PROJECT MANUAL

NORTH CHARLESTON
WANNAMAKER COUNTY
PARK
PARK CENTER
REPLACEMENT

For The Owner:

Charleston County Park & Recreation

GBA PROJECT No.: 2123

DATE: November 7, 2022

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DOCUMENT 00 01 05

PROJECT DIRECTORY

PROJECT: North Charleston Wannamaker County Park
Park Center Replacement

OWNER: CHARLESTON COUNTY PARK & RECREATION COMISSION

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AVAILABLE PROJECT INFORMATION

PART 1 GENERAL

1.01 EXISTING CONDITIONS

A. Certain information relating to existing surface and subsurface conditions and structures is available to bidders but will not be part of the Contract Documents, as follows:

   1. This report, by its nature, cannot reveal all conditions that exist on the site. Should subsurface conditions be found to vary substantially from this report, changes in the design and construction of foundations will be made, with resulting credits or expenditures to the Contract Price accruing to Owner.

PART 2 PRODUCTS (NOT USED)
PART 3 EXECUTION (NOT USED)

END OF SECTION
PART 1 GENERAL

1.01 PROJECT
A. Project Name: North Charleston Wannamaker County Park – Park Center Replacement
B. Architect's Name: Glick/Boehm & Associates, Inc.
C. The Park Center Replacement project consists of a new structure to replace the building which was previously destroyed and has been demolished. The building contains public gang restrooms, a family restroom, an office, bike repair, storage and snack-bar. The exterior materials are CMU, Hardie and asphalt or stone coated steel shingles. New mechanical, plumbing, electrical and IT utilities will be installed. Minor additional site and site utilities renovations will take place on the site and the areas immediately adjacent the site.

1.02 WORK BY OWNER
A. Items noted NIC (Not in Contract) will be supplied and installed by Owner before Substantial Completion. Some items include:
   1. IT cable installation.
   2. Furniture installation.

1.03 OWNER OCCUPANCY
A. Owner intends to continue to occupy portions of the existing site and adjacent buildings during the entire construction period.
B. Owner intends to occupy the Project upon Substantial Completion.
C. Cooperate with Owner to minimize conflict and to facilitate Owner's operations.
D. Schedule the Work to accommodate Owner occupancy.

1.04 CONTRACTOR USE OF SITE AND PREMISES
A. Construction Operations: Limited to areas noted on Drawings.
   1. Locate and conduct construction activities in ways that will limit disturbance to site.
B. 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.
C. Utility Outages and Shutdown:
   1. Limit disruption of utility services to hours the site is unoccupied.
   2. Do not disrupt or shut down life safety systems, including but not limited to fire alarm system, without 7 days notice to Owner and authorities having jurisdiction.
   3. Prevent accidental disruption of utility services to other facilities.

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. Procedures for preparation and submittal of application for final payment.

1.02 RELATED REQUIREMENTS
A. Section 01 21 00 - Allowances: Payment procedures relating to allowances.

1.03 SCHEDULE OF VALUES
A. Electronic media printout including equivalent information will be considered in lieu of standard form specified; submit draft to Architect for approval.
B. Forms filled out by hand will not be accepted.
C. Submit Schedule of Values in duplicate within 15 days after date of Owner-Contractor Agreement.
D. Format: Utilize the Table of Contents of this Project Manual. Identify each line item with number and title of the specification Section. Identify site mobilization and bonds and insurance.
E. Include in each line item, the amount of Allowances specified in this section. For unit cost Allowances, identify quantities taken from Contract Documents multiplied by the unit cost to achieve the total for the item.
F. 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. Electronic media printout including equivalent information will be considered in lieu of standard form specified; submit sample to Architect for approval.
C. Forms filled out by hand will not be accepted.
D. For each item, provide a column for listing each of the following:
   1. Item Number.
   2. Description of work.
   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.
  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 30 00.
3. Provide with every Application for Payment partial release of liens from General Contractor, major Subcontractors and vendors.
J. When Architect requires substantiating information, submit data justifying dollar amounts in question.

1.05 MODIFICATION PROCEDURES
A. Submit name of the individual authorized to receive change documents and who will be responsible for informing others in Contractor's employ or subcontractors of changes to the Contract Documents.
B. For minor changes not involving an adjustment to the Contract Sum or Contract Time, Architect will issue instructions directly to Contractor.
C. For other required changes, Architect will issue a document signed by Owner instructing Contractor to proceed with the change, for subsequent inclusion in a Change Order.
   1. The document will describe the required changes and will designate method of determining any change in Contract Sum or Contract Time.
   2. Promptly execute the change.
D. For changes for which advance pricing is desired, Architect will issue a document that 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 days.
E. 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.
F. Computation of Change in Contract Amount: As specified in the Agreement and Conditions of the Contract.
   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 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.
G. Substantiation of Costs: For all cost changes (adds and credits) to the contract the General Contractor shall provide full information required for evaluation. It is the General Contractors responsibility to attain the information from the subcontractors. The General Contractor shall review/confirm the information submitted by the subcontractor meets the scope of work and the costs issued are equitable. Provide full information required for evaluation.
   1. Provide the following data:
      a. Quantities of products, labor, and equipment. Provide costs in detail for labor and material and equipment. Provide industry standards for quantities, i.e. square footage, linear footage, cubic yards, etc.
      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, similarly documented.

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.

H. Execution of Change Orders: Architect will issue Change Orders for signatures of parties as provided in the Conditions of the Contract.

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 70 00.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electronic document submittal service.
B. Preconstruction meeting.
C. Progress meetings.
D. Construction progress schedule.
E. Submittals for review, information, and project closeout.
F. Number of copies of submittals.
G. Submittal procedures.

1.02 RELATED REQUIREMENTS

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

1.03 REFERENCE STANDARDS


PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 ELECTRONIC DOCUMENT SUBMITTALS

A. All documents transmitted for purposes of administration of the contract are to be in electronic (PDF) format and transmitted via an Internet-based submittal service that receives, logs and stores documents, provides electronic stamping and signatures, and notifies addressees via email.
1. Besides submittals for review, information, and closeout, this procedure applies to requests for information (RFIs), progress documentation, contract modification documents (e.g. supplementary instructions, change proposals, change orders), applications for payment, field reports and meeting minutes, Contractor's correction punchlist, and any other document any participant wishes to make part of the project record.
2. It is Contractor's responsibility to submit documents in PDF format.
3. All other specified submittal and document transmission procedures apply, except that electronic document requirements do not apply to samples or color selection charts.

3.02 PRECONSTRUCTION MEETING

A. Schedule meeting after Notice of Award.
B. Attendance Required:
   1. Owner.
   3. Contractor.
C. Agenda:
   1. Execution of Owner-Contractor Agreement.
   2. Submission of executed bonds and insurance certificates.
   4. Submission of list of Subcontractors, list of Products, schedule of values, and progress schedule.
   5. Designation of personnel representing the parties to Contract, Owner and Architect.
6. Procedures and processing of field decisions, submittals, substitutions, applications for payments, proposal request, Change Orders, and Contract closeout procedures.
7. Scheduling.
D. Record minutes and distribute copies within two days after meeting to participants, with two copies to Architect, Owner, participants, and those affected by decisions made.

3.03 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, preside at meetings.
C. Attendance Required:
   1. Contractor.
   2. Owner.
   3. Architect.
   4. Contractor’s Superintendent.
   5. Major Subcontractors as appropriate to agenda topics.
D. Agenda:
   1. Review minutes of previous meetings.
   2. Review of Work progress.
   3. Field observations, problems, and decisions.
   4. Identification of problems that impede, or will impede, planned progress.
   5. Review of submittals schedule and status of submittals.
   6. 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 to participants, with two copies to Architect, Owner, participants, and those affected by decisions made.

3.04 CONSTRUCTION PROGRESS SCHEDULE
A. Within 10 days after date of the Agreement, submit preliminary schedule defining planned operations for the first 60 days of Work, with a general outline for remainder of Work.
B. If preliminary schedule requires revision after review, submit revised schedule within 10 days.
C. Within 20 days after review of preliminary schedule, submit draft of proposed complete schedule for review.
   1. Include written certification that major contractors have reviewed and accepted proposed schedule.
D. Within 10 days after joint review, submit complete schedule.
E. Submit updated schedule with each Application for Payment.

3.05 SUBMITTALS FOR REVIEW
A. When the following are specified in individual sections, submit them for review:
   1. Product data.
   2. Shop drawings.
   3. Samples for selection.
   4. Samples for verification.
B. Submit to Architect for review for the limited purpose of checking for 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 78 00 - 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. Other types indicated.
B. Submit for Architect's knowledge as contract administrator or for Owner. No action will be taken.

3.07 SUBMITTALS FOR PROJECT CLOSEOUT
A. Submit Correction Punch List for Substantial Completion.
B. Submit Final Correction Punch List for Substantial Completion.
C. When the following are specified in individual sections, submit them at project closeout:
   1. Project record documents.
   2. Operation and maintenance data.
   3. Warranties.
   5. Other types as indicated.
D. Submit for Owner's benefit during and after project completion.

3.08 NUMBER OF COPIES OF SUBMITTALS
A. Electronic Documents: Submit one electronic copy in PDF format; an electronically-marked up file will be returned. Create PDFs at native size and right-side up; illegible files will be rejected.
B. Samples: Submit the number specified in individual specification sections; one of which will be retained by Architect.
   1. After review, produce duplicates.
   2. Retained samples will not be returned to Contractor unless specifically so stated.

3.09 SUBMITTAL PROCEDURES
A. General Requirements:
   1. Use a separate transmittal for each item.
   2. Submit separate packages of submittals for review and submittals for information, when included in the same specification section.
   3. Transmit using approved form.
      a. Use Form AIA G810.
      b. Use Contractor's form, subject to prior approval by Architect.
   4. Sequentially identify each item. For revised submittals use original number and a sequential numerical suffix.
   5. Identify: Project; Contractor; subcontractor or supplier; pertinent drawing and detail number; and specification section number and article/paragraph, as appropriate on each copy.
   6. 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.
      a. Submittals from sources other than the Contractor, or without Contractor's stamp will not be acknowledged, reviewed, or returned.
7. Schedule submittals to expedite the Project, and coordinate submission of related items.
   a. For each submittal for review, allow 15 days excluding delivery time to and from the Contractor.
   b. For sequential reviews involving Architect's consultants, Owner, or another affected party, allow an additional 7 days.

B. Product Data Procedures:
   1. Submit only information required by individual specification sections.
   2. Collect required information into a single submittal.
   3. Submit concurrently with related shop drawing submittal.
   4. Do not submit (Material) Safety Data Sheets for materials or products.

C. Shop Drawing Procedures:
   1. Prepare accurate, drawn-to-scale, original shop drawing documentation by interpreting the Contract Documents and coordinating related Work.
   2. Generic, non-project specific information submitted as shop drawings do not meet the requirements for shop drawings.

D. Transmit each submittal with a copy of approved submittal form.

E. Transmit each submittal with approved form.

F. Sequentially number the transmittal form. Revise submittals with original number and a sequential alphabetic suffix.

G. Identify Project, Contractor, Subcontractor or supplier; pertinent drawing and detail number, and specification section number, as appropriate on each copy.

H. 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.

I. Schedule submittals to expedite the Project, and coordinate submission of related items.

J. For each submittal for review, allow 15 days excluding delivery time to and from the Contractor.

K. Identify variations from Contract Documents and Product or system limitations that may be detrimental to successful performance of the completed Work.

L. Provide space for Contractor and Architect review stamps.

M. When revised for resubmission, identify all changes made since previous submission.

N. Distribute reviewed submittals as appropriate. Instruct parties to promptly report any inability to comply with requirements.

O. Submittals not requested will not be recognized or processed.

3.10 SUBMITTAL REVIEW

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

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

C. Architect's actions will be reflected by marking each returned submittal using virtual stamp on electronic submittals.
   1. Notations may be made directly on submitted items and/or listed on appended Submittal Review cover sheet.

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

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

END OF SECTION
SECTION 01 32 16
CONSTRUCTION PROGRESS SCHEDULE

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Preliminary schedule.
   B. Construction progress schedule, bar chart type.

1.02 REFERENCE STANDARDS
   B. M-H (CPM) - CPM in Construction Management - Project Management with CPM; O'Brien; 2006.

1.03 SUBMITTALS
   A. Within 10 days after date of Agreement, submit preliminary schedule defining planned operations for the first 60 days of Work, with a general outline for remainder of Work.
   B. If preliminary schedule requires revision after review, submit revised schedule within 10 days.
   C. Within 20 days after review of preliminary schedule, submit draft of proposed complete schedule for review.
   D. Within 10 days after joint review, submit complete schedule.
   E. Submit updated schedule with each Application for Payment.

1.04 QUALITY ASSURANCE
   A. Scheduler: Contractor's personnel or specialist Consultant specializing in CPM scheduling with one years minimum experience in scheduling construction work of a complexity comparable to this Project, and having use of computer facilities capable of delivering a detailed graphic printout within 48 hours of request.

1.05 SCHEDULE FORMAT
   A. Listings: In chronological order according to the start date for each activity. Identify each activity with the applicable specification section number.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 PRELIMINARY SCHEDULE
   A. Prepare preliminary schedule in the form of a horizontal bar chart.

3.02 CONTENT
   A. Show complete sequence of construction by activity, with dates for beginning and completion of each element of construction.
   B. Identify each item by specification section number.
   C. Include critical submittal items
   D. Show accumulated percentage of completion of each item, and total percentage of Work completed, as of the first day of each month.
   E. Indicate delivery dates for owner-furnished products.
   F. Provide legend for symbols and abbreviations used.

3.03 BAR CHARTS
   A. Include a separate bar for each major portion of Work or operation.
   B. Identify the first work day of each week.
3.04 NETWORK ANALYSIS
   A. Prepare network analysis diagrams and supporting mathematical analyses using the Critical Path Method.
   B. Illustrate order and interdependence of activities and sequence of work; how start of a given activity depends on completion of preceding activities, and how completion of the activity may restrain start of subsequent activities.
   C. Mathematical Analysis: Tabulate each activity of detailed network diagrams, using calendar dates, and identify for each activity:
      1. Preceding and following event numbers.
      2. Activity description.
      3. Estimated duration of activity, in maximum 15 day intervals.
      4. Earliest start date.
      5. Earliest finish date.
      6. Actual start date.
      7. Actual finish date.
      8. Latest start date.
      9. Latest finish date.
     10. Total and free float; float time shall accrue to Owner and to Owner’s benefit.
     11. Monetary value of activity, keyed to Schedule of Values.
     12. Percentage of activity completed.
   D. Analysis Program: Capable of accepting revised completion dates, and recomputation of all dates and float.
   E. Required Reports: List activities in sorts or groups:
      1. By preceding work item or event number from lowest to highest.
      2. By amount of float, then in order of early start.

3.05 REVIEW AND EVALUATION OF SCHEDULE
   A. Participate in joint review and evaluation of schedule with Architect at each submittal.
   B. Evaluate project status to determine work behind schedule and work ahead of schedule.
   C. After review, revise as necessary as result of review, and resubmit within 10 days.

3.06 UPDATING SCHEDULE
   A. Maintain schedules to record actual start and finish dates of completed activities.
   B. Indicate progress of each activity to date of revision, with projected completion date of each activity.
   C. Annotate diagrams to graphically depict current status of Work.
   D. Identify activities modified since previous submittal, major changes in Work, and other identifiable changes.
   E. Indicate changes required to maintain Date of Substantial Completion.
   F. Submit reports required to support recommended changes.
   G. Issue schedule update with each pay application.

3.07 DISTRIBUTION OF SCHEDULE
   A. Distribute copies of updated schedules to Contractor’s project site file, to subcontractors, suppliers, Architect, Owner, and other concerned parties.
   B. Include updated schedule with Application for Payments.
   C. Instruct recipients to promptly report, in writing, problems anticipated by projections shown in schedules.

END OF SECTION
PART 1 GENERAL
1.01 SECTION INCLUDES
A. Submittals.
B. Mock-ups.
C. Control of installation.
D. Tolerances.
E. Testing and inspection agencies and services.
F. Control of installation.
G. Mock-ups.
H. Tolerances.
I. Defect Assessment.

1.02 RELATED REQUIREMENTS
A. Document 00 72 00 - General Conditions: Inspections and approvals required by public authorities.
B. Section 01 60 00 - Product Requirements: Requirements for material and product quality.

1.03 REFERENCE STANDARDS

1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Design Data: Submit for Architect's knowledge as contract administrator for the limited purpose of assessing conformance with information given and the design concept expressed in the contract documents, or for Owner's information.
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 report submittals are for Architect's knowledge as contract administrator for the limited purpose of assessing conformance with information given and the design concept expressed in the contract documents, or for Owner's information.

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 for information for the limited purpose of assessing conformance with information given and the design concept expressed in the contract documents.

1.05 TESTING AND INSPECTION AGENCIES AND SERVICES

A. Owner will employ and pay for services of an independent testing agency to perform specified testing and inspections specified in 01 41 50 Special Inspections and Structural Testing.

B. Contractor shall employ and pay for services of an independent testing agency to perform other specified testing.

C. Employment of agency in no way relieves Contractor of obligation to perform Work in accordance with requirements of Contract Documents.

D. Contractor Employed Agency:
   2. Inspection agency: Comply with requirements of ASTM D3740 and ASTM E329.
   3. Laboratory: Authorized to operate in the State in which the Project is located.
   4. Testing Equipment: Calibrated at reasonable intervals either by NIST or using an NIST established Measurement Assurance Program, under a laboratory measurement quality assurance program.

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. Integrated Exterior Mock-ups: construct integrated exterior mock-up. Coordinate installation of exterior envelope materials and products as required in individual Specification Sections. Provide adequate supporting structure for mock-up materials as necessary.
B. Mock-up weather barrier installation at window opening following manufacturer's instructions. Mock-up window installation.
C. Accepted mock-ups shall be a comparison standard for the remaining Work.
D. Mock-ups may be in-place if coordinated with Architect.

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:
   2. Perform specified sampling and testing of products in accordance with specified standards.
   3. Ascerten compliance of materials and mixes with requirements of Contract Documents.
   4. Promptly notify Architect and Contractor of observed irregularities or non-conformance of Work or products.
   5. Perform additional tests and inspections required by Architect.
   6. 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 that require testing, along with proposed mix designs.
   2. Cooperate with laboratory personnel, and provide access to the Work and to manufacturers' facilities.
   3. Provide incidental labor and facilities:
      a. To provide access to Work to be tested/inspected.
      b. To obtain and handle samples at the site or at source of Products to be tested/inspected.
      c. To facilitate tests/inspections.
      d. To provide storage and curing of test samples.
   4. Notify Architect and laboratory 24 hours prior to expected time for operations requiring testing/inspection services.
   5. Employ services of an independent qualified testing laboratory and pay for additional samples, tests, and inspections required by Contractor beyond specified requirements.
   6. Arrange with Owner's agency and pay for additional samples, tests, and inspections required by Contractor beyond specified requirements.
E. Re-testing required because of non-conformance to specified requirements shall be performed by the same agency on instructions by Architect.

F. Re-testing required because of non-conformance to specified requirements shall be paid for by Contractor.

3.05 DEFECT ASSESSMENT

A. Replace Work or portions of the Work not conforming to specified requirements.

END OF SECTION
SECTION 01 45 33
CODE-REQUIRED SPECIAL INSPECTIONS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Code-required special inspections.
B. Testing services incidental to special inspections.
C. Submittals.

1.02 DEFINITIONS
B. Authority Having Jurisdiction (AHJ): Agency or individual officially empowered to enforce the building, fire and life safety code requirements of the permitting jurisdiction in which the Project is located.
C. National Institute of Standards and Technology (NIST).
D. Special Inspection: 1. Special inspections are inspections and testing of materials, installation, fabrication, erection or placement of components and connections mandated by the AHJ that also require special expertise to ensure compliance with the approved contract documents and the referenced standards.
   2. Special inspections are separate from and independent of tests and inspections conducted by Owner or Contractor for the purposes of quality assurance and contract administration.

1.03 REFERENCE STANDARDS

1.04 SUBMITTALS
A. Special Inspection Agency Qualifications: Prior to the start of work, the Special Inspection Agency shall:
   1. Submit agency name, address, and telephone number, 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.
   3. Submit certification that Special Inspection Agency is acceptable to AHJ.
B. Special Inspection Reports: After each special inspection, Special Inspector shall promptly submit two copies of report; one to Architect and one to the AHJ.
   1. Include:
      a. Date issued.
      b. Project title and number.
      c. Name of Special Inspector.
      d. Date and time of special inspection.
      e. Identification of product and specifications section.
      f. Location in the Project.
      g. Type of special inspection.
      h. Date of special inspection.
      i. Results of special inspection.
      j. Conformance with Contract Documents.
   2. Final Special Inspection Report: Document special inspections and correction of discrepancies prior to the start of the work.
1.05 SPECIAL INSPECTION AGENCY
A. Owner will employ services of a Special Inspection Agency to perform inspections and associated testing and sampling required by the building code.
B. The Special Inspection Agency may employ and pay for services of an independent testing agency to perform testing and sampling associated with special inspections and required by the building code.
C. Employment of agency in no way relieves Contractor of obligation to perform work in accordance with requirements of Contract Documents.

1.06 QUALITY ASSURANCE
A. Special Inspection Agency Qualifications:
   1. Independent firm specializing in performing testing and inspections of the type specified in this section.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 SCHEDULE OF SPECIAL INSPECTIONS, GENERAL
A. See Statement of Special Inspections on the structural drawings.
B. Frequency of Special Inspections: Special Inspections are indicated as continuous or periodic.
   1. Continuous Special Inspection: Special Inspection Agency shall be present in the area where the work is being performed and observe the work at all times the work is in progress.
   2. Periodic Special Inspection: Special Inspection Agency shall be present in the area where work is being performed and observe the work part-time or intermittently and at the completion of the work.

3.02 SPECIAL INSPECTIONS FOR SEISMIC RESISTANCE
A. Mechanical and Electrical Components:
   1. Anchorage of electric equipment required for emergency or standby power systems; periodic.
   2. Installation and anchorage of other electrical equipment; periodic.

3.03 SPECIAL INSPECTIONS FOR WIND RESISTANCE
A. Structural Observations for Wind Resistance: Visually observe structural system for general conformance with the approved contract documents; periodic.

3.04 SPECIAL INSPECTION AGENCY DUTIES AND RESPONSIBILITIES
A. Special Inspection Agency shall:
   2. Perform specified sampling and testing of products in accordance with specified reference standards.
   3. Ascertain compliance of materials and products with requirements of Contract Documents.
   4. Promptly notify Architect and Contractor of observed irregularities or non-conformance of work or products.
   5. Perform additional tests and inspections required by Architect.
   6. Submit reports of all tests or inspections specified.
B. Re-testing required because of non-conformance to specified requirements shall be performed by the same agency on instructions by Architect.
C. Re-testing required because of non-conformance to specified requirements shall be paid for by Contractor.

3.05 TESTING AGENCY DUTIES AND RESPONSIBILITIES
A. Testing Agency Duties:
2. Perform specified sampling and testing of products in accordance with specified standards.
3. Ascertain compliance of materials and mixes with requirements of Contract Documents.
4. Promptly notify Architect and Contractor of observed irregularities or non-conformance of work or products.
5. Perform additional tests and inspections required by Architect.
6. Submit reports of all tests or inspections specified.

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

C. Re-testing required because of non-conformance to specified requirements shall be performed by the same agency on instructions by Architect.

D. Re-testing required because of non-conformance to specified requirements shall be paid for by Contractor.

3.06 CONTRACTOR DUTIES AND RESPONSIBILITIES

A. Contractor Responsibilities, General:
1. Deliver to agency at designated location, adequate samples of materials for special inspections that require material verification.
2. Cooperate with agency and laboratory personnel; provide access to the work, to manufacturers' facilities, and to fabricators' facilities.
3. Provide incidental labor and facilities:
   a. To provide access to work to be tested or inspected.
   b. To obtain and handle samples at the site or at source of Products to be tested or inspected.
   c. To facilitate tests or 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 or inspection services.
5. Arrange with Owner's agency and pay for additional samples, tests, and inspections required by Contractor beyond specified requirements.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Temporary telecommunications services.
B. Temporary sanitary facilities.
C. Temporary Controls: Barriers, enclosures, and fencing.
D. Vehicular access and parking.
E. Waste removal facilities and services.
F. Project identification sign.
G. 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.

1.03 TELECOMMUNICATIONS SERVICES

A. Provide, maintain, and pay for telecommunications services to field office at time of project mobilization.

1.04 TEMPORARY SANITARY FACILITIES

A. Provide and maintain required facilities and enclosures. Provide at time of project mobilization.
B. Maintain daily in clean and sanitary condition.
C. At end of construction, return facilities to same or better condition as originally found.

1.05 BARRIERS

A. Provide barriers to prevent unauthorized entry to construction areas, to prevent access to areas that could be hazardous to workers or the public and to protect existing facilities and adjacent properties from damage from construction operations and demolition.
B. Protect non-owned vehicular traffic, stored materials, site, and structures from damage.
C. Traffic Controls: Required by governing authorities for public rights-of-way.

1.06 FENCING

A. Provide 6 foot high, chain link fence around construction site; equip with vehicular and pedestrian gates with locks.

1.07 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.

1.08 VEHICULAR ACCESS AND PARKING

A. Comply with regulations relating to use of streets and sidewalks, access to emergency facilities, and access for emergency vehicles.
B. Coordinate access and haul routes with governing authorities and Owner.
C. Provide and maintain access to fire hydrants, free of obstructions.
D. Provide means of removing mud from vehicle wheels before entering streets.
E. Coordinate parking needs with Owner.
1.09 WASTE REMOVAL
   A. See Section 01 74 19 - Construction Waste Management and Disposal, for additional requirements.
   B. Provide waste removal facilities and services as required to maintain the site in clean and orderly condition.
   C. Provide containers with lids. Remove trash from site periodically.
   D. 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.
   E. 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: Weathertight, with lighting, electrical outlets, heating, cooling equipment, and equipped with sturdy furniture.

1.12 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS
   A. Remove temporary utilities, equipment, facilities, materials, prior to Date of Substantial Completion inspection.
   B. Remove underground installations to a minimum depth of 2 feet. Grade site as indicated.
   C. Clean and repair damage caused by installation or use of temporary work.

PART 2 PRODUCTS - NOT USED
PART 3 EXECUTION - NOT USED

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. Maintenance materials, including extra materials, spare parts, tools, and software.

1.02 RELATED REQUIREMENTS
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:
1. Made using or containing CFC's or HCFC's.

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 MAINTENANCE MATERIALS
A. Furnish extra materials, spare parts, tools, and software 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. Document each request with complete data substantiating compliance of proposed substitution with Contract Documents.
B. 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. Agrees to provide the same warranty for the substitution as for the specified product.
3. Agrees to coordinate installation and make changes to other Work that may be required for the Work to be complete with no additional cost to Owner.
4. Waives claims for additional costs or time extension that may subsequently become apparent.

C. 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.

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. Package products for shipment in manner to prevent damage; for equipment, package to avoid loss of factory calibration.
B. If special precautions are required, attach instructions prominently and legibly on outside of packaging.
C. Coordinate schedule of product delivery to designated prepared areas in order to minimize site storage time and potential damage to stored materials.
D. Transport and handle products in accordance with manufacturer's instructions.
E. Transport materials in covered trucks to prevent contamination of product and littering of surrounding areas.
F. Promptly inspect shipments to ensure that products comply with requirements, quantities are correct, and products are undamaged.
G. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage, and to minimize handling.
H. 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. Protect products from damage or deterioration due to construction operations, weather, precipitation, humidity, temperature, sunlight and ultraviolet light, dirt, dust, and other contaminants.

H. Comply with manufacturer's warranty conditions, if any.

I. Do not store products directly on the ground.

J. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.

K. Prevent contact with material that may cause corrosion, discoloration, or staining.

L. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.

M. 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
SECTION 01 70 00
EXECUTION AND CLOSEOUT 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, including Contractor's Correction Punch List, except payment procedures.

1.02 RELATED REQUIREMENTS
A. Section 01 30 00 - Administrative Requirements: Submittals procedures, Electronic document submittal service.
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.
   4. Provide FEMA flood certificate.
C. Cutting and Patching: Submit written request in advance of cutting or alteration that 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.
   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. Effect on work of Owner or separate Contractor.
      f. Written permission of affected separate Contractor.
      g. 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 Owner. Submit evidence of Surveyor’s Errors and Omissions insurance coverage in the form of an Insurance Certificate.
B. For design of temporary shoring and bracing, employ a Professional Engineer experienced in design of this type of work and 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 and over adjacent property.
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. Provide temporary measures such as berms, dikes, and drains, to prevent water flow and drain site appropriately.
F. 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. Comply with federal, state, and local regulations.

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 that 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 - Product Requirements.
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. Protect survey control points prior to starting site work; preserve permanent reference points during construction.

E. Promptly report to Architect the loss or destruction of any reference point or relocation required because of changes in grades or other reasons.

F. Replace dislocated survey control points based on original survey control. Make no changes without prior written notice to Architect.

G. Utilize recognized engineering survey practices.

H. 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.
   I. Periodically verify layouts by same means.
   J. Maintain a complete and accurate log of control and survey work as it progresses.
   K. 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 printed 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. Whenever possible, execute the work by methods that avoid cutting or patching.
   B. Perform whatever cutting and patching is necessary to:
      1. Complete the work.
      2. Fit products together to integrate with other work.
      3. Provide openings for penetration of mechanical, electrical, and other services.
      4. Match work that has been cut to adjacent work.
      5. Repair areas adjacent to cuts to required condition.
      6. Repair new work damaged by subsequent work.
      7. Remove samples of installed work for testing when requested.
      8. Remove and replace defective and non-conforming work.
   C. Execute work by methods that avoid damage to other work and that will provide appropriate surfaces to receive patching and finishing. In existing work, minimize damage and restore to original condition.
   D. Employ original installer to perform cutting for weather exposed and moisture resistant elements, and sight exposed surfaces.
   E. Cut rigid materials using masonry saw or core drill. Pneumatic tools not allowed without prior approval.
   F. Restore work with new products in accordance with requirements of Contract Documents.
   G. Fit work air tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
   H. 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.
   I. Patching:
      1. Finish patched surfaces to match finish that existed prior to patching. On continuous surfaces, refinish to nearest intersection or natural break. For an assembly, refinish entire unit.
      2. Match color, texture, and appearance.
      3. Repair patched surfaces that are damaged, lifted, discolored, or showing other imperfections due to patching work. If defects are due to condition of substrate, repair substrate prior to repairing finish.

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. Remove protective coverings when no longer needed; reuse or recycle coverings if possible.

3.09 SYSTEM STARTUP
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 that 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. 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.
3.12 FINAL CLEANING
   A. Use cleaning materials that are nonhazardous.
   B. 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.
   C. Remove all labels that are not permanent. Do not paint or otherwise cover fire test labels or nameplates on mechanical and electrical equipment.
   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, scuppers, overflow drains, area drains 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.
   B. Accompany Project Coordinator on preliminary inspection to determine items to be listed for completion or correction in the Contractor's Correction Punch List for Contractor's Notice of Substantial Completion.
   C. Notify Architect when work is considered ready for Architect's Substantial Completion inspection.
   D. Submit written certification containing Contractor's Correction Punch List, 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 Substantial Completion inspection.
   E. Conduct Substantial Completion inspection and create Final Correction Punch List containing Architect's and Contractor's comprehensive list of items identified to be completed or corrected and submit to Architect.
   F. Correct items of work listed in Final Correction Punch List and comply with requirements for access to Owner-occupied areas.
   G. Notify Architect when work is considered finally complete and ready for Architect's Substantial Completion final inspection.
   H. Complete items of work determined by Architect listed in executed Certificate of Substantial Completion.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This item shall consist of furnishing, placing, replacing when required, marking, and maintaining all Construction Layout stakes necessary for proper guidance and control of construction operations. It shall also include the preparation of all construction staking, field books, such as alignment books, slope, and grade books, blue-top books etc. It shall also include any additional Surveyor's, Civil, Structural, or other professional engineering services specified or required to execute Contractor's construction methods.

1.02 QUALIFICATIONS OF SURVEYOR OR ENGINEER

A. When it is specified or required for the Contractor to retain the services of an engineer or surveyor, then each shall meet the following requirements:

1. Surveyor shall be a Registered Professional Land Surveyor in the State the project site is located.

2. Engineer shall be a Registered Professional Engineer in the State the project site is located.

PART 2 - PRODUCTS

2.01 EQUIPMENT AND MATERIALS

A. All surveying equipment, stakes, and any other material necessary to perform the work shall be furnished by the Contractor, either directly or by a sub-contracted Registered Land Surveyor.

PART 3 - EXECUTION

3.01 SURVEY REFERENCE POINTS

A. Existing basic horizontal and vertical control points for the Project are those designated on drawing.

B. Locate and protect control points prior to starting site work and preserve all permanent reference points during construction.

C. The Contractor shall provide a Registered Land Surveyor, subject to the Owner's approval, to establish and/or re-establish all benchmarks, reference points, line and grade points necessary to complete the work at no additional expense to the Owner.

D. The Contractor shall notify the Project Engineer in the event any original reference point or benchmark as defined in subparagraph A and B, is destroyed or lost, and if required by the Project Engineer, shall replace said reference point or benchmark as per the requirements of subparagraph C.
3.02 CONSTRUCTION STAKEOUT

A. Establish lines and levels, locate and layout by instrumentation and similar appropriate means all site improvements
   1. Stakes for grading, fill and topsoil placement.
   2. Stakes for alignment and grades for roadways, parking facilities, and other pavements or structures.
   3. Storm drainage and sanitary sewers alignment and invert elevations.
   4. Water distribution systems, and other non-gravity utility system fixtures, fittings, bends and other appurtenances needed for proper location and alignment.

B. A complete and accurate log of all control and survey work, as it progresses, shall be maintained.

C. Contractor shall verify layouts, and line and grade of work, as work progresses, at random times to verify proper installation and shall notify Project Engineer of status.

D. At the Project Engineer's request, surveying stakeout data shall be submitted for review to verify accuracy of field engineering work.

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 REQUIREMENTS

A. General Conditions: Performance bond and labor and material payment bonds, warranty, and correction of work.
B. Section 01 30 00 - Administrative Requirements: Submittals procedures, shop drawings, product data, and samples.
C. Section 01 70 00 - Execution and Closeout Requirements: Contract closeout procedures.
D. Individual Product Sections: Specific requirements for operation and maintenance data.
E. Individual Product Sections: Warranties required for specific products or Work.
F. Finish and Accessory schedule selections: requirements for operation and maintenance data.
G. Finish and Accessory schedule selections: Warranties 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 operated by Owner, submit completed documents within ten days after acceptance.
   3. Submit one 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 10 days after acceptance.
   2. Make other submittals within 10 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 10 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 and Shop Drawings: Legibly mark each item to record actual construction including:
   1. Field changes of dimension and detail.
   2. Details not on original Contract drawings.

3.02 OPERATION AND MAINTENANCE DATA

A. Source Data: 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. Where additional instructions are required, beyond the manufacturer's standard printed instructions, have instructions prepared by personnel experienced in the operation and maintenance of the specific products.

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. Where additional instructions are required, beyond the manufacturer's standard printed instructions, have instructions prepared by personnel experienced in the operation and maintenance of the specific products.

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. Provide control diagrams by controls manufacturer as installed.

J. Additional Requirements: As specified in individual product specification sections.

3.05 ASSEMBLY OF OPERATION AND MAINTENANCE MANUALS

A. Assemble operation and maintenance data into durable manuals for Owner's personnel use, with data arranged in the same sequence as, and identified by, the specification sections.

B. Where systems involve more than one specification section, provide separate tabbed divider for each system.

C. Prepare instructions and data by personnel experienced in maintenance and operation of described products.

D. Prepare data in the form of an instructional manual.

E. Binders: Commercial quality, 8-1/2 by 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.

F. Cover: Identify each binder with typed or printed title OPERATION AND MAINTENANCE INSTRUCTIONS; identify title of Project; identify subject matter of contents.

G. Project Directory: Title and address of Project; names, addresses, and telephone numbers of Architect, Consultants, Contractor and subcontractors, with names of responsible parties.

H. Tables of Contents: List every item separated by a divider, using the same identification as on the divider tab; where multiple volumes are required, include all volumes Tables of Contents in each volume, with the current volume clearly identified.

I. Dividers: Provide tabbed dividers for each separate product and system; identify the contents on the divider tab; immediately following the divider tab include a description of product and major component parts of equipment.

J. Text: Manufacturer's printed data, or typewritten data on 24 pound paper.

K. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.

L. Arrange content by systems under section numbers and sequence of Table of Contents of this Project Manual.

M. 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. 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.

3.06 WARRANTIES AND BONDS

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

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

C. Co-execute submittals when required.

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

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This item shall consist of furnishing end-of-job close-out final as-constructed surveys of the constructed improvements: water distribution system, sanitary sewer system, storm drainage piping and the stormwater management detention system.

1.02 QUALIFICATIONS OF SURVEYOR

A. Coordinate with the standard requirements of Section 01 71 23 CONSTRUCTION STAKEOUT AND FIELD ENGINEERING.

PART 2 - PRODUCTS

2.01 EQUIPMENT AND MATERIALS

A. All surveying equipment, stakes and any other material necessary to perform the work shall be furnished by the Contractor, either directly or by a sub-contracted Registered Land Surveyor.

PART 3 - EXECUTION

3.01 RECORD DRAWINGS AND CERTIFICATION

A. AS-BUILT RECORD DRAWINGS: Upon completion of the work, the Contractor shall provide a certified final as-built survey by a Registered Land Surveyor showing all dimensions, locations, angles, and elevations of all portions of work performed under his contract. The Contractor will be provided a copy of the original Site electronic CAD files to use as a base for the creation of these as-built record drawings. Survey shall show all improvements and their relations to any and all existing conditions that are relative to their use.

B. UTILITY AS-BUILTS: Contractor shall, as part of his work, survey the as-constructed location of all new buried utilities. These locations shall document the horizontal location, size, material, and elevation, or depth of cover over the buried utility pipe, cable or duct.
   1. Water Distribution Record Drawing Survey: Contractor shall, as part of his work, survey the as-constructed location of all new water lines, both buried and above ground. These locations shall document the horizontal location, size, material, and elevation, or depth of cover over the buried piping. Provide water record drawings in accordance with the requirements of the water system utility company having authority and the requirements of Section 33 11 00 WATER DISTRIBUTION PIPING.
   2. Sanitary Sewer Wastewater System Record Drawing Survey: Provide sanitary sewer record drawings in accordance with the requirements of the sewer utility company having authority and the requirements of Section 33 30 00 SANITARY SEWERS.

C. UTILITY EASEMENT PLATS: Contractor shall provide new easement plats for all new potable/fire water lines, storm drainage piping systems, and sanitary sewer piping systems that cross private property lines or parcels. Plats shall be prepared by a professional surveyor and
shall meet all requirements of the utility company having jurisdiction, as applicable.

D. CERTIFICATE OF CONFORMANCE: Submit a certificate signed by Professional Engineer or Registered Land Surveyor, as each portion of work requires, certifying that elevations and locations of improvements are in conformance or non-conformance with Contract Documents.

END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY

A. The scope of work under this section is for demolition and removal of site infrastructure paving, slabs, utilities and other exterior elements indicated for demolition, salvage or relocation, as well as site temporary erosion control measures. It does not cover demolition of buildings or selective demolition to interiors of structures or buildings.

1.02 GENERAL REQUIREMENTS

A. Do not begin demolition or any land disturbing activity until all erosion control devices are installed, inspected, and approved by the Architect. Remove rubbish and debris from the project site. Do not allow accumulations. Store materials that cannot be removed daily in areas specified by the Architect.

1.03 REGULATORY REQUIREMENTS

A. Comply with federal, state, and local regulations for demolition, hauling and disposal. Obtain all necessary permits as required by the above Governmental agencies.

1.04 DUST AND DEBRIS CONTROL

A. Prevent the spread of dust and debris and avoid the creation of a nuisance in the surrounding area. Do not use water if it results in hazardous or objectionable conditions such as, but not limited to, ice, flooding, or pollution.

1.05 EROSION AND SEDIMENT CONTROL

A. The Contractor will be responsible for all sediment and erosion control on the project site. He shall comply with the State regulations regarding the sediment and erosion control for land disturbing activities and erosion control devices and requirements indicated on the drawing. He will be responsible for all weekly inspections until all disturbed surfaces are stabilized with pavement repairs or established vegetation of non-paved areas.

B. Standard SCDHEC SWPPP Notes:

1. If necessary, slopes which exceed eight (8) vertical feet should be stabilized with synthetic or vegetative mats, in addition to hydroseeding. It may be necessary to install temporary slope drains during construction. Temporary berms may be needed daily until the slope is brought to grade.

2. Stabilization measures shall be initiated as soon as practicable in portions of the site where construction activities have temporarily or permanently ceased, but in no case more than (14) days after work has ceased, except as stated below.
   a. Where stabilization by the 14th day is precluded by snow cover or frozen ground conditions stabilization measures must be initiated as soon as practicable.
   b. Where construction activity on a portion of the site is temporarily ceased, and earth-disturbing activities will be resumed within 14 days, temporary stabilization measures do not have to be initiated on that portion of the site.
3. All sediment and erosion control devices shall be inspected once every calendar week. If periodic inspections or other information indicates that a BMP has been inappropriately installed, or incorrectly maintained, the Permittee must address the necessary replacement or modification required to correct the BMP within 48 hours of identification.

4. Provide silt fences and/or other control devices, as may be required, to control soil erosion during utility construction. All disturbed areas shall be cleaned, graded and stabilized with grassing immediately after the utility installation. Fill, cover, and temporary seeding at the end of each day are recommended. If water is encountered while trenching, the water shall be filtered to remove any sediments before being pumped back into any waters of the state.

5. All erosion control devices shall be properly maintained during all phases of construction until the completion of all construction activities and all disturbed areas have been stabilized. Additional control devices may be required during construction in order to control erosion and/or off-site sedimentation. All temporary control devices shall be removed once construction is complete and the site is stabilized.

6. The contractor must take necessary action to minimize the tracking of mud onto paved roadways from construction areas and the generation of dust. The contractor shall daily remove mud/soil from pavement, as may be required.

7. Residential subdivisions require erosion control features for infrastructure as well as for individual lot construction. Individual property owners shall follow these plans during construction or obtain approval of an individual plan in accordance with S.C. Reg. 72-300 et seq. and SCR100000.

8. Temporary diversion berms and/or ditched will be provided as needed during construction to protect work areas from upslope runoff and/or to divert sediment-laden water to appropriate traps or stable outlets.

9. All waters of the state (WOS), including wetlands, are to be flagged or otherwise clearly marked in the field. A double row of silt fence is to be installed in all areas where a 50-foot buffer can’t be maintained between the disturbed area and all WOS. A 10-foot buffer should be maintained between the last row of silt fence and all WOS.

10. Litter, construction debris, oils, fuels, and building products with significant potential for impact (Such as stockpiles, of freshly treated lumber) and construction chemicals that could be exposed to storm water must be prevented from becoming a pollutant source in stormwater discharges.

11. A copy of the SWPPP, inspection records, and rainfall data must be retained at the construction site or a nearby location easily accessible during normal business hours, from the date of commencement of construction activities to the date that final stabilization is reached.

12. Initiate stabilization measures on any exposed steep slope (3H:1V or greater) where land-disturbing activities have permanently or temporarily ceased and will not resume for a period of 7 calendar days.

13. Minimize soil compaction and, unless infeasible, preserve topsoil.

14. Minimize the discharge of pollutants from equipment and vehicle washing, wheel wash water, and other wash waters. Wash waters must be treated in a sediment basin or alternative control that provides equivalent or better treatment prior to discharge.

15. Minimize the discharge of pollutants from dewatering of trenches and excavated areas. These discharges are to be routed through appropriate BMP’s (sediment basins, filter bag, etc.).

16. The following discharges from sites are prohibited:
   - Wastewater from washout of concrete, unless managed by an appropriate control.
   - Wastewater from washout and cleanout of stucco, paint, form release oils, curing
compounds and other construction materials.

- Fuels, oils, or other pollutants used in vehicle and equipment operation and maintenance; and
- Soaps, or solvents used in vehicle and equipment washing.

17. After construction activities begin, inspections must be conducted at a minimum of at least once every calendar week and must be conducted until final stabilization is reached on all areas of the construction site.

18. If existing BMP’s need to be modified or if additional BMP’s are necessary to comply with the requirements of this permit and/or SC’s Water Quality Standards, implementation must be completed before the next storm event whenever practicable. If implementation before the next storm event is impracticable, the situation must be documented in the SWPPP and alternative BMP’s must be implemented as soon as reasonably possible.

19. A Pre-construction Conference must be held for each construction site with an approved on-Site SWPPP prior to the implementation of construction activities. For non-linear projects that disturb 10 acres or more this conference must be held on-site unless the Department (SCDHEC-OCRM) has approved otherwise.

C. Additional SWPPP Notes:

1. The contractor shall maintain barriers and silt fences around all drainage inlets, open pipe inlets, unfinished junction boxes, or any openings that allow storm water borne sediments to enter the drainage system or be discharged from the site. Erosion control shall be maintained and/or replaced as needed until all permanent surfaces (i.e. pavement, grass, planting, etc.) are in place.

2. A concrete truck wash down location will NOT be located on the site for concrete trucks delivering concrete to the site.

4. The contractor shall be responsible for establishing final surface stabilization of all areas of land disturbance disturbed by construction operations. This includes pavements, mulches, landscaping, and grassing. Any unpaved area disturbed not specifically identified on the drawings for the type of vegetative stabilization shall be stabilized to match the adjacent surface or to match the original type of surface, i.e. grass, mulch, landscape bed, etc. No disturbed area shall be left unstabilized.

1.06 PROTECTION

A. Existing Work: Protect existing work, which is to remain in place, be reused, or remain the property of the Owner. Repair items which are to be salvaged and which are damaged during performance of the work to their original condition or replace with new. Do not overload pavements to remain. Provide new supports and reinforcement for existing construction weakened by demolition or removal work. Repairs, reinforcement, or structural replacement must have approval from the Architect.

B. Trees: All trees designated to remain shall be protected. No excavation shall be allowed any closer to the trunk than indicated on the construction drawings. The contractor shall not park equipment or store materials under the "drip-line" of any tree canopy.

C. Facilities: Protect mechanical services and utilities. Where removal of existing utilities and pavement is specified or indicated, provide approved barricades, temporary covering of exposed areas, and temporary services and mechanical utilities where utility outage is not allowed.
1.07 BURNING

A. Burning is not allowed.

PART 2 – PRODUCTS

2.01 EROSION CONTROL MATERIALS

A. Geotextiles
   1. Sediment/Silt fence Fabric: Polypropylene, woven monofilament geotextile, UV and soil chemical resistant:
      a. Manufacturer: Fence fabric must be on the SCDOT list #34 of approved materials.
   2. Synthetic Filter fabric and Sediment Trap Fabric: Polypropylene, staple fiber, needle punched non-woven geotextile, UV and soil chemical resistant:
      d. Manufacturers: Fabric must be on the SCDOT list #44 of approved materials.
   3. Other erosion control materials as indicated on the drawings.

PART 3 - EXECUTION

3.01 EXISTING FACILITIES TO BE REMOVED

A. Utilities and Related Equipment
   1. General Requirements
      Do not interrupt existing utilities serving occupied or used facilities, except when authorized in writing by the Architect. Do not interrupt existing utilities serving facilities occupied and used by the Owner except when approved in writing and then only after temporary utility services have been approved and provided. Do not begin demolition work until all utility disconnections have been made. Shut off and cap utilities for future use, as indicated.
   2. Disconnecting Existing Utilities
      Remove existing utilities, as indicated, and terminate in a manner conforming to the nationally recognized code covering the specific utility and approved by the Architect. When utility lines are encountered that are not indicated on the drawings, the Architect shall be notified prior to further work in that area. Remove existing meters and related equipment and return them to the respective utility according to their standard requirements (i.e. water meter and meter box shall be returned to Charleston Water Systems at their location of choice).

B. Paving and Slabs: Remove concrete paving and slabs as needed to install new work and utility lines. Provide neat sawcuts at limits of pavement removal as indicated. Sawcuts shall be at full depth of the pavement. Assume for bidding purposes that concrete sidewalks are 4 inches thick, and exterior structural or utility slabs are 6" thick, unless otherwise indicated.

C. Concrete: Saw concrete along straight lines. Make sawcuts full depth of pavement. At locations where the thickness exceeds the capabilities of a saw blade, grind smooth the rough broken area where new concrete pavement will be installed abutting the saw cut pavement so as to allow the proper installation of pre-formed expansion joint material between the existing concrete pavements and the new concrete pavements.
D. Miscellaneous Metal: Scrap metal shall become the Contractor's property. Recycle scrap metal to the greatest extent possible as part of demolition operations. Provide separate containers to collect scrap metal and transport to a scrap metal collection or recycle facility.

E. Patching: Where removals leave holes and damaged surfaces exposed in the finished work, patch and repair these holes and damaged surfaces to match adjacent finished surfaces. Finished surfaces of patched area shall be flush with the adjacent existing surface and shall match the existing adjacent surface as closely as possible as to texture and finish. Patching shall be as specified and indicated.

3.02 DISPOSITION OF MATERIALS

A. Title to Materials: Except where specified in other sections, all materials and equipment removed, and not reused, shall become the property of the Contractor, and shall be removed from the property. Title to materials resulting from demolition, is vested in the Contractor upon authorization by the Architect to begin demolition. The Owner will not be responsible for the condition or loss of, or damage to, such property after notice to proceed. Materials and equipment shall not be viewed by prospective purchasers or sold on the site.

C. Salvaged Materials and Equipment: Remove materials and equipment that are indicated and/or specified to be removed by the Contractor and that are to remain the property of the Owner, and deliver to a storage site, as directed within 10 miles of the work site.
   1. Salvage items and material to the maximum extent possible.
   2. Material salvaged for the Contractor shall be stored as approved by the Architect and shall be removed from Owner property before completion of the contract. Material salvaged for the Contractor shall not be sold on the site.

D. Unsalvageable Material

Concrete, masonry, and other noncombustible material, except concrete permitted to remain in place, shall be disposed of off the site.

3.03 CLEAN-UP

A. Debris and rubbish shall be removed from disturbed site areas, trenches, and similar excavations prior to any backfilling. Under no circumstances will rubbish or demolition debris be allowed to be buried on site. Dispose of debris, rubbish, scrap, and other non-salvageable materials resulting from removal operations with all applicable federal, state, and local regulations. Debris shall be transported in a manner that prevents spillage on streets or adjacent areas.

END OF SECTION
SECTION 033000
CAST-IN-PLACE CONCRETE

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 cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:
   1. Footings.
   2. Slabs-on-grade.
B. Products installed, but not furnished, under this Section include the following:
   1. Anchor rods and embed plates indicated to be cast into cast-in-place concrete, furnished under Division 05 Section "Structural Steel Framing"
C. Related Sections:
   1. Division 01 Section "Quality Requirements" for independent testing agency procedures and administrative requirements.

D. PERFORMANCE REQUIREMENTS
E. Moisture level in finished concrete shall be within limits acceptable to types of finish flooring indicated. Test methods and acceptable limits shall be as specified in Division 09 finish flooring Sections, or as required by finish flooring manufacturer’s written product data or certified written statement. General Contractor is responsible for choosing and implementing methods of limiting excessive moisture during construction and curing, or remedial treatment, process, or other means to bring moisture level within acceptable limits, and for assigning and contracting for these responsibilities to installers.

1.3 DEFINITIONS
A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.

1.4 SUBMITTALS
A. Product Data:
   1. Bar supports
2. Vapor barriers
3. Epoxy Bonding Adhesive
4. Cartridge Injection Adhesive
5. Form materials
6. Form-release agents
7. Evaporation retarder
8. Curing compound
9. Curing and sealing compound
10. Floor and slab treatments
11. Liquid floor slab treatments

B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1. Indicate amounts of mixing water to be withheld for later addition at Project site.
2. Mix design submittals shall include test results and/or trial batch data that meet or exceed the required average compressive strength as required by ACI 301.
3. Trial batches shall consist of identical cementitious materials, fine and coarse aggregates, and admixtures to be used for mix design.

C. Steel Reinforcement Shop Drawings:

1. Drawings that detail fabrication, bending, and placement.
2. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.
3. Include slab on grade construction joint reinforcement

D. Mill Test Reports:

1. Submit mill test reports for ASTM A615 reinforcing steel indicating compliance with the ASTM and additional restrictions
2. Submit mill test reports for ASTM A706 reinforcing steel indicating compliance with the ASTM.

E. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.

1. Location of construction joints is subject to approval of the Architect.

F. Qualification Data:

1. For ready-mix concrete manufacturer.
2. For Cartridge injection adhesive installer. Include manufacturer's training certificates or letter from manufacturer certifying training was complete with a list of individuals that were trained

G. Material Certificates: For each of the following indicating compliance with the required standards and signed by manufacturers:

1. Vapor barriers
2. Reinforcing Steel
3. Plain-Steel Welded Wire Reinforcement
4. Aggregates
5. Cementitious Materials

H. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:

1. Aggregates
   a. Submit material certificates in accordance with ACI 301 not more than 90 days old demonstrating compliance with the specified ASTM standards.

2. Cementitious materials.
   a. Submit material certificates in accordance with ACI 301 not more than 90 days old demonstrating compliance with the specified ASTM standards.

3. Capillary Barriers

I. Research/Evaluation Reports:

1. Submit ICC reports for the following:
   a. Epoxy Adhesive

J. Hot and Cold Weather Program: Describe in detail procedure for working in Hot and Cold Weather. Included detailed description of methods, materials, and equipment to be used to comply with requirements.

K. Substitutions for Epoxy Adhesive:

1. Substitution requests may only be made using products with ICC-ESR reports for the product in the specific substrate.
2. Substitution request shall include signed and sealed calculations demonstrating that the product provides equivalent performance to the specified product for each specific location and condition when calculated using the data in the referenced ESR report and in accordance with the appropriate design procedure and standards required by the building code.
3. Substitution request shall specify the diameter and embedment depth of the substituted product.
4. Any increase in material cost resulting from the substitution shall be the responsibility of the contractor.

L. Minutes of preinstallation conference.

1.5 QUALITY ASSURANCE

A. Engineering Responsibility: Preparation of Shop Drawings, design calculations, and other structural data by a qualified professional engineer.

B. Installer Qualifications: The installer shall be experienced placing, finishing, curing, treating and protecting concrete equal in material, design and scope to that required for this project.
C. Epoxy Adhesive Installer Training: Conduct a thorough training session with the manufacturer's representative. Each individual responsible for the installation of anchors shall attend the training session. Training shall consist of a review of the complete process for the installation of the anchors and the use of proper equipment for drilling and installing the anchors, to include but not limited to:

1. Hole drilling procedure. Clarify acceptability of rotary hammer drilling and/or core drilling.
2. Hole drilling equipment
3. Type and diameter of drill bits
4. Hole preparation and hole cleaning technique
5. Hole cleaning equipment
6. Adhesive injection technique
7. Adhesive injection equipment
8. Adhesive curing requirements

D. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

E. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

1. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.

F. 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.

G. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 301, "Specifications for Structural Concrete," Sections 1 through 5 and Section 7, "Lightweight Concrete.
2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

H. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

I. Preinstallation Conference: Conduct conference at Project site.

1. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, joint-filler strips, semirigid joint fillers, forms and form removal limitations, shoring and reshoring procedures, capillary barrier requirements, vapor retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, cartridge injection adhesive installer requirements, floor and slab flatness and levelness measurement, concrete repair procedures, and concrete protection.
1.6 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement:
   1. Deliver, store, and handle steel reinforcement to prevent bending and damage.
   2. Maintain reinforcement free of dirt and other deleterious materials.
   3. Store reinforcing on dunnage or other supports isolated from ground.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT

A. Reinforcing Bars:
   1. ASTM A706, Grade 60, deformed
   2. ASTM A 615/A 615M, Grade 60, deformed.
      a. With mill tested yield strength not exceeding specified yield by more than 18,000 psi.
   B. Plain-Steel Wire: ASTM A 82/A 82M, as drawn.
   C. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, plain, fabricated from as-drawn steel wire into flat sheets (rolls not allowed).

2.2 REINFORCEMENT ACCESSORIES

A. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs.
B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
C. Epoxy Adhesive: A polymer or hybrid mortar adhesive injection system for anchorage of new reinforcing steel to existing concrete construction.
   1. Provide as indicated in the Construction Drawings:
D. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
   1. Portland Cement for Polished Concrete Slabs: ASTM C 150, Type I.
   2. Portland Cement for Other Slabs: ASTM C 150, Type I, Type I/II or Type III, Supplement with the following:
      a. Fly Ash: ASTM C 618, Class F.
E. Normal-Weight Aggregates: ASTM C 33, Class 3M 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.

2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.


2.3 ADMIXTURES

A. Air-Entraining Admixture: ASTM C 260. Do not use air entraining admixture on slabs which will receive polished finish.

B. Chemical Admixtures: 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.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

C. Non-Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, non-set-accelerating, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.

2.4 VAPOR BARRIERS:

A. Vapor barrier shall have all of the following qualities:

1. Maintain permeance of less than 0.01 Perms/(ft²·hr·inHg) as tested in accordance with mandatory conditioning tests per ASTM E1745 Section 7.1 (7.1.1-7.1.5).
2. Other performance criteria:
   a. Strength: ASTM E1745 Class A.
   b. Thickness: 15 mils minimum
3. Provide third party documentation that all testing was performed on a single production roll per ASTM E1745 Section 8.1

B. Vapor barrier products:

1. Basis of Design: Stego Wrap Vapor Barrier (15-mil) by Stego Industries LLC
2. Approved Alternate: Vaporguard by Reef Industries
3. Approved Alternate: Moistop Ultra 15 Mil
4. No substitutions.

C. Seam Tape: Manufacturer’s recommended adhesive or pressure-sensitive tape.

2.5 CAPILLARY BARRIERS:
A. 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.

2.6 LIQUID FLOOR TREATMENTS

A. VOC Content: Liquid floor treatments shall have a VOC content of 200 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or silicate materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces.

1. Basis of Design Product: Subject to compliance with requirements, provide Euco Diamond Hard by Euclid Chemical Company or Architect approved equal by one of the following:
   a. Curecrete Distribution Inc.
   b. Kaufman Products, Inc.
   c. L&M Construction Chemicals, Inc.
   d. Meadows, W. R., Inc.
   e. Symons by Dayton Superior.

2.7 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering.

E. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.

2.8 RELATED MATERIALS


B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 per ASTM D 2240.

C. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:

1. Type IV, for bonding hardened or freshly mixed concrete to hardened concrete.
D. Reglets: Fabricate reglets of not less than 0.022-inch thick, galvanized-steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.

2.9 REPAIR MATERIALS

A. Cementitious Repair Mortar: Packaged, dry mix complying with ASTM C 928

1. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by repair mortar manufacturer.
2. Compressive Strength: Equal or greater than strength of concrete receiving repair, but not less than 5000 psi at 28 days when tested according to ASTM C 109/C 109M.

B. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.

1. Cement Binder: ASTM C 150, Portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by underlayment manufacturer.
4. Compressive Strength: Equal or greater than strength of concrete receiving repair, but not less than 5000 psi at 28 days when tested according to ASTM C 109/C 109M.

2.10 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.

1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than Portland cement in concrete as follows:

1. Fly Ash: 20 percent.
2. Combined Fly Ash and Pozzolan: 20 percent.

C. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

D. Admixtures: Use admixtures as noted in mix design and according to manufacturer's written instructions, limited to 20 percent, by weight, of cementitious materials.

1. Use water-reducing, high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.
2.11 CONCRETE MIXTURES FOR BUILDING ELEMENTS

A. Footings: Proportion normal-weight concrete mixture as follows:
   1. Minimum Compressive Strength: 3000 psi at 28 days.
   2. Slump Limit: 4 to 6 inches, 8 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture plus or minus 1 inch.
   3. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery.

B. Slabs-on-Grade: Proportion normal-weight concrete mixture as follows:
   1. Minimum Compressive Strength for Polished Concrete Slabs: 4000 psi at 28 days.
   2. Minimum Compressive Strength for Other Slabs: 3500 psi at 28 days.
   3. Slump Limit: 4 to 6 inches, 8 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture plus or minus 1 inch.
   4. Maximum Water-Cementitious Materials Ratio for Polished Concrete Slabs: 0.45.
   5. Air Content: 3 percent maximum at point of delivery.

2.12 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.13 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and furnish batch ticket information.

   1. Unless a detailed hot weather concrete plan incorporating the recommendations of ACI 305 has been submitted and approved comply with the following:
      a. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes.
      b. When air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.
      c. For concrete to be used in polished concrete slabs, maintain concrete temperature below 85 deg. F.

   2. Wash out all drums before loading. Ready-mix supplier shall maintain a 5” inch slump +/-1/2”. Obtain approval from Architect if slump is outside these parameters. Minimize driver added water to maintain a 5” slump at point of discharge without compromising a .45 water content ratio.
PART 3 - EXECUTION

3.1 EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."
2. Anchor rods and embeds shall be securely fastened in formwork prior to placing concrete, and concrete vibrated around the anchor or embed to ensure proper flow of concrete around anchors and embeds.
3. Anchor rod sleeves (where required) shall be accurately located and fastened in formwork prior to placing concrete.
4. Wet setting of anchors and embeds is not permitted.

3.2 VAPOR BARRIERS

A. Sheet Vapor Barriers: Place, protect, and repair sheet vapor barrier according to ASTM E 1643 and manufacturer's written instructions.

1. Place vapor barrier with longest dimension parallel to direction of pour and face laps away from the expected direction of placement whenever possible.
2. Lap joints per manufacturer, but not less than 6 inches and seal with manufacturer's recommended tape or adhesive.
3. Extend vapor barrier to edge of slab in all cases.
4. At conditions terminating into a wall turn vapor barrier up wall, extend to top of slab and seal to wall with manufacturer's tape or mastic unless obstructed by dowels or other elements or unless specifically required otherwise by manufacturer.

   a. Where specific conditions prevent turning vapor barrier up and sealing submit specific procedure for turning vapor barrier down and sealing to wall or footing.

5. Manufacturer's seam tape or mastic shall be applied to clean and dry vapor barrier in strict accordance with manufacturer's recommendations.
6. Seal all penetrations including pipes and permanent stakes per manufacturer's instructions.
7. Do not use non-permanent stakes driven through the vapor barrier.
8. Repair damaged areas with vapor barrier patch of the typical vapor barrier material sealed with manufacturer's tape or mastic in strict accordance with manufacturer's recommendations for repair.

3.3 CAPILLARY BARRIERS:

A. General: Place capillary barrier on compacted subgrade beneath vapor barrier for all slabs on grade unless noted otherwise.

1. Compact capillary barrier with mechanical equipment to an elevation tolerance of plus 0 and minus ¾ inch.
2. Capillary barriers are not required where mud slabs and below slab sheet waterproofing are indicated.
3. Ensure surface of capillary barrier is uniform to prevent damage to vapor barriers.

3.4 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
   1. Do not cut or puncture vapor barrier. Repair damage and reseal vapor barrier before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.

C. Anchorage of reinforcement into hardened concrete using cartridge injection adhesive anchors shall only be used where specifically indicated on plans or with written direction from the Engineer of Record for a specific location.

D. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

E. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

F. Welded Wire Reinforcement:
   1. Install welded wire reinforcement in longest practicable lengths
   2. Locate welded wire reinforcement in top 1/3 of slab on grades unless noted otherwise
   3. Locate welded wire reinforcement at mid-depth of concrete slab thickness over deck flutes unless noted otherwise.
   4. Lap edges and ends of adjoining sheets at least one mesh spacing plus 2", but not less than 6". Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.
   5. Slabs on Grade 4" or less in thickness: Support welded wire reinforcement on chairs, bolsters or bar supports spaced to minimize sagging, and as required to support construction traffic
      a. Alternately, welded wire reinforcement may be placed on grade and "hooked"/pulled to the proper location
      b. Placement of welded wire reinforcement after placement of concrete and "walking in" is not permitted.
   6. Slabs on Grade: Support welded wire reinforcement on chairs, bolsters or bar supports spaced to minimize sagging, and as required to support construction traffic
      a. Placement of welded wire reinforcement on grade or deck and "hooked"/pulled up into slab as concrete is placed is not permitted.
      b. Placement of welded wire reinforcement after placement of concrete and "walking in" is not permitted.
3.5 EPOXY ADHESIVE

A. Where manufacturer recommends the use of special tools for installation of anchors, such tools shall be used.

B. Drill holes perpendicular to substrate surface.

C. Drill holes with rotary impact hammer drills using carbide-tipped bits or core drills using diamond core bits as indicated in the ICC-ESR report.

D. Drill bits and core bits shall be of diameters indicated in the ICC-ESR report.

E. All holes shall be cleaned with compressed air to remove all drilling dust and other deleterious substances.

F. Remove water from holes to attain a surface dry condition unless specifically permitted otherwise by ICC-ESR report.

G. Base Material Strength: Unless otherwise specified, do not drill holes in concrete or masonry until concrete has achieved full design strength.

H. Embedded Items: Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Exercise care in coring or drilling to avoid damaging existing reinforcing or embedded items. Notify the Engineer if reinforcing steel or other embedded items are encountered during drilling. Take precautions as necessary to avoid damaging prestressing tendons, electrical and telecommunications conduit, and gas lines.

I. Inject adhesive into holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.

J. Follow manufacturer recommendations to ensure proper mixing of adhesive components.

K. Sufficient adhesive shall be injected in the hole to ensure that the annular gap is filled to the surface.

L. Remove excess adhesive from the surface.

M. Shim reinforcement with suitable device to center the reinforcement in the hole.

N. Do not disturb or load reinforcement before manufacturer specified cure time has elapsed.

O. Observe manufacturer recommendations with respect to installation temperatures.

3.6 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

1. Place joints perpendicular to main reinforcement.

2. Continue reinforcement across construction joints unless otherwise indicated.

3. Provide supplemental reinforcing and/or smooth dowels where indicated at joints.
4. Strip bulkheads from footings, beams, grade beams, tie beams, and slabs and roughen surface of concrete to a minimum 1/4” amplitude while concrete is still plastic.
5. Form keyed joints unless indicated otherwise. Embed keys at least 1-1/2 inches into concrete unless noted otherwise.
6. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
7. Locate joints in slabs on steel deck as follows:
   a. Joints parallel to joist (perpendicular to girders) shall be located at the midpoint between two adjacent joists
   b. Joints perpendicular to parallel to girders (perpendicular to joists) shall be located at the midpoint of two adjacent girders.
   c. Stagger and offset joints as required to meet the requirements.
8. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
9. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
10. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least [one-fourth of concrete thickness as follows:
   1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
   2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch wide joints into concrete.
      a. Cut joints as soon as cutting action will not tear, abrade, or otherwise damage surface, but not more than 12 hours after finished, and before concrete develops random contraction cracks.

D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
   1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated.
   2. Terminate full-width joint-filler strips not less than 1/2 inch more than 1 inch below finished concrete surface where joint sealants, specified in Division 07 Section “Joint Sealants,” are indicated.
   3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

3.7 PREPARATION FOR POLISHED CONCRETE SLABS

A. Concrete Placement: Place concrete with 5” slump at point of discharge, *strike off with laser screed, bull float 90 degrees to screeds pull direction, 10’ check rod is preferred over the bull
float, if not available the bull float shall be 6’ in length or larger, smaller bull floats are to be used on sloped area’s, vibrate & consolidate, level to the proper elevation.

B. Edges:
   1. When placing edges use a 3’ metal or wooden 2x 4 screed and run parallel with form or edge after initial screed and before floating.
   2. Hand floating shall be parallel to edge and done in 2’ increments to avoid lifting or depressing edges. Do not reach out beyond 2’ of edge with hand tools or float in a fan direction pulling excessive mud to the forms.
   3. Edges against concrete CMU should use zip strips along all edges.
   4. All edges poured against previously poured concrete shall be saw cut.

C. Machine Floating: Machine Floating with pans shall begin after placement when concretes psi is sufficient to operate without causing excessive mortar or ridges and little or no bleed water is present. Slab shall be checked and re-straightened with 10’ or larger highway straight edge or bump cutter to ensure FF’s are met.

D. Machined Edges:
   1. When using pans, over-run the formed edge by 5 inches.
   2. If walk behind machines are used, provide pans for floating. The first pass along the edges shall be with the left side of the machine which is referred to as the cutting side. This will pull the high concrete away from the edges first. The second pass shall be on the right side of the machine which is referred to as the fill side to fill the low spots.
   3. Use riding trowels in the same manner as the walk behind. The cut side of the machine is the rear; the fill side of the machine is the front.

E. Saw Cutting: Use Soff Cut saw ASAP without raveling edges or dislodging aggregates. Provide the following based on slab thickness to help minimize slab curling and panel cracking: Provide Saw Cut Joints as indicated in Construction Documents

3.8 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

B. Do not add water to concrete during delivery, at Project site, or during placement unless specifically identified in the mix design and amount of withheld water is noted on batch ticket.
   1. Do not add more water than is allowed in mix design.

C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301 and as follows.
   1. Do not add water to concrete unless the batched water is specifically noted as less than the mix design and is indicated as such on the batch ticket.
   2. Do not add more water than the amount of withheld water which is specifically identified on the batch ticket.
   3. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.

1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations 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 lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
3. Screed slab surfaces with a straightedge and strike off to correct elevations.
4. Slope surfaces uniformly to drains where required.
5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

F. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When 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 specified and approved in mixture designs.

G. Hot-Weather Placement: Comply with ACI 301 and as follows:

1. Unless a detailed hot weather concrete plan incorporating the recommendations of ACI 305 has been submitted and approved; maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

3.9 FINISHING FLOORS AND SLABS

A. General: Comply with ACI 302.1R recommendations for screeding, re-straightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
B. **Scratch Finish:** While still plastic, texture concrete surface that has been screeed and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch in one direction.

1. Apply scratch finish to surfaces to receive concrete floor toppings or to receive mortar setting beds for bonded cementitious floor finishes.

C. **Float Finish:** Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and re-straightening until surface is left with a uniform, smooth, granular texture.

1. Apply float finish to surfaces to receive trowel finish, trowel and fine broom finish, or to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.
2. Apply to mud slabs.

D. **Trowel Finish:** After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and re-straighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.

1. Apply a trowel finish to surfaces to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
2. Finish and measure surface so gap at any point between concrete surface and an unlevelled, freestanding, 10-ft long straightedge resting on two high spots and placed anywhere on the surface does not exceed 3/16 inch.

E. **Trowel Finish for Polished Concrete Slabs:** Troweling shall begin after the surface has received a float finish. Concrete finish floors shall have a 3 pass non burned steel troweled finish; the use of plastic trowel blades will help prevent burning the aggregate. The slab drying must proceed naturally and must not be hastened by the dusting on of dry cement or sand. Lightly tool or machine all edges at construction joints and exercise care that slab edges are not depressed or chattered along bulkheads, formed edges, columns, and pipes during finishing operations, particularly hand troweling.

1. Finish surfaces to the following tolerances, according to ASTM E 1155, for a randomly trafficked floor surface:
   a. Specified overall values of flatness, F(F) 45; and of levelness, F(L) 35; with minimum local values of flatness, F(F) 30; and of levelness, F(L) 24.

F. **Trowel and Fine-Broom Finish:** Apply a first trowel finish to surfaces where ceramic or quarry tile is to be installed by either thickset or thin-set method without cleavage membrane. While concrete is still plastic, slightly scarify surface with a fine broom.

1. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.

G. **Broom Finish:** Apply a broom finish to exterior concrete platforms, bulk storage bins, open shed slabs, truck wash, car wash, steps, ramps, and elsewhere as indicated.
1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

H. Polished Concrete Finish: Refer to Section 033510 – Polished Concrete Finishing.

3.10 MISCELLANEOUS CONCRETE ITEMS

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

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by 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 at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.

3.11 CONCRETE PROTECTING AND CURING

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 moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer’s written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

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. Footings:

1. Protect top sides of footings to receive masonry or concrete construction from dirt and debris.

2. Excavations:

   a. Do not allow excavations directly adjacent to or beneath footings to the absolute greatest extent possible.

   b. Where excavations must occur beneath in place footings or slabs the area shall be careful excavated as to not damage structural elements. The area shall be backfilled and compacted at the end of the work day.
c. Areas excavated below footings shall be backfilled with Controlled Low-Strength Material.

d. Areas excavated adjacent to and at or below footing elevation shall be backfilled with Controlled Low-Strength Material unless the area is large enough to be backfilled with control fill in lifts attaining proper compaction between lifts.

F. Slabs:

1. Protect slabs to remain exposed, stained or receive other non-opaque floor coverings or treatments with impervious covers to prevent staining of the slab.

2. Do not allow construction equipment or vehicles to drive on slabs.

3. Excavations:

   a. Do not allow excavations directly adjacent to or beneath slabs on grade to the absolute greatest extent possible.

   b. Where excavations must occur beneath in place footings or slabs the area shall be carefully excavated as to not damage structural elements. The area shall be backfilled and compacted at the end of the work day.

   c. Areas excavated below slabs shall be backfilled with Controlled Low-Strength Material. Areas excavated adjacent to and at or below slab elevation shall be backfilled with Controlled Low-Strength Material unless the area is large enough to be backfilled with control fill in lifts attaining proper compaction between lifts.

   d. Repair vapor barriers per manufacturer's requirements.

G. Cure concrete according to ACI 308.1, as follows:

1. 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.

   a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.

   b. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project.

2. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Reccoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

   a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project.

3. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Reccoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.
a. Apply curing and sealing compound to areas of exposed concrete not to receive any floor treatment, staining, painting or floor covering. Coordinate with finish schedule.

3.12 JOINT FILLING

A. Fill all joints in exposed concrete slabs

B. Prepare, clean, and install joint filler according to manufacturer's written instructions.
   1. Defer joint filling until concrete has aged at least one month. Do not fill joints until construction traffic has permanently ceased.

C. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.

D. Install semirigid joint filler full depth in saw-cut joints and at least 1-inch deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.13 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part Portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing. On surfaces exposed to view by blending white Portland cement and standard Portland cement so that, when dry, patching mortar will match surrounding color

C. Cementitious Repair Mortar: Mix in strict accordance with manufacturer's recommendations. Extend with aggregate are required and as permitted by manufacturer.

D. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
   1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete.
   2. Limit cut depth to 3/4 inch.
   3. Make edges of cuts perpendicular to concrete surface.
   4. Clean, dampen with water, and brush-coat holes and voids with bonding adhesive.
   5. Concealed surfaces:
      a. Fill and compact with cementitious repair mortar before bonding agent has dried.
      b. Fill form-tie voids with cementitious repair mortar or cone plugs secured in place with bonding adhesive.
   6. Exposed surfaces:
      a. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching.
      b. Fill and compact with patching mortar before bonding agent has dried
c. Compact patching mortar in place and strike off slightly higher than surrounding surface.
d. Fill form-tie voids with patching mortar secured in place with bonding adhesive

7. Repair defects on concealed formed surfaces that affect concrete’s durability and structural performance as determined by Architect.

E. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
2. After concrete has cured at least 14 days, correct high areas by grinding.
3. Correct localized low areas 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. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete.

a. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around.
b. Dampen concrete surfaces and apply epoxy bonding adhesive.
c. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate.
d. Place, compact, and finish to blend with adjacent finished concrete.
e. Place before bonding agent has dried.
f. Cure in same manner as adjacent concrete.

7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar.

a. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles.
b. Dampen cleaned concrete surfaces and apply bonding adhesive.
c. Place patching mortar before bonding agent has dried.
d. Compact patching mortar and finish to match adjacent concrete.
e. Keep patched area continuously moist for at least 72 hours.

F. Remedy for Out-of-Tolerance Work at Polished Concrete Slabs (See FF/FL Testing Requirements): The entire Random Traffic Floor shall be subdivided into Minimum Local Floor Sections bounded either by the column and half-column lines, or the construction and control joints, whichever subdivision yields the smaller areas. All Minimum Local Floor Sections measuring at or above the specified MLFF and MLFL numbers shall be accepted for F-number compliance as
constructed. All Minimum Local Floor Sections which fail to meet or exceed both specified minimum local F-numbers shall be removed and replaced (in the case of slabs-on-grade), or ground and/or re-topped (in the case of elevated slabs). No remedies for defective Minimum Local Floor Sections other than removal and replacement of slabs-on-grade and grinding and/or re-topping of elevated slabs will be permitted. Finish needs to be uniform in color and levelness with no trowel marks, footprints or depressions from hand tools, knee boards, etc. Concrete to be placed in accordance with ACI 302 1R 04 Class 5 floor. Concrete to be finished in accordance with ACI 117.

G. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and cementitious repair mortar.

H. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.14 FIELD QUALITY CONTROL

A. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports in accordance with the schedule of special inspections.

B. FF/FL Testing: Owner may engage a qualified independent testing agency to perform floor flatness, levelness, and grade conformity tests on each newly installed Random Traffic Slab within 8 hours after completion of the final troweling operation. FF and FL tests shall be made by a factory certified technician in accordance with ASTM E1155 (latest revision) using an "F-Meter". Grade conformity tests shall be made using an optical or laser level. Results of all floor tolerance tests - including a formal notice of acceptance or rejection of the work - shall be provided to polished concrete system installer within 12 hours after testing. Failure to adhere to the testing and reporting requirements set forth in this paragraph shall constitute acceptance of the work.

C. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

D. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Concrete masonry units (CMU's).

B. Related Sections:
   1. Section 076200 "Sheet Metal Flashing and Trim" for furnishing manufactured reglets installed in masonry joints.

1.2 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Owner will engage a qualified independent testing agency to perform preconstruction testing indicated below. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.

   1. Concrete Masonry Unit Test: For each type of unit required, according to ASTM C 140 for compressive strength.
   2. Mortar Test (Property Specification): For each mix required, according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C 91 for air content.
   3. Grout Test (Compressive Strength): For each mix required, according to ASTM C 1019.

1.3 ACTION SUBMITTALS

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

B. Shop Drawings: For reinforcing steel. Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement. Show elevations of reinforced walls.

C. Samples for Verification: For each type and color of exposed masonry units.

1.4 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each type and size of product indicated. For masonry units include data on material properties and material test reports substantiating compliance with requirements.

B. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C 91 for air content.

2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.

1.5 QUALITY ASSURANCE

A. Masonry Standard: Comply with ACI 530.1/ASCE 6/TMS 602 unless modified by requirements in the Contract Documents.

1.6 PROJECT CONDITIONS

A. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

B. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

PART 2 - PRODUCTS

2.1 MASONRY UNITS, GENERAL

A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects will be exposed in the completed Work.

B. Fire-Resistance Ratings: Where indicated, provide units that comply with requirements for fire-resistance ratings indicated as determined by testing according to ASTM E 119, by equivalent masonry thickness, or by other means, as acceptable to authorities having jurisdiction.

2.2 CONCRETE MASONRY UNITS

A. Regional Materials: CMUs shall be manufactured within 500 miles of Project site from aggregates and cement that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.

B. Shapes: Provide shapes indicated and for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.

C. Integral Water Repellent: Provide units made with liquid polymeric, integral water repellent admixture that does not reduce flexural bond strength for exposed units.

1. Products: Subject to compliance with requirements, provide available products that may be incorporated into the Work include, but are not limited to, the following:

a. ACM Chemistries; RainBloc.
b. BASF Aktiengesellschaft; Rheopel Plus.

D. CMUs: ASTM C 90.
1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2150 psi
2. Density Classification: Normal weight.

2.3 MASONRY LINTELS

A. General: Provide the following:

B. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs with reinforcing bars placed as indicated and filled with coarse grout.

2.4 MORTAR AND GROUT MATERIALS

A. Regional Materials: Aggregate for mortar and grout, cement, and lime shall be extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.

B. 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.

C. Hydrated Lime: ASTM C 207, Type S.

D. Portland Cement-Lime Mix: Packaged blend of Portland cement and hydrated lime containing no other ingredients.

E. Masonry Cement: ASTM C 91.

Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work to include, but not limited to, the following:

a. Essroc, Italcementi Group; Velvet
b. Holcim (US) Inc.; Mortamix Masonry Cement
c. Lafarge North America Inc.; Magnolia Masonry Cement
d. Lehigh Cement Company; Lehigh Masonry Cement

F. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C 979. Use only pigments with a record of satisfactory performance in masonry mortar.

1. Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:

a. Davis Colors; True Tone Mortar Colors.
b. Lanxess Corporation; Bayferrox Iron Oxide Pigments.
c. Solomon Colors, Inc.; SGS Mortar Colors.
G. Aggregate for Mortar: ASTM C 144.
   1. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.
   2. White-Mortar Aggregates: Natural white sand or crushed white stone.
   3. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.


I. Epoxy Pointing Mortar: ASTM C 395, epoxy-resin-based material formulated for use as pointing mortar for structural-clay tile facing units (and approved for such use by manufacturer of units); in color indicated or, if not otherwise indicated, as selected by Architect from manufacturer's colors.

J. Cold-Weather Admixture: Non-chloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.

Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Euclid Chemical Company (The): Accelguard 80.
   c. Sonneborn Products, BASF Aktiengesellschaft; Trimix-NCA.

K. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with CMUs containing integral water repellent by same manufacturer.

   1. Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:

      a. ACM Chemistries: RainBloc for Mortar.
      b. BASF Aktiengesellschaft: Rheopel Mortar Admixture.

L. Water: Potable.

2.5 REINFORCEMENT

A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60.

B. Masonry Joint Reinforcement, General: ASTM A 951/A 951M.

   1. Interior Walls: Hot-dip galvanized, carbon steel.
   2. Exterior Walls: Hot-dip galvanized, carbon steel.
   5. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.
   6. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units.
C. Masonry Joint Reinforcement for Single-Wythe Masonry: Either ladder or truss type with single pair of side rods.

2.6 TIES AND ANCHORS

A. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated.

3. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Anchor Bolts: Headed steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and flat washers; hot-dip galvanized to comply with ASTM A 153/A 153M, Class C; of dimensions indicated.

2.7 EMBEDDED FLASHING MATERIALS

A. Metal Flashing: Provide metal flashing complying with Section 076200 "Sheet Metal Flashing and Trim" and as follows:

1. Metal Drip Edge: Fabricate from stainless steel. Extend at least 3 inches into wall and 1/2 inch out from wall, with outer edge bent down 30 degrees and hemmed.
2. Metal Sealant Stop: 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 1/4 inch to form a stop for retaining sealant backer rod.

B. Flexible Flashing: Use one of the following unless otherwise indicated:

1. Copper-Laminated Flashing: 7-oz./sq. ft. copper sheet bonded between 2 layers of glass-fiber cloth. Use only where flashing is fully concealed in masonry.
   a. Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
      1) Advanced Building Products Inc.; Copper Sealtilte 2000.
      2) Dayton Superior Corporation, Dur-O-Wall Division; Copper Fabric Thru-Wall Flashing.
      3) Hohmann & Barnard, Inc.; H & B C-Fab Flashing.
      4) Sandell Manufacturing Co., Inc.; Copper Fabric Flashing.

2. Rubberized-Asphalt Flashing: Composite flashing product consisting of a pliable, adhesive rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film to produce an overall thickness of not less than 0.040 inch.
a. Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:

1) Advanced Building Products Inc.; Peel-N-Seal.
2) Carlisle Coatings & Waterproofing; CCW-705-TWF Thru-Wall Flashing.
3) Dayton Superior Corporation, Dur-O-Wal Division; Dur-O-Barrier Thru-Wall Flashing.
5) Heckmann Building Products Inc.; No. 82 Rubberized-Asphalt Thru-Wall Flashing.


a. Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:

1) DuPont; Thru-Wall Flashing.
2) Hohmann & Barnard, Inc.; Flex-Flash.
3) Hyload, Inc.; Hyload Cloaked Flashing System.
4) Mortar Net USA, Ltd.; Total Flash.

4. EPDM Flashing: Sheet flashing product made from ethylene-propylene-diene terpolymer, complying with ASTM D 4637, 0.040 inch thick.

a. Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work to include, but are not limited to, the following:

1) Carlisle Coatings & Waterproofing; Pre-Kleened EPDM Thru-Wall Flashing.
2) Firestone Specialty Products; FlashGuard.
3) Heckmann Building Products Inc.; No. 81 EPDM Thru-Wall Flashing.
4) Hohmann & Barnard, Inc.; Epra-Max EPDM Thru-Wall Flashing.
5) Sandell Manufacturing Co., Inc.; EPDM Flashing.

C. Solder and Sealants for Sheet Metal Flashings: As specified in Section 076200 "Sheet Metal Flashing and Trim."

D. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

2.8 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Pre-molded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; formulated from eurethane or PVC.
B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 or PVC, complying with ASTM D 2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

2.9 MASONRY CLEANERS

A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   
   a. Diedrich Technologies, Inc.
   b. EaCo Chem, Inc.
   c. ProSoCo, Inc.

2.10 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
2. Use portland cement-lime or masonry cement mortar unless otherwise indicated.
3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated.

1. For masonry below grade or in contact with earth, use Type S.
2. For reinforced masonry, use Type S.
3. For mortar parge coats, use Type S or Type N.
4. For exterior, above-grade, load-bearing and non-load-bearing walls and parapet walls; for interior load-bearing walls; for interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type N.
5. For interior non-load-bearing partitions, Type O may be used instead of Type N.

D. Grout for Unit Masonry: Comply with ASTM C 476.
1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
2. Proportion grout in accordance with ASTM C 476, Table 1 or paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 2000 psi.
3. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143/C 143M.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

B. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.

C. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested per ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.

3.2 TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation do not vary by more than plus or minus 1/4 inch.
2. For location of elements in plan do not vary from that indicated by more than plus or minus 1/4 inch.
3. For location of elements in elevation do not vary from that indicated by more than plus or minus 1/4 inch per story height or 1/2" maximum.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls do not vary from level by more than 1/4 inch in 10 feet or 1/2 inch maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet or 1/2 inch maximum.
3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet or 1/2 inch maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet or 1/2 inch maximum.
5. For lines and surfaces do not vary from straight by more than 1/4 inch in 10 feet or 1/2 inch maximum.

C. Joints:
1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.
2. For head and collar joints, do not vary from thickness indicated by more than plus or minus 1/4 inch.
3. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch.

3.3 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

C. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

D. Fill cores in hollow CMUs with grout to slab/footing under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

3.4 MORTAR BEDDING AND JOINTING

A. Lay CMUs as follows:

1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.

B. Lay solid masonry units with full bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Lay structural-clay tile as follows:

1. Lay vertical-cell units with full head joints unless otherwise indicated. Provide bed joints with full mortar coverage on face shells and webs.
2. Lay horizontal-cell units with full bed joints unless otherwise indicated. Keep drainage channels, if any, free of mortar. Form head joints with sufficient mortar so excess will be squeezed out as units are placed in position. Butter both sides of units to be placed, or butter one side of unit already in place and one side of unit to be placed.
3. Maintain joint thicknesses indicated except for minor variations required to maintain bond alignment. If not indicated, lay walls with 1/4- to 3/8-inch-thick joints.
4. Where epoxy-mortar pointed joints are indicated, rake out setting mortar to a uniform depth of 1/4 inch and point with epoxy mortar to comply with epoxy-mortar manufacturer’s written instructions.
D. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

E. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes other than paint unless otherwise indicated.

3.5 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

A. Anchor masonry to slab on composite deck where masonry supports slab on composite deck to comply with the following:

1. Provide an open space not less than 1 inch wide between masonry and Metal Building. Keep open space free of mortar and other rigid materials.
2. Laterally brace masonry with anchors embedded in masonry and attached to slab on composite deck.
3. Space anchors as indicated, but not more than 24 inches horizontally.

3.6 FLASHING, WEEP HOLES, CAVITY DRAINAGE, AND VENTS

A. General: Install embedded flashing at lintels, ledges, other obstructions to downward flow of water in wall, 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.

3.7 REINFORCED UNIT MASONRY INSTALLATION

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.

1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough 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. Limit height of vertical grout pours to not more than 60 inches.
3.8 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare 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. Inspections: Special Inspections according to the "International Building Code" and in accordance with local Building Department requirements.
   1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
   2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
   3. Place grout only after inspectors have verified proportions of site-prepared grout.

C. Testing Prior to Construction: One set of tests.

D. Testing Frequency: One set of tests for each 5000 sq. ft. of wall area or portion thereof.

E. Clay Masonry Unit Test: For each type of unit provided, according to ASTM C 67 for compressive strength.

F. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C 140 for compressive strength.

G. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, according to ASTM C 780.

H. Mortar Test (Property Specification): For each mix provided, according to ASTM C 780. Test mortar for mortar air content and compressive strength.

I. Grout Test (Compressive Strength): For each mix provided, according to ASTM C 1019.

3.9 PARGING

A. Parge exterior faces of below-grade masonry walls, where indicated, in 2 uniform coats to a total thickness of 3/4 inch.

B. Use a steel-trowel finish to produce a smooth, flat, dense surface. Form a wash at top of parging and a cove at bottom.

C. Damp-cure parging for at least 24 hours and protect parging until cured.

3.10 REPAIRING, POINTING, AND CLEANING

A. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

B. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
1. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes.
2. Protect surfaces from contact with cleaner.
3. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.
6. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

3.11 MASONRY WASTE DISPOSAL

A. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.
   1. Do not dispose of masonry waste as fill within 18 inches of finished grade.

B. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION
SECTION 061000
ROUGH CARPENTRY

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. Framing with dimension lumber
2. Wood blocking, cants, and nailers
3. Wood furring and grounds.

B. Related Requirements:
1. Division 06 Section "Sheathing"
2. Division 06 Section "Exterior Rough Carpentry"
3. Division 06 Section "Wood Decking"

1.3 DEFINITIONS

A. Exposed Framing: Framing not concealed by other construction.

B. Dimension Lumber: Lumber of 2 inches nominal or greater but less than 5 inches nominal in least dimension.

C. Lumber grading agencies, and the abbreviations used to reference them, include the following:
1. SPIB: The Southern Pine Inspection Bureau.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
2. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
3. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

1.5 INFORMATIONAL SUBMITTALS

A. Material Certificates: For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.
B. Evaluation Reports: For the following, from ICC-ES:
1. Wood-preservative-treated wood.
2. Engineered wood products.
5. Metal framing anchors.

1.6 QUALITY ASSURANCE
A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.7 DELIVERY, STORAGE, AND HANDLING
A. Stack lumber flat with spacers beneath and between each bundle to provide air circulation. Protect lumber from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL
A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
1. Factory mark each piece of lumber with grade stamp of grading agency.
2. For exposed lumber indicated to receive a stained or natural finish, mark grade stamp on end or back of each piece or omit grade stamp and provide certificates of grade compliance issued by grading agency. Coordinate with Architect’s preference.
3. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
4. Provide dressed lumber, S4S, unless otherwise indicated.
B. Maximum Moisture Content of Lumber: 15 percent for 2-inch nominal thickness or less, 19 percent for more than 2-inch nominal thickness unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED LUMBER
A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with the ground, Use Category UC3b for exterior construction not in contact with the ground, and Use Category UC4a for items in contact with the ground.
1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium. Do not use inorganic boron (SBX) for sill plates.
2. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.
B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or that does not comply with requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
   1. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by inspection agency. Coordinate with Architect’s preference.

D. Application: Treat items indicated on Drawings, and the following:
   1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
   2. Wood sills, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.
   3. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
   4. Wood framing members that are less than 18 inches above the ground.

2.3 DIMENSION LUMBER FRAMING

A. Rafters, Headers, Roof Beams, Continuous members at High Roof perimeter: No. 1 grade.
   1. Species: Southern pine; SPIB.

B. Other Framing Not Listed Above: No. 1.
   1. Species: Southern pine; SPIB.

2.4 MISCELLANEOUS LUMBER

A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
   1. Blocking
   2. Nailers
   3. Cants
   4. Furring
   5. Grounds
   6. Utility shelving

B. For items of dimension lumber size, provide No. 2 grade lumber of the following species:
   1. Southern pine; SPIB

C. For utility shelving, provide lumber with 15 percent maximum moisture content of the following species and grades:
   1. Southern pine; No. 1 grade; SPIB.
   2. Spruce-pine-fir (south) or spruce-pine-fir; Select Merchantable or No. 1 Common grade; NeLMA, NLGA, WCLIB, or WWPA.

D. For blocking not used for attachment of other construction, Utility, Stud, or No. 2 grade lumber of any species may be used provided it is cut and selected to eliminate defects that will interfere with its attachment and purpose.

E. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.
For furring strips for installing plywood, select boards with no knots capable of producing bent-over nails and damage to paneling.

2.5 PLYWOOD BACKING PANELS

A. Equipment Backing Panels: Exterior, Structural I, not less than 1/2-inch nominal thickness.
   1. Plywood shall comply with the testing and product requirements of the California Department of Health Services’ "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.6 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
   1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.

B. Nails: ASTM F 1667.


D. Wood Screws: ASME B18.6.1.

2.7 METAL FRAMING ANCHORