as a temporary measure until such time as the permanent planting can be made.
- B. As inlets are completed, temporary sediment barriers and inlet protection shall be installed in accordance with the City Specifications.
- C. At the completion of the paving and final grading, the disturbed area(s) shall be revegetated in accordance with the plans and specifications.
- D. Silt fence and inlet sediment barriers shall remain in place until revegetation has been completed.
- E. Disturbed areas that are seeded or sodded shall be checked periodically to see that grass coverage is properly maintained. Disturbed areas shall be watered, fertilized, and reseeded and

resodded, if necessary.

- F. If the erosion control is removed for construction and/or access purposes, the contractor shall replace it at the end of each work day.
- G. Erosion protection may be added or deleted per the City.
- H. If off-site soil borrow or spoil sites are used in conjunction with this project, this information shall be disclosed and shown on the Erosion Control Plan. Off-site borrow and spoil areas are considered a part of the project site and therefore shall comply with the City erosion control requirements. These areas shall be stabilized with permanent ground cover prior to final approval of the project.
- I. Erosion control facilities and stabilization measures shall be provided and maintained by a qualified contractor or contractors experienced in providing said facilities and services.
- J. Accumulated sediment shall be periodically removed from silt fences as required in order to maintain the effectiveness of the installation.
- K. Silt fencing, when used, shall be installed in accordance with the manufacturers recommendations and in accordance with the details on these plans.
- L. Upon completion of paving and drainage construction, final lot grading and general cleanup, all on-site street parkways (the area from the back of curb to the R.O.W. line) and adjacent street parkways disturbed by the construction shall be stabilized by Sod, Seeding or Hydromulching and shall conform to local City Standards and Specifications or Texas Department of Transportation Specifications. Stabilized parkways subsequently disturbed by utility comply contractors shall be repaired by the utility company or its contractor.
- M. Off-site utility construction shall be performed in a manner consistent with the requirements of this plan relative to preventing storm water pollution. Upon completion of trench backfilling and general cleanup, and soil areas disturbed by the construction shall be promptly stabilized.
- N. Upon completion of all utility and paving construction and prior to finish grading, all soil contaminated by construction operations and construction waste material shall be removed from the site and disposed of at an appropriate authorized landfill or waste disposal facility.
- O. If any contractor sees any violation of this plan by an operator or another contractor, he shall then notify the operator or contractor in violation as well as the facility operator.
- P. A copy of the Notice of Intent (NOI) and a copy of the Storm Water Pollution Prevention Plan must be kept and maintained on the construction site.
- Q. Stabilization measures are to be inspected at a minimum once every 14 days and within 24 hours after any rainfall greater than 0.5 inches. Inspection reports shall be maintained by the contractor and made part of the plan.
- R. The contractor shall adopt appropriate construction site management practices to prevent the discharge of oils, grease, paints, gasoline, and other pollutants to the storm water system.
- S. The Storm Water Pollution Prevention Plan (SWPPP) must be signed by the owner and contractor (as co-permittees) and retained on-site. The permittee shall post a notice near the main entrance of the construction site with the following information: 1) the NPDES permit number for the project or a copy of the NOI if a permit number has not been assigned; 2) the name and contact of the location contact person; 3) a brief description of the project; and 4) the location of SWPPP if the site is inactive or does not have an on-site location to store the plan.
- T. The permittee is also responsible for amending or updating the SWPPP as construction activities progress and site conditions change.
- U. Both the owner and contractor are responsible for reviewing the rules and requirements as outlined in the Texas Pollutant Discharge Elimination System General Permit No. TXR 150000

issued on March 5, 2008.

- V. The permittee is also responsible for notifying the Texas Commission on Environmental Quality Director of the "person or specifically described position as an authorized person for signing reports, storm water pollution prevention plans, certificates, or other information requested by the Director or required by the permit" other than the NOI. Referenced tests, Material standards and specifications are the minimum requirements. The Contractor will meet the requirements and recommendations of the applicable portions of the standards listed. Where compliance with two (2) or more industry standards or requirements are specified, and the overlapping of those different or conflicting minimums for levels of quality, the most stringent requirements is intended and will be enforced. The Contractor shall notify the Owner of any conflicts that are to be resolved.
1. City Standard Specifications and Details, Current Edition.
 2. North Central Texas Council of Governments (COG) Standard Specifications for Public Works Construction, Current Edition and Amendments.
 3. Texas Highway Department Standard Specification for Construction of Highways, Streets and Bridges, Current Addition and Amendments.
 4. American Associations of State Highway and Transportation Officials (AASHTO), Current Editions.
 5. American Water Works Associations (AWWA), Current Editions.
 6. American Society for Testing and Materials (ASTM), Current Edition.

Any Reference to Methods of Measurement or Payment in Reference Standards or Specifications are not applicable.

END OF SECTION

SECTION 31 63 29

DRILLED CONCRETE PIERS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. Information concerning a sub-surface soil investigation by the Owner's Geotechnical Engineer is available and will be furnished by the Owner upon request. The contractor may use the data included therein for his general information only. The Architect/Engineer is not responsible for the accuracy or applicability of the data therein.

1.02 DEFINITIONS

- A. Casing: Steel cylinder used to resist earth and water pressures, to serve as concrete form, and to protect personnel.
- B. Dry Method: A method of pier installation in which concrete is placed in the dry. Casing may or may not be used to maintain sidewall stability.
- C. Owner's Representative: The Architect, Structural Engineer, or Geotechnical Engineer authorized to act on behalf of the Owner.
- D. Owner's Representative - Geotechnical Engineer: The Geotechnical Engineer specifically authorized to carry out the responsibilities defined in this specification.
- E. Slurry Displacement Method: Method of drilling and concreting in which controlled slurry consisting of water, with or without additives such as bentonite, attapulgite, or polymer, is used to stabilize the hole. The slurry may be used either to maintain the stability of the uncased drilled pier hole or to allow concrete placement when water seepage into a drilled pier hole is too severe to permit concreting in the dry or both.
- F. Tremie method: Procedure for placing concrete under water or slurry using a watertight steel pipe or tube to place concrete without washing out cement fines.

1.03 STANDARDS

- A. The following Standards are listed in this specification:

ASTM A36	Standard Specification for Carbon Structural Steel
ASTM A283	Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A929	Standard Specification for Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe
ASTM C33	Standard Specification for Concrete Aggregates
ASTM C94	Specification for Ready Mixed Concrete
ASTM C150	Specification for Portland Cement
ASTM D1143	Standard Test Method for Piles Under Static Axial Compressive Load
ASTM D4380	Standard Test Method for Density of Bentonitic Slurries
ASTM D4381	Standard Test Method for Sand Content by Volume of Bentonitic Slurries

ASTM D4972 Standard Test Method for pH of Soils

1.04 SCOPE OF WORK

- A. The Drilling Contractor shall furnish all labor, materials, services, equipment (including temporary casings and/or dewatering where required), and shall install all piers at the locations and depths shown on the drawings or as otherwise directed by the Owner's Geotechnical Engineer. Installation methods compatible with the design may be used if acceptable to the Owner's Geotechnical Engineer. Methods that are not compatible with the design shall be excluded from consideration.
- B. The Drilling Contractor shall furnish and place all reinforcing steel, dowels, and anchor bolts that are shown on the drawings to be embedded in the pier.
- C. The General Contractor shall provide all necessary excavation, sheeting and bracing or other adequate maintenance of excavation banks, suitable runways and ramps as necessary for access of pier drilling, control of ground and surface water as necessary to keep the work area sufficiently dry, suitable access roads for movement of equipment and materials to and from pier locations, field layout required for pier work including setting and maintaining a location stake for each pier and giving cut-off grades on all piers, removal and replacement of all overhead and underground obstructions as required, and coordination of all concrete ordering and delivery.

1.05 QUALIFICATIONS

- A. Drilled piers shall be installed by a specialty Drilling Contractor with suitable equipment, competent personnel, and a reputation of satisfactorily performing the work. The Contractor shall have a minimum of 5 years successful experience and a minimum of 5 successful installations on projects of a similar size and scope to this project and of using similar installation methods as may be anticipated for this project. Evidence of compliance with this section shall be submitted to the Architect/Engineer prior to entering into a contract for the work.

1.06 QUALITY ASSURANCE

The Contractor is responsible for quality control, including workmanship and materials furnished by his subcontractors and suppliers.

- A. Codes and Standards: The Drilling Contractor shall comply with the provisions of the following codes, specifications, and standards, except where more stringent requirements are shown or specified:
 - 1. ACI 301 - "Specifications for Structural Concrete for Buildings".
 - 2. ACI 117 - "Specifications for Tolerances for Concrete Construction and Materials."
 - 3. ACI 318 - "Building Code Requirements for Reinforced Concrete".
 - 4. Concrete Reinforcing Steel Institute (CRSI), "Manual of Standard Practice".
 - 5. ANSI/AWS D1.1 "Structural Welding Code - Steel".
 - 6. ANSI/AWS D1.4 "Structural Welding Code – Reinforcing Steel".

In addition, all applicable building code and local regulations shall be followed. In case of conflict, the strictest interpretation shall govern.

B. Survey Work:

1. The General Contractor shall employ a qualified and licensed professional engineer/land surveyor to perform all surveys, layouts and measurements for drilled pier work including the layout of anchor rods and/or reinforcing steel dowels embedded in drilled piers. The surveyor shall conduct the layout work for each drilled pier to the lines and levels required prior to beginning excavation and shall make actual in-place measurements of each drilled pier plan location, shaft diameter, bottom and top elevations and deviations from specified tolerances.
2. The surveyor shall record and submit all information pertinent to each drilled pier and cooperate with other testing and inspection personnel to provide data for all required reports.

C. Testing Laboratory Requirements: The Drilling Contractor shall cooperate with all testing and inspection personnel employed to perform field quality control tests and inspections. See Testing Laboratory section of the specifications for required tests and inspections to be performed by the Testing Laboratory and Geotechnical Engineer.

Inspection or testing by the Owner does not relieve the Contractor of his responsibility to perform the Work in accordance with the Contract Documents.

1.07 JOB CONDITIONS

A. Site Information:

1. Data on indicated subsurface conditions are not intended as representations or warranties of continuity of such conditions. It is expressly understood that Owner will not be responsible for interpretations or conclusions drawn therefrom by the Contractor. The data are made available for convenience of the Contractor.
2. The Contractor may make additional test borings and other exploratory operations at no additional cost to the Owner.
3. The Contractor shall inspect the site prior to drilling operations and shall determine any constraints to the work presented by the existing surface conditions and report them to the Owner's Representative.

B. Protection of Existing Structures: Locate all existing underground structures and utilities that are to remain in service during construction. Protect above-ground structures, underground utilities and other construction from damage caused by drilling operations. Report any conflicts between drilling work and underground utilities and structures to the Owner's Representative and do not proceed with the work until the conflict is resolved.

1.08 PREINSTALLATION CONFERENCE

- A.** At least 7 days prior to beginning pier installation, the Contractor shall conduct a meeting to review the proposed excavation, inspection, and concrete and reinforcement placement methods and procedures to produce pier construction of the required quality. Also review requirements for submittals, status of coordinating work and availability of materials. Establish work progress schedule and procedures for bearing surface inspection, materials testing, and certifications. The Contractor shall send a pre-installation conference agenda to all attendees 7 days prior to the scheduled date of the conference.

- B. The Contractor shall require responsible representatives of every party who is concerned with the concrete work to attend the conference, including but not limited to the following:

Contractor's Superintendent
Laboratory responsible for field material testing
Drilling Subcontractor
Ready-Mix Concrete Producer
Geotechnical Engineer
Owner's and Architect's/Engineer's Representative

- C. Minutes of the meeting shall be recorded, typed and printed by the Contractor and distributed by him to all parties concerned within 5 days of the meeting. One copy of the minutes shall be transmitted to the following for information purposes:

Owner's Representative
Architect
Engineer-of-Record

- D. The Engineer shall be present at the conference. The Contractor shall notify the Engineer at least 7 days prior to the scheduled date of the conference.

1.09 SUBMITTALS

- A. Concrete Mix Design: Submit concrete mix designs suitable for method of concrete placement for Engineer and Owner's Testing Laboratory approval prior to pier installation.
- B. Drilling Records: The Contractor and the Owner's Geotechnical Engineer or other authorized inspector shall each submit copies of the drilling record for each pier to the Architect/Engineer immediately after drilling. The reports shall indicate the name of the job, name of Contractor, and name of drilling superintendent. For each pier installed, the report shall indicate the following information:
1. Pier number and location
 2. Pier shaft diameter
 3. Bottom elevation
 4. Top elevation
 5. Pier length
 6. Theoretical volume of concrete in pier
 7. Actual volume of concrete placed
 8. Reinforcing steel size and depth actually placed
 9. Drilling start and finish time
 10. Concreting start and finish time
 11. Variation from specified tolerances including surveyed location and plumbness
 12. Construction method (dry method, casing method, or slurry displacement method)

13. Groundwater conditions (rate of water infiltration and depth of water in hole prior to concreting for dry piers; water elevation in hole for wet piers)
14. Elevation of top and bottom of any casing left in place
15. Description of temporary or permanent casing (including purpose, diameter, wall thickness and length)
16. Description and elevation of any obstructions encountered and whether removal was obtained
17. Description of pier bottom including amount and extent of loose material
18. Method of concrete placement
19. Any difficulties encountered in drilling or concreting operations
20. Any deviations from specifications.

For piers founded in rock, also record elevation at which rock was encountered, depth of socket, and record of any rock core samples made.

Reports prepared by the Owner's Geotechnical Engineer or authorized inspector shall be compiled and signed by a licensed professional engineer in the state where the project is located. Reports prepared by the Contractor shall be compiled and signed by the drilling superintendent.

C. Shop Drawings:

1. Reinforcing Steel: Submit shop drawings for all drilled pier and pier cap reinforcing steel.
2. Installation Method: Submit detailed procedures of the installation method, including (where applicable) type and number of drilling rigs and equipment, casing size and length, casing removal method, drilling fluid type, dewatering method, concrete placement, and reinforcing steel securing and placement.

D. Product Data: Submit manufacturer's product data with application and installation instructions for proprietary materials and items.

E. Qualification Data:

1. Submit qualification data for firms and persons specified in the article entitled "Qualifications" to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
2. Submit Welding Procedure Specifications (WPS) in accordance with ANSI/AWS D1.1 for all welded joints in steel casing. Submit test reports showing successful passage of qualification tests for all non-prequalified WPSs.
3. Provide certification that welders to be employed in work have satisfactorily passed AWS qualification tests as specified in section 1.05-B. If recertification of welders is required, retesting will be at Contractor's responsibility.

F. Alternates: The Drilling Contractor shall submit his bid based on the specifications as written without exceptions. He may submit bids for alternates to the specifications or modifications to the

design, load test program, or installation specifications for consideration by the Owner's Representative and the Owner.

- G. Post Construction Survey: After completion of pier placement, the Contractor shall provide the Owner's Representative with an as-built survey showing the actual locations of the piers at the top elevations. This survey shall show the plumbness of vertical piers, and all abandoned piers and their replacements. No construction of superstructures shall commence until this survey has been reviewed and accepted by the Owner's Representative. In order to facilitate the progress of the Work, the Contractor shall submit partial pier surveys for approval as the Work proceeds.

PART 2 PRODUCTS

2.01 CONCRETE

Concrete shall be as specified in the "Cast-in-Place Concrete" section of the specifications, in the general notes, and on the drawings, with the additional requirements specified below:

- A. Maximum Aggregate Size: Provide maximum aggregate size of three quarters of minimum clear spacing between individual reinforcing bars or bundles of bars, with 1 1/2" maximum.
- B. Water Reducing Admixtures: Where required by mix design, use water-reducing admixtures in strict compliance with manufacturers directions. Admixtures to increase cement dispersion, or provide increased workability for low-slump concrete may be used at contractor's option. Use admixtures in the amounts as recommended by manufacturer for climatic conditions prevailing at time of placing concrete. Adjust quantities of admixtures as required to maintain quality control.
- C. Slump Limits: Proportion concrete to have a slump that is suitable for the placement process used. The mix must remain fluid throughout the concrete placement time and during extraction of any temporary casing. Provide a minimum 6" slump concrete with retarder for temporarily cased piers at time of pulling casing.

2.02 REINFORCING STEEL

- A. Reinforcing Steel: ASTM A615, grade 60, refer to Specification Section 03200 for complete requirements.
- B. Reinforcing Support and Positioning Devices: Devices made of non-corrosive material that support and align reinforcing steel within the shaft and that provide the appropriate side and bottom cover to the reinforcing steel. Acceptable manufacturers include:

"Pierresearch"
"Aztec, a Dayton-Superior Company"
"Foundation Technologies, Inc."

2.03 STEEL CASING

- A. Steel casing shall conform to ASTM A 283, Grade C or ASTM A 36.

2.04 GROUT

- A. Grout used for filling annular void outside permanent casings shall be sand cement grout consisting of Portland cement (ASTM C 150 Type I or III), sand (ASTM C 33), and water. Proportions by weight shall be one part cement, 2 1/4 to 2 1/2 parts sand, and the minimum amount of water required to obtain a workable mix but not exceeding a water-cement ratio of 1.0.

The grout mix shall be suitable for the method of installation, whether by gravity feed or by pumping under pressure.

2.05 CONCRETE MIXING

- A. Ready Mix Concrete: Comply with the requirements of ASTM C94.
- B. Hot Weather Concreting: The maximum acceptable concrete temperature at the truck discharge point shall be 95°F. Refer to Hot Weather Concreting Practices specified in "Cast-in-Place Concrete" section of the specifications for required hot weather concreting practices.
- C. Cold Weather Concreting Practices: Refer to the "Cast-in-Place Concrete" section of the specifications for cold weather concreting practices and the conditions under which they are to be followed.

PART 3 EXECUTION

3.01 EXCAVATION

- A. Requirements:
 - 1. Excavate holes for drilled piers to dimensions and required bearing strata or elevations as shown on the drawings unless directed otherwise in the field by the Owner's Geotechnical Engineer.
 - 2. Maintain sidewall stability during drilling. If sidewall instability is encountered that the Owner's Representative considers excessive, the Contractor shall use alternate drilling methods such as temporary casing or slurry displacement method.
 - 3. Excavate holes for closely spaced piers and those occurring in fragile or sand stratas only after adjacent holes are filled with concrete and allowed to set a minimum of 6 hours or longer as required for concrete to harden unless temporary casing to maintain sidewall stability is used.
 - 4. Drilled pier design dimensions and depths shown on the drawings shall be considered minimums and are based on bearing and/or friction in assumed strata. If bearing stratum is not capable of maintaining the assumed capacity, the foundation system shall be revised as directed by the Owner's Geotechnical Engineer and Owner's Representative. Revisions will be paid for in accordance with contract conditions relative to changes in the work. Refer to drawings for design bearing pressures, skin friction values, or pier load capacity.
 - 5. Remove loose material and free water from the bottom of the shaft. The bearing surface should be essentially flat within a tolerance of 1 vertical to 12 horizontal or with one step that is less than one-quarter of the diameter of the bearing area.
- B. Equipment:
 - 1. Provide adequate equipment so work is expedited to the fullest extent possible. Use equipment fully capable of excavating shafts to depths, diameters, and sizes indicated, and within the specified tolerances. Maintain equipment in satisfactory operating condition and provide sufficient quantity of equipment to maintain the projected schedule of the Work.

2. Using bits or augers with a power-driven rotary-type rig, a shaft of a diameter specified on the drawings shall be excavated from the ground surface to a depth as specified on the drawings or as ordered by the Owner's Geotechnical Engineer.

C. Obstructions:

1. If rocks, boulders, or other unforeseen obstructions are encountered which cannot be removed by standard drilled pier excavation methods, and if such obstructions are not indicated by available sub-surface data, removal of such obstructions will be paid for in accordance with the terms of the Contract relative to changes in the Work.
2. Remove such obstructions by hand labor using air-powered tools or by other safe methods recognized in the construction industry. Standard drilled pier excavation methods include the use of core barrels with pier drilling equipment.
3. The work of this Section includes demolition and removal of rock, boulders, concrete, masonry, and other subsurface obstructions that are indicated by the Contract Documents, or by the available subsurface exploration data, and such work will not be considered a change in the Work.

- D. Overexcavation: No payment will be made for extra length or greater diameter of drilled piers when they are installed to a greater depth or are larger than required unless authorized by the Owner's Geotechnical Engineer. Overexcavated drilled piers will be measured and paid for in accordance with the original design or authorized design depth and diameter.

E. Excavated Material:

1. Deposit and spread excavated material on site observing proper placement and compaction requirements.

3.02 DEWATERING

- A. Provide and maintain pumping equipment to keep excavations free of water before placing concrete. An excavation is considered dry if the water rises at a rate of less than 1/4 inch per minute and the height of water at the bottom of the pier does not exceed two inches at the time of concrete placement.
- B. Dewater in a manner that will not create subsidence or ground loss that might adversely affect the Work or existing adjacent structures. Should the dewatering system employed involve pumping inside the pier, extreme caution shall be used to prevent an unbalanced water head from causing a "blowout", bottom heave, or "quick" condition that could disturb the proposed bearing stratum or surrounding soil strata.
- C. The dewatering method shall be submitted for review and approval of the Owner's Geotechnical Engineer.
- D. Conduct water to general site run-off ditches and disposal areas with discharge lines. Provide ditching as required to conduct water to site drainage facilities.
- E. If excessive water and/or sidewall instability is encountered and drilling operations must be halted, consult with Geotechnical Engineer and Owner's Representative before using alternate methods of construction.

3.03 TEMPORARY STEEL CASINGS

A. Requirements:

1. Provide temporary casing at locations as directed by the Geotechnical Engineer where the soil will not stand without support or where sloughing of the sides of shafts may seriously delay or endanger the satisfactory completion of excavation and placement of concrete. Also provide temporary casing at locations as directed by the Geotechnical Engineer to seal off the inflow of water into the excavation.
2. The Contractor shall have immediately available for use on the job an ample supply of casing for each size that will be required for use in the shafts and shall provide additional amounts, as required, to ensure the orderly progress of the job.
3. Such casing may be in short pieces but with jointing devices of sufficient strength that assembled sections of casing may be pulled complete as concrete is placed, or immediately thereafter. Provide casing of sufficient strength to withstand handling stresses, concrete pressure, and surrounding earth and/or fluid pressures. Make diameter of excavation in relation to diameter of casing such as to create a minimum of void space outside of casing. Provide casing with a minimum outside diameter equal to normal outside diameter of drilled foundations.

B. Delivery, Handling, and Storage of Casing

1. Deliver casing to site in undamaged condition.
2. Handle and protect casing to maintain diameter within plus or minus two percent.

- C. Casing Withdrawal: Unless otherwise approved by the Owner's Representative, all temporary casing shall be removed from shafts as concrete is placed or immediately thereafter, and in such a manner as to prevent sloughing material from dropping to the bottoms of shafts or falling on top of freshly placed concrete. Casings shall be pulled in a single continuous smooth operation without sudden jerks or impact. Maintain head of concrete above the bottom of the casing that exceeds the soil and water pressure at all times during casing withdrawal. Do not vibrate concrete internally before the casing is withdrawn. A vibratory casing extractor may be used. Do not withdraw casing after the concrete has attained initial set. The casing withdrawal and concreting operations shall be observed by the Geotechnical Engineer.

3.04 DRILLED PIERS IN ROCK

- A. Requirement: Provide drilled piers socketed into rock as shown on the drawings or as directed by the Owner's Geotechnical Engineer.
- B. Classification of Rock: Rock is defined as material which cannot be drilled with a conventional earth auger or underreaming tool, and requires use of special rock augers, core barrels, air tools, blasting, or other methods of hand excavation. Earth seams, rock fragments, and voids included in rock excavation area will be considered rock for full volume of shaft from initial contact with rock for pay purposes. The work of this section includes demolition and removal of rock, boulders, concrete, masonry, and other subsurface obstructions that are clearly indicated by contract documents, or by available subsurface exploration data, and such work will not be considered a change in work.

3.05 REINFORCING STEEL PLACEMENT

- A. Before placing, clean reinforcing steel and dowels of loose rust, scale, dirt, grease and other material that could reduce or destroy bond.

- B. Fabricate and erect reinforcing cages in shafts as one continuous unit using inner ring reinforcing guide. Place reinforcement accurately and symmetrically about axis of hole and hold securely in position during concrete placement. The Contractor shall verify depths of drilled piers prior to cutting and tying reinforcing steel cages. Reinforcing steel shall be delivered to the site in standard 60-foot lengths and cut as required. Splice no more than 33% of the bars at any one location, alternating spliced and unspliced bars in a symmetrical pattern. Splices shall be 30 bar diameter compression splices for bars #11 and smaller and mechanical end bearing compression splices for #14 and #18 bars unless noted otherwise on the drawings. See drawings for additional splice information. The Contractor shall be responsible for adding additional reinforcing steel ties or spirals as required to ensure stability of cage and maintenance of shape and configuration as required for proper lifting, handling, and placement.
- C. Provide cover to reinforcing steel of not less than 3 inches where exposed to soil and not less than 4 inches in temporarily cased piers. Provide spacer devices to maintain side and bottom cover. Devices shall be installed in accordance with manufacturer's instructions.
- D. Permissible reinforcing steel upward vertical movement during casing withdrawal shall be no greater than 6 inches. Downward movement should not exceed 6 inches for every 20 feet of shaft length.
- E. Use templates to set anchor bolts, leveling plates and other accessories furnished under work of other sections. A qualified and licensed Engineer/Land Surveyor shall determine the plan location and elevation of such devices. Provide spacers (capable of sliding on any temporary casings required), blocking and holding devices to maintain required position during concrete placement.
- F. The General Contractor shall protect exposed ends of dowels and anchor bolts from mechanical damage and exposure to weather by wrapping and taping with polyethylene or other suitable material.
- G. Provide additional pier ties as required to facilitate pier cage lifting, erection and placement.

3.06 CONCRETE PLACEMENT

- A. General:
 - 1. Fill drilled piers with concrete immediately after inspection and approval by the Geotechnical Engineer or other authorized inspector. Use protection sheets (cut out to receive concrete) over excavation openings, extending at least 12" beyond edge. Complete the excavation and concrete placement in uncased excavations before the end of the workday unless the Architect/Engineer and Geotechnical Engineer grants permission to do otherwise in writing.
 - 2. Place concrete continuously and in a smooth flow without segregating the mixed materials.
 - 3. Place concrete by means of bottom discharge bucket, flexible drop chute, elephant trunk hopper, concrete pump, or tremie. Free fall of concrete may be used if provided for in concrete mix design and provided it is directed through a hopper or chute such that fall is down center of shaft without hitting sides or reinforcing steel. Free fall of concrete is not permitted for depths greater than the smaller of 20 times the shaft diameter or 60 feet.
 - 4. Place concrete in-the-dry if at all possible. If water occurs, and it is impracticable to dewater drilled pier excavation, and reasonable attempts to seal off water flow have failed, allow water level to attain its normal level and place concrete by tremie method or by concrete pumping. Other methods of depositing concrete underwater may only be used if approved by Architect/Engineer.

5. Stop concrete placement at cut-off elevation shown, screed level, and apply a scoured, rough finish. Where cut-off elevation is above ground elevation, form top section above grade and extend shaft to required elevation.
6. Provide mechanical vibration for consolidation of at least top 5' of each shaft but only after any temporary casing is pulled or when casing is permanent.
7. Interrupted placing operations of over one hour duration will require a cold joint installation as follows. Leave resulting shaft surface approximately level. At resumption of concrete placing, clean off surface laitance, roughen as required, and slush with a 1-to-1 cement grout or commercial bonding agent before remainder of concrete is placed. Intentional cold joints will not be permitted.
8. Concrete shall not be placed in adjacent drilled piers located within three center-to-center shaft diameters of each other until concrete has cured a minimum of 6 hours.
9. Aluminum pipe or equipment shall not be used for placing concrete.

B. Tremie Method:

1. The drilled shafts shall be filled with concrete by the use of a tremie or concrete pump, sealed at the bottom, extending from above the ground surface to the bottom of the drilled shaft. Inspection of the empty tremie on the bottom may be requested of the Contractor by the Owner's authorized inspector. With the sealed tremie on the bottom of the shaft, the tube shall be filled to the top extending above the ground. The filled tremie shall be picked up approximately one (1) foot off the bottom of the shaft to allow the weight of the concrete to displace the seal at the bottom of the tremie. At no time is the tremie to be pulled to such a height as to clear the surface of the concrete already placed in the shaft. All concrete shall be poured through the now open tremie with care taken to maintain a sufficient head of concrete to completely displace all water and suspended cuttings of material and to provide sufficient pressure so as to prevent reduction in pile diameter by earth pressure on the fresh concrete. The concrete in each pile shall be carried above cut-off elevation and then dipped out while fresh to cut-off elevation.
2. All concrete shall be deposited through the tremie or pumpline so as to provide a continuous flow, without aggregate segregation, from bottom to top of pile. The production and delivery of the ready-mixed concrete shall be such that not more than 45 minutes shall elapse between the depositing of successive batches of concrete to ensure a monolithic unit of concrete. No deviation from this method will be acceptable.
3. Should the surface of the concrete in the shaft be breached by the tremie or pumpline, the tube shall immediately be withdrawn from the hole, re-sealed and re-lowered below the surface of the concrete, and pouring operations re-started. Should the Owner's authorized inspector deem it necessary, the Contractor shall instead retrieve the reinforcing steel cage, redrill the shaft to reopen the hole, and begin the concreting operations from the bottom of the pier shaft.
4. If the Owner's authorized inspector has reason to suspect that the concrete was breached by the tremie or pumpline or that the pier, for any other reason, may contain extraneous material or otherwise fail the specifications, he may order the pier cored for inspection and/or testing. If the core recovery and/or test results indicate non-compliance with the specifications, the Contractor shall bear the expense of the investigation and/or testing and shall also, at no cost to the Owner, install proper additional construction as required by the Architect/Engineer. Should the investigation and/or testing indicate compliance with the specifications the Owner shall bear the cost of such investigation and/or testing.

C. Hot and Cold Weather Placement: Refer to Part II.

3.07 SLURRY DISPLACEMENT METHOD

A. General:

1. The slurry displacement method of construction may be employed only if approved by the Geotechnical Engineer. The excavation shall be carried to final depth with the hole stabilized using drilling fluid of a minimum density acceptable to the Geotechnical Engineer. The drilling fluid may be reused, but it shall be treated, if necessary, to remove the granular material that is in suspension. Care shall be taken in the drilling to avoid caving or sloughing. The bottom of the hole shall be cleaned with a clean-out bucket or other appropriate tool. Type and proposed density of drilling fluid shall be submitted for approval by the Owner's Geotechnical Engineer.
2. Each finished shaft shall consist of a continuous column of concrete extending from the required top elevation to the required bearing surface, having firm contact against the vertical and horizontal surface of the earth surrounding it.
3. Shaft drilling and concrete placement shall be sequenced to prevent damage to adjacent shaft or shaft excavations.

B. Definitions

1. Slurry displacement method (SDM): Drilling, concreting, or drilling and concreting where slurry is used to stabilize the hole. The slurry may be used (a) for the maintenance of the stability of the unlined drilled shaft element; (b) to assist the drilling or insertion of casing as part of the shaft construction; or (c) to allow acceptable concrete placement when water seepage into a drilled shaft is too severe to permit concreting in the "dry."
2. Slurry or drilling fluid - water or prepared drilling mud properly mixed with water. The drilling fluid shall be treated as necessary to conform to the requirements given in Table 1.
3. Mud - pulverized solids used as the basic ingredient for making a water-based slurry.

C. Excavation

1. Shaft excavation shall be to the elevations and to the diameters shown on the Engineer's drawings. Bottom elevations are minimum depths. Shafts may be extended only at the approval of the Geotechnical Engineer.
2. Use methods and equipment for shaft excavation that leave the side of the hole and bottom free of loose material that would prevent intimate contact of the concrete with firm, undisturbed soil or rock. If loose or unacceptable material is present, reclean the hole to the satisfaction of the Geotechnical Engineer.
3. Use drilling tools and excavation procedures that minimize excessive negative pressure and avoid disturbance of the surrounding material in the excavations. Raise and lower the drilling tool in the hole at a rate that does not swirl the slurry and affect the stability of the hole.
4. At the completion of excavation and again before the start of concrete placement, clean the drilled-shaft bottom with an air-lift or recirculation system or a cleanout bucket equipped with a one-way flap gate that prevents spoils in the bucket from reentering the shaft.

5. For piers designed without end bearing, the accumulated sediment at the bottom of the pier, measured by sounding with a weighted tape just prior to concreting, shall be less than 6 inches. If greater, reclean the hole to the satisfaction of the Geotechnical Engineer.
6. All spoil and excavated materials shall be kept away from each open shaft excavation to avoid contamination of the excavation after final cleanup.
7. Excavated materials shall be stockpiled or disposed of in areas designated by the Owner's representative.
8. Excavated materials temporarily placed at other locations for the convenience of the Contractor will be allowed only with written approval of the Owner's representative and shall finally be removed and placed within designated disposal areas.

D. PROVISIONS FOR OBSERVATION

1. The Contractor shall cooperate with the Owner and design team to ensure the expeditious and safe observation of the shaft excavations.
2. If the Geotechnical Engineer determines that the material at the bottom of any excavation is unsatisfactory, additional excavation or other corrective action shall be made as directed by the Geotechnical Engineer.
3. If additional excavation is required, the shaft bottom shall be drilled again and observed as described above. This procedure shall be repeated until a bearing material is reached that is approved by the Geotechnical Engineer.

E. SLURRY REQUIREMENTS

1. The mud slurry shall consist of a stable colloidal suspension of pulverized solids thoroughly mixed with water so that the properties specified in Table 1 are maintained. Attapulgite and bentonite shall meet API Specification 13A, Section 3, "Oil-Well Drilling-Fluid Material" dated March 1981. The type of mud used will depend on the subsurface conditions and mixing water character. The water used to mix the slurry shall be clean, drinkable, fresh water, obtained from sources approved by the Owner's Representative. Any physical or chemical treatment to the water or slurry that is considered necessary to have the slurry meet the specifications is the responsibility of the drilled shaft contractor. A written certificate shall be supplied to the Architect/Engineer by the mud supplier specifying the quality and yield for each shipment of mud received. A test report from the supplier giving the physical and chemical properties of the mud shall be supplied to the Architect/Engineer at the start of the work.
2. Water may be used in place of mixed mud slurry, subject to the approval of the Geotechnical Engineer on a pier-by-pier basis except for end bearing piers.
3. For shafts with endbearing greater than or equal to 25% of the total allowable capacity as shown on the structural drawings, the mud slurry sand content shall be limited to 4%.
4. The mud slurry shall be mixed in mud tanks on-site or arrive at the site premixed. The mud slurry shall be mixed, stored, and transported using equipment made for these purposes. Combining or mixing slurry in the shaft shall be not permitted.
5. The in-hole slurry shall meet the specifications prior to concreting. Replace or clean, recirculate, and remove sand from, the slurry to maintain the required slurry properties. Recycling of slurry is permitted provided that the recycled slurry satisfies the specified requirements. Submit to the Owner's Representative a written record of test results for each drilled pier.

6. The Contractor shall perform testing of the slurry according to the test methods prescribed in Table 1 and shall record the results for quality control purposes. Provide all field test equipment as required. The drilled-pier contractor shall have available at the site a slurry sampler capable of obtaining slurry samples at any depth within the drilled pier excavation. Slurry shall be sampled and tested in the mud tank and from samples recovered within 1 ft. from the bottom of each drilled shaft.

TABLE 1
SLURRY SPECIFICATIONS

<u>Item to be Measured</u>	<u>Range of Results at 20°C</u>	<u>Test Method</u>
Density, (pcf)** For slurry 1 ft from pier bottom		ASTM D 4380 (Mud Balance)
Mineral Slurries		
a. No end bearing	85 Max.	
b. With end bearing	70 Max.	
Polymer Slurry	64 Max.	
Marsh Funnel Viscosity, (sec./qt)		API-RP13B-1* Section 2 (Marsh funnel & CUP)
a. Mineral Slurry	25 to 60	
b. Polymer Slurry	40 to 90	
Sand Content by Volume (%), before concreting, for slurry 1 ft from pier bottom		ASTM D 4381 (Sand screen set)
Mineral Slurries		
a. No end bearing	20 Max.	
b. With end bearing	4 Max.	
Polymer Slurry	1 Max.	
pH, during excavation	7 to 12	ASTM D 4972

* Reference Test Method is American Petroleum Institute (API), Spec. 13B, Eighth Edition, April 1980, issued by American Petroleum Institute - Production Department - 211 N. Ervay, Suite 1700, Dallas, Texas 75201.

** The density of the mud slurry shall not be less than what is needed to drill the shaft.

F. Installation Method

1. Where pre-drilled piers are to be installed below the groundwater level or in caving and sloughing soils, and the procedure is approved by the Geotechnical Engineer and the Owner's Representative, use a premixed mud slurry to stabilize the excavation. Maintain the slurry level in the excavation above any unstable zones a sufficient distance to prevent caving or sloughing of those zones but no less than 5 feet above the groundwater level.
2. Set temporary surface casing to contain the slurry, unless waived by the Owner's Representative.

G. Concreting Method

1. Concreting of the drilled pier shall be completed the same day that the excavation is complete. If this is not possible, the excavation will be required to be redrilled, cleaned, and slurry tested before concreting.
2. Place concrete by tremie method or by pumping. Use tremie or pump pipes made of steel and with watertight joints. Use tremie pipe with a minimum diameter of 8 inches or pump pipe with a minimum diameter of 4 inches.
3. Use a capped or pig-plugged tremie or pump pipe inserted and seated in the excavation at the bottom of the pier prior to commencement of the concrete placement.
4. If a capped pipe is used, use tremie or pump pipe with a seal consisting of a bottom plate, or a device acceptable to the Geotechnical Engineer, that seals the bottom of the pipe until the pipe reaches the hole bottom. Place enough concrete in the pipe to prevent the flow of slurry into the tremie pipe when it is lifted off the bottom.
5. If a pig is used, set the open tremie pipe loosely on the bottom. Insert the pig at the top and then place concrete pushing the pig ahead, separating the concrete from the slurry. Take care to ensure that the pig is properly sized to fit in the pipe, and keep the concrete separate from the slurry so that all slurry is expelled from the pipe during the initial charging process. When the pipe is fully filled with concrete, lift the pipe off the bottom the minimum amount needed to start the concrete flowing. Once concrete flow has started, place concrete into tremie at a fast enough rate to maintain a positive head of concrete inside pipe relative to slurry level outside pipe.
6. Embed tremie or pump pipe sufficiently in concrete to maintain seal throughout concrete placement to prevent re-entry of slurry suspension into the pipe. Provide minimum embedment of 5 feet. If the seal is lost, withdraw pipe, replace the seal, and re-start tremie using a capped tremie or capped pump pipe.
7. Displace out of the pier or remove from the pier the first portion of concrete that comes to the top of the pier that contains concrete contaminated with slurry until acceptable concrete is visible. Add or remove concrete to specified cutoff level.
8. Raise or lower the tremie pipe in an acceptable manner that does not break the seal and does not cause channelization or segregation.
9. Pump the displaced slurry to holding tanks. Do not allow slurry to spill onto or contaminate the site. Do not use excavated slurry pits, unless accepted by the Owner's Representative.
10. Do not use aluminum pipe or equivalent for placing concrete.

11. Measure and report actual volume of concrete placed and theoretical volume versus depth at depth intervals not exceeding the shaft diameter.

3.08 CONSTRUCTION TOLERANCES

- A. Plan Location: The tolerance on plan location for the top of the drilled pier shall not be more than 1/24 of the pier diameter or 3" in any direction, whichever is less. If the as-installed shaft is larger than required, the center of the shaft may be taken as the center of a shaft having the required area that lies wholly within the as-installed shaft.
- B. Plumbness: Permissible tolerance for plumbness shall be 1.5% of the length. The centers of the top and bottom may be taken as the center of the required area that lies wholly within the as-installed area.
- C. Bottom Area: The bottom of the pier shall be essentially horizontal within a tolerance of 1 vertical to 12 horizontal with the area of the bottom bearing not less than 98% of that specified on the drawings.
- D. Top Area: The Contractor shall remove excess concrete at the top of the pier beyond the limits of the pier diameter. The pier top diameter shall be the same diameter as the shaft below. Piers extending above the ground surface shall be formed.
- E. Concrete Cut-Off Elevation: Concrete cut-off elevation at the pier top shall be plus one inch to minus three inches.
- F. Battered Piers: Battered piers shall be installed within 5% of the length from the specified inclination.
- G. Anchorage Embedment Tolerance: Vertical and horizontal deviation from design location for individual anchorage components embedded in the pier shall not exceed ± 0.5 inches.
- H. If any of the above tolerances are exceeded, the Architect/Engineer shall immediately be notified to evaluate the eccentricity in the pier and recommend corrective measures. The cost of re-engineering and corrective construction shall be borne by the Contractor.

3.09 INSPECTIONS AND TESTS FOR DRILLED PIER EXCAVATIONS

- A. Verification of Design: Bottom elevations, bearing and/or skin friction capacities and lengths of drilled piers as shown on the drawings are estimated from available subsurface data. Actual elevations, pier lengths, and bearing and/or skin friction capacities will be determined by the Geotechnical Engineer from conditions found in the excavations.

For piers bearing on rock, a rock core shall be taken for a depth equal to one pier diameter below the bottom of the pier for observation and possible testing by the Geotechnical Engineer to confirm rock quality below the bearing elevation.

- B. Notification of Architect/Engineer: If field conditions differ from the data and design recommendations outlined in the Geotechnical Report, the Geotechnical Engineer shall notify the Architect/Engineer immediately.
- C. Additional Tests: Additional tests may be required by the Geotechnical Engineer to determine new design criteria. Such tests shall be made as quickly as possible so as not to delay the concreting operations any longer than absolutely required.

- D. Observation Requirements: Each drilled pier shall be inspected by the authorized inspector and approved prior to placement of concrete.
- E. Cooperation with Testing and Inspection Personnel: The Contractor shall provide facilities as required to assist in the inspection and testing of the excavations, and cooperate with the inspecting and testing personnel to expedite the work.
- F. Notification of Observer: The Contractor shall notify the authorized observer at least twelve hours prior to the time the excavation will be ready for inspection. Drilled shaft installation shall not proceed without the authorized observer on site.
- G. Personnel Safety: The Contractor shall provide gas testing equipment, protective cage, or temporary casing or shoring of proper diameter, length, and thickness, and all other safety equipment required by law for inspection and testing of drilled piers and to protect workmen and inspectors during hand belling or other operations necessitating entry into shaft.

3.10 APPROVAL BY THE GEOTECHNICAL ENGINEER

- A. Approval by the Owner's Geotechnical Engineer is required on all pier installation criteria and his decision and judgment on pier length, rejection of piers, additional piers required, and all other pier installation and capacity questions shall be final.

3.11 CONTRACT BASIS

- A. Basis of Bids: Bids shall be based on number of drilled piers, design length from top elevation to bottom of shaft and diameter of shaft, as shown on drawings. The bid price shall include cost for temporary casing of excavation that may be required.
- B. Basis for Payment: Payment for drilled piers will be made on actual net volume of drilled piers in place and accepted. The actual length and shaft diameter may vary to coincide with elevation where satisfactory bearing or friction strata is encountered, and with actual bearing value of bearing strata determined by testing services, and with stability and characteristics of soil strata. Adjustments will be made on net variation of total quantities, based on design dimensions for shafts.
 - 1. There will be no additional compensation for excavation, concrete fill, reinforcing, casings, or other costs due to unauthorized overexcavating shafts. Overexcavated piers will be measured and paid for in accordance with required design or authorized depth. No payment will be made for rejected drilled piers.
 - 2. Prices quoted shall include full compensation for labor, temporary casing, materials, tools, equipment, and incidentals required for excavation, trimming, shoring, casings, dewatering, reinforcement, concrete, and other items for complete installation.
- C. Unit Prices: Unit prices for the following items, as set forth in contract conditions, will apply in event additions to or deductions from work are required and authorized by written order from Architect/Engineer to Contractor.

Soil excavation (including temporary casing if required)	per cu. yd.
Soil excavation by slurry method	per cu. yd.
Rock excavation	per cu. yd.
Permanent steel casings, installed	per lin. ft.
Reinforcing steel and dowels, installed	per lb.
Concrete	per cu. yd.

END OF SECTION

SECTION 32 13 13

CONCRETE PAVING

PART 1 - GENERAL

1.01 RELATED CONDITIONS

- A. Provisions established within the 00 72 00 General Conditions, the 00 73 00 Supplementary Conditions, the General Requirements (Sections of Division 1) and the Drawings are hereby made a part of this Section.

1.02 SCOPE

- A. This Section includes labor, material, equipment and related services necessary to furnish and install paving, including sidewalks, and surfacing indicated on the Drawings or specified herein.

1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. Subgrade Preparation - Section 31 22 00, Grading.
- B. Drainage Items - Section 33 40 00, Storm Drainage Utilities.
- C. Concrete - Section 32 13 13, Cast-in-Place Concrete.

1.04 REFERENCE STANDARDS

- A. Meet requirements and recommendations of applicable portions of the Standards listed:
 - 1. City Standard Details and Specifications.
 - 2. North Central Texas Council of Governments (COG) Standard Specifications for Public Works Construction, Current Edition and Amendments.
 - 3. Texas Highway Department Standard Specification for Construction of Highways, Streets and Bridges, 1995 (THD).
 - 4. American Association of State Highway and Transportation Officials (AASHTO).
 - 5. American Water Works Associations (AWWA), Current Editions.
 - 6. American Society for Testing and Materials (ASTM), Current Edition.
- B. Any reference to methods of measurement or payment in reference specifications are not applicable. In event of conflict this specification applies.

1.05 MINIMUM REQUIREMENTS

- A. Referenced tests, material standards and specification are minimum requirements.

1.06 SOURCE LOCATIONS

- A. Identify location of sources of each required material and of batching plant and ready-mix (if applicable).

1.07 SUBMITTALS

- A. Submit Test Reports, Product Data, Mix Design etc. to the Engineer.
- B. PRODUCT DATA
 - 1. Submit material source and ready-mix plant location(s) for approval.
 - 2. Submit type and size of equipment to be used for each required operation.
 - 3. Submit test panels for exposed aggregate surfaces.
- C. CONCRETE TEST REPORTS AND MIX DESIGNS
 - 1. As specified in Section 03 30 00.
- D. DELIVERY TICKETS
 - 1. As specified in Section 03 30 00.

PART 2 - PRODUCTS

2.01 PORTLAND CEMENT

- A. Portland cement shall be Type 1 of a standard brand of cement and shall conform to the applicable provisions of Texas Highway Department Standard Specification, Item 360, "Concrete Pavement."

2.02 AGGREGATES FOR CONCRETE

- A. Shall be considered as either fine or coarse and shall meet the requirements of the City Standard Specification.

2.03 CONCRETE

- A. Shall be composed of Portland cement, coarse aggregate, fine aggregate, water, mineral filler and/or admixtures if permitted by the Engineer. Concrete shall have a minimum compressive strength, at 28 days, of not less than 3500 psi (or as noted on the plans) 5" concrete thickness and not less than 3500 psi (or as noted on the plans) for 6" concrete thickness, and a slump from 3 to 5". Measuring materials, batching, and mixing shall conform to ASTM C94. Air entrainment shall be between 5% and 7%.

2.04 REINFORCING STEEL

- A. Shall conform to ASTM A615, Grade 40 or 60.

2.05 CONCRETE CURBS/GUTTERS

- A. Conform to requirements of City Standard Specification.

2.06 CONCRETE WALKS

- A. Conform to requirements of City Standard Specification.

2.07 PAVING EXPANSION JOINTS

- A. Hot poured elastic type sealant, ASTM D1190, over bituminous non-extruding, impregnated cane fiber board, ASTM D1751. Thickness as indicated for exterior concrete paving and slabs.

2.08 SIDEWALK EXPANSION JOINTS

- A. Pourable to component synthetic polymer type sealant, ASTM D1850, over ethafoam joint material (foamed polyethylene) by Dow Chemical Co., Midland, Michigan. Make minimum of 1/2" deep or as detailed.

2.09 POLYVINYL CHLORIDE PIPE (PVC) PIPE

- A. PVC pipe shall be Schedule 40 and shall conform to commercial standard CS 256-63. PVC compounds are restricted to PVC 1120 and PVC 1220.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine the areas and conditions under which paving and surfacing operations are to be performed. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.02 COORDINATION

- A. Coordinate paving and surfacing operations to protect both existing and new concurrent construction.

3.03 ALIGNMENT AND GRADE STAKES

- A. Provide necessary alignment and grade stakes to do work. Set stakes at maximum intervals of

50' for roads, walks, or parking aisles (gutters and crown) and every 2500 square feet for parking areas, and at spot elevations shown on drawings.

3.04 SUBGRADE VERIFICATION/PREPARATION FOR CONCRETE PAVING

- A. Recompact the upper six inches of the subgrade as specified in Section 31 22 13 and prepare the subgrade for paving. The subgrade is defined as that portion of the roadbed upon which the paving or base is to be placed. The subgrade shall be finished to the lines, grades and section shown on the Drawings. All soft, yielding material, clods or other material shall be removed and replaced with suitable material or the condition otherwise satisfactory corrected.

3.05 COMPACTION DENSITY

- A. Compact subbases under paving as specified in Section 31 20 00 – Earth Moving, and on the grading plans

3.06 COMPACTION EQUIPMENT

- A. Comply with the following minimum requirements.
 - 1. Tamping Roller - 200 psi per tamper foot.
 - 2. Pneumatic Tire Roller - 150 to 250 lbs. Per inch of overall width.
 - 3. Steel Wheeled Roller - 8 tons total weight.
 - 4. Vibratory Compactor - as approved.

3.07 CONCRETE – GENERAL

- A. Conform to applicable requirements City Standard Specifications, except as otherwise specified herein.
- B. Excavate, shape and compact subgrade for suitable bearing surface. Remove any unacceptable material. Remove roots occurring within 12" or nearest concrete surface. Fill depressions with acceptable material and compact.
- C. Provide suitable forms of metal, wood or as approved to contain concrete to indicated line, grade and shape until set. Provide face forms for curb and other section free of defects and conforming to indicating shapes. Provide side forms to full depth of concrete. Use approved flexible forms or curved forms of proper radius on curves having a radius of 150' or less.
- D. Coat forms with form treating material prior to placing concrete to prevent concrete damage during form removal.
- E. Concrete Mixing
 - 1. ACI 301, Chapter 7, ready-mixed unless Engineer gives permission to site mix.
- F. Concrete Placing
 - 1. Place construction and control joints as indicated on Drawings and as specified.
 - 2. Immediately before concrete placement, thoroughly wet moisture absorbing material that will be in contact with the concrete.
 - 3. Place concrete in forms without segregation. Vibrate to remove voids. Strike off concrete and float smooth.
 - 4. Do not place concrete as specified.
 - 5. Finish concrete as specified.
 - 6. Place backfill using required material as soon as possible without damaging concrete.
 - 7. Repair or remove and replace damaged concrete as directed. Conform to ACI 301, Chapter 9.
- G. Curing
 - 1. ACI 301, Section 5 use waterproof sheet materials or liquid membrane.

3.08 CONCRETE CURB AND GUTTER (NOT USED)

3.09 CURB/GUTTER MACHINE PLACEMENT (NOT USED)

3.10 ON GRADE CONCRETE

- A. Conform to the City Standard Specification.
- B. The contractor may use a mix design currently being used on any City project which meet these Specifications.
- C. Place expansion joints as indicated on Drawings. In addition, place where concrete surrounds or adjoins any existing fixed objects such as fire hydrants, columns, building foundations, and other rigid structures.
- D. Maximum Allowable Deviation of Formed Edges from Indicated Location: 1/2". Maximum Allowable Deviation of Surface: 1/4" when checked with a ten foot straight edge. Remove to nearest joint and replace any walk or slab exceeding stated deviations.
- E. Slope walks and slabs away from buildings as indicated but not less than 1/8" per foot. Maintain design drainage grades to avoid low spots trapping water.
- F. After water sheen has disappeared, lightly brush surface to a uniform texture unless otherwise indicated or directed. Edge joints to provide a smooth border around each panel.

3.11 FINISHES

Exposed aggregate finish.

- A. Float surfaces to required lines and grades.
- B. Wash aggregate prior to placing. While concrete is still plastic broadcast moistened finish aggregate uniformly over surface to depth of single stone.
- C. Roll surfaces to fully embed aggregate.
- D. Wash and brush surfaces to remove overlying cement matrix and expose aggregate. Use chemical retarder if required to extend working time.
- E. Match approved mock up.

3.12 CONCRETE TESTING

- A. Slump and compression cylinders as specified under Section 03 30 00.

3.13 CONDUITS

- A. PVC piping shall be installed a minimum depth of 24" below the final paving grade at the locations shown on the Drawings. PVC conduit shall be as detailed on the Drawings. All backfill shall be compacted to 95% Standard Proctor Density.

3.14 CLEANING UP

- A. Upon completion of the Work, clean up work areas by removing debris, surplus material and equipment from the Site. Paved surfaces shall be swept clean and curbs shall be backfilled.

3.15 GUARANTEE

- A. The Contractor shall furnish, at no cost to the Owner, a one year guarantee on paving, which shall cover defects in materials and workmanship, and shall cover repair and maintenance during the building construction period. The guarantee shall be one year from the final acceptance of the pavement by the Owner.

END OF SECTION

SECTION 33 10 00

WATER UTILITIES

PART 1 - GENERAL

1.01 RELATED CONDITIONS

- A. Provisions established within the 00 72 00 General Conditions and 00 73 00 Supplementary Conditions, Division 1 - General Requirements, and the Drawings are collectively applicable to this Section.

1.02 SCOPE RELATED CONDITIONS: Work included in this section, while not all inclusive but listed as a guide, shall include:

- A. Furnishing all labor, tools, materials, and incidentals required to complete the work.
- B. Installation of water mains, service lines, appurtenances and connections to existing system.
- C. Testing and sterilization of water system.
- D. Clean up.

1.03 STANDARDS

- A. Standards will as a minimum meet the requirements and recommendations of applicable portions of the standards listed. See Section 01 01 42 19 Reference Standards.
- B. Meet requirements and recommendations of applicable portions of the Standards listed:
 - 1. City Standard Details and Specifications.
 - 2. North Central Texas Council of Governments (COG) Standard Specifications for Public Works Construction, Current Edition and Amendments.
 - 3. Texas Highway Department Standard Specification for Construction of Highways, Streets and Bridges, 1995 (THD).
 - 4. American Association of State Highway and Transportation Officials (AASHTO).
 - 5. American Water Works Associations (AWWA), Current Editions.
 - 6. American Society for Testing and Materials (ASTM), Current Edition.

PART 2 - MATERIALS

2.01 All materials shall conform to City specifications.

PART 3 - EXECUTION

3.01 GENERAL: The Contractor shall comply with all requirements of the City's Public Works Department Standards and Specifications regarding materials and installation of work specified herein.

3.02 EXCAVATION: The Contractor shall excavate all materials encountered regardless of the difficulties encountered. The ditch shall be no greater in width or depth than is necessary to permit construction in accordance with the Plans and these Specifications. The maximum width of trench at top of pipe without sheeting, shoring and bracing shall be not more than the external diameter of pipe plus 16 inches.

The Contractor shall determine the need for sheeting and bracing to safeguard the workmen. When sheeting and bracing are necessary the trench or excavation shall be dug to such width that proper allowance is made for the space occupied by the sheeting. All sheeting, shoring and bracing shall have sufficient strength and rigidity to withstand the pressure exerted and protect all persons or property from injury or damage. Sheeting, shoring and bracing endanger new or existing structures.

All holes or voids left by the removal of sheeting shall be backfilled.

Soft, spongy or otherwise unstable materials which will not provide a firm foundation for the pipe shall be removed and replaced to the extent required by the City or Civil Engineer.

The material thus removed shall be replaced with suitable selected material from the excavation or other sources approved by the City or Civil Engineer, and shall be compacted as proved in these Specifications. When unstable conditions are not corrected by the above means, the Contractor shall be required to use crushed rock, gravel or concrete foundations. The type of foundation shall be determined by the City or Civil Engineer. There will be no extra compensation for this work.

- 3.03 BEDDING:** The bedding for pipe shall provide a firm foundation of uniform density throughout the entire length of the pipe. Recesses for bells of the pipe shall be excavated for every joint and shall be of sufficient size and depth to relieve the bell of the load, permitting the barrel of the pipe to lay firmly throughout the entire length. The pipe positively will not be supported on blocks in order to raise the bell.

Earth bedding shall be used unless another type is designated on the Drawings. The pipe shall be placed on the natural undisturbed earth foundation which has been carefully shaped to fit the lower part of the conduit for not less than 1/4 of its circumference. When rock, shale or boulders are encountered in the trench, they shall be removed to a depth of six (6) inches below the grade lines and the trench shall be refilled with crushed rock, gravel or granular material up to the original grade and tamped into place. Bell holes will be required as above.

Other types of bedding and embedment shall be provided when designated on the Drawings.

- 3.04 BACKFILL:** After the pipe has been installed and embedded as designated on the drawings, selected material from the excavation at optimum to -1 to 4% above optimum moisture content, shall be placed in layers not exceeding six (6) inches loose depth layers and compacted by approved methods to a density of not less than 95% standard proctor density.

3.05 WATER MAIN CONSTRUCTION

A. **WATER JETTING WILL NOT BE PERMITTED.**

- B. Installing Ductile Iron (DI) Water Pipe: Pipe shall be installed according to the Standard Specification and the manufacturer's recommendations.

Whenever necessary to deflect pipe from a straight line, either in the vertical or horizontal place, to avoid obstructions, to plumb stems, or for other reasons, the degree of deflection shall not exceed that recommended by the pipe manufacturer.

No pipe shall be laid in water, or when the trench conditions or the weather is unsuitable for such work, except when approved by the City or Civil Engineer.

- C. Installation of Gate Valves: All Valves for the water distribution main shall be gate valves and shall be installed at the location indicated on the Drawings or as directed by the City or Civil Engineer. Valves shall be set with the stems true vertical. After valves have been installed and adjusted they shall be tested for operation under maximum operating pressure. Valve bases shall be installed so that covers are flush with the proposed finished ground surface.
- D. Fire Hydrant Installation: Fire hydrants shall be located as shown on the drawings, or as directed by the City or Civil Engineer and shall be set truly vertical.
- E. Sterilization: Sterilization of water mains and service lines shall be performed by the Contractor as required by the AWWA Standard Specifications. The Contractor will pay for all testing and sterilization.

END OF SECTION

SECTION 33 30 00

SANITARY SEWERAGE UTILITIES

PART 1 - GENERAL

1.01 RELATED CONDITIONS

- A. Provisions established within the 00 72 00 General Conditions and 00 73 00 Supplementary Conditions, Division 1 - General Requirements, and the Drawings are collectively applicable to this Section.

1.02 SCOPE RELATED CONDITIONS: Work included in this section, while not all inclusive but listed as a guide, shall include:

- A. Furnishing all labor, tools, materials, and incidentals required to complete the work.
- B. Installation of sanitary sewer line, manholes and cleanouts.
- C. Testing of sanitary sewer system.
- D. Clean up.

1.03 STANDARDS

- A. Standards will as a minimum meet the requirements and recommendations of applicable portions of the standards listed. See Section 01 42 19 Reference Standards.
- B. Meet requirements and recommendations of applicable portions of the Standards listed:
 - 1. City Standard Details and Specifications.
 - 2. North Central Texas Council of Governments (COG) Standard Specifications for Public Works Construction, Current Edition and Amendments.
 - 3. Texas Highway Department Standard Specification for Construction of Highways, Streets and Bridges, 1995 (THD).
 - 4. American Association of State Highway and Transportation Officials (AASHTO).
 - 5. American Water Works Associations (AWWA), Current Editions.
 - 6. American Society for Testing and Materials (ASTM), Current Edition.

PART 2 - MATERIALS

2.01 All materials shall conform to City specifications.

PART 3 - EXECUTION

3.01 GENERAL: The Contractor shall comply with all requirements of the City of Public Works Department Standards and Specifications regarding materials and installation of work specified herein.

3.02 EXCAVATION: The Contractor shall excavate all materials encountered regardless of the difficulties encountered. The ditch shall be no greater in width or depth than is necessary to permit construction in accordance with the Plans and these Specifications. The maximum width of trench at top of pipe without sheeting, shoring and bracing shall be not more than the external diameter of pipe plus 16 inches.

The Contractor shall determine the need for sheeting and bracing to safeguard the workmen. When sheeting and bracing are necessary the trench or excavation shall be dug to such width that proper allowance is made for the space occupied by the sheeting. All sheeting, shoring and bracing shall have sufficient strength and rigidity to withstand the pressure exerted and protect all persons or property from injury or damage. Sheeting, shoring and bracing endanger new or existing structures.

All holes or voids left by the removal of sheeting shall be backfilled.

Soft, spongy or otherwise unstable materials which will not provide a firm foundation for the pipe shall be removed and replaced to the extent required by the City or Civil Engineer.

The material thus removed shall be replaced with suitable selected material from the excavation or other sources approved by the City or Civil Engineer, and shall be compacted as proved in these Specifications. When unstable conditions are not corrected by the above means, the Contractor shall be required to use crushed rock, gravel or concrete foundations. The type of foundation shall be determined by the City or Civil Engineer. There will be no extra compensation for this work.

- 3.03 BEDDING:** The bedding for pipe shall provide a firm foundation of uniform density throughout the entire length of the pipe. Recesses for bells of the pipe shall be excavated for every joint and shall be of sufficient size and depth to relieve the bell of the load, permitting the barrel of the pipe to lay firmly throughout the entire length. The pipe positively will not be supported on blocks in order to raise the bell.

Earth bedding shall be used unless another type is designated on the Drawings. The pipe shall be placed on the natural undisturbed earth foundation which has been carefully shaped to fit the lower part of the conduit for not less than 1/4 of its circumference. When rock, shale or boulders are encountered in the trench, they shall be removed to a depth of six (6) inches below the grade lines and the trench shall be refilled with crushed rock, gravel or granular material up to the original grade and tamped into place. Bell holes will be required as above.

Other types of bedding and embedment shall be provided when designated on the Drawings.

- 3.04 BACKFILL:** After the pipe has been installed and embedded as designated on the drawings, selected material from the excavation at optimum to -1 to 4% above optimum moisture content, shall be placed in layers not exceeding six (6) inches loose depth layers and compacted by approved methods to a density of not less than 95% standard proctor density.

3.05 SEWER MAIN CONSTRUCTION

- A. Pipe: Pipe shall be protected during handling against impact shocks and free fall. The pipe shall not be dragged across a hard surface or rolled over sharp or rough objects.

Before being lowered into the trench, all sections of pipe shall be inspected for defects. Defective, damaged or unsound pipe shall be rejected. Laying shall begin at the lowest point with the spigot end pointing in the direction of flow. Pipe shall be laid accurately on the line and grade shown on the Drawings on bedding of the type shown on the Drawings.

Pipe sockets and barrel shall be clean and free from dirt at the time of jointing. The pipe shall be tightly butted together. All pipe shall be so laid that the contact in the joint between two lengths of pipe shall be uniform throughout the circumference of the joint. Curves in the alignment as indicated on the Drawings shall be made with standard pipe by pulling on the outside edge of the pipe away from the seat to make a smooth joint. Where curves are sharp, a standard or special made bend will be used. When the pipe has been checked for line and grade, enough backfill shall be placed on both sides of the pipe to hold it firmly in position.

Openings at the end of a day's work, openings in wyes, deep cut connections, laterals, cleanouts, etc., shall be capped and sealed water tight with G-K compound.

- B. Wye Branches: Wye branches for service lines shall be installed where shown on the Drawings. All Wye branches for service lines shall be six (6) inches in diameter unless otherwise shown on the Drawings. Cutting into the sewer main for connections will not be permitted. Wye branches for service lines shall be blocked before backfilling.
- C. Manholes: Shall be constructed as detailed on the Drawings. Bricks used in manhole construction shall be clean and thoroughly wetted shortly before they are laid. The flow channel shall be true to line and grade. It shall be troweled to a smooth, hard finish. Cast iron frames

and covers shall be embedded in a full bed of mortar and shall have a full bearing with toe at the established grade. Precast manholes shall be constructed as shown on the drawings.

- D. Cleanouts: Shall be constructed with 27" Wye. A cast iron casting with "cleanout" printed on the cover shall be set over the top of the cleanout and set to the established grade.
- E. Sewer Tests: The Contractor shall include in his bid price all costs of required testing to complete the work.
- F. Cleaning up: Upon completion of the work covered by this Section, the Contractor shall clean up all work areas by removing all debris, surplus materials and equipment from site. The ground surface will be restored to its original position as nearly as possible.

END OF SECTION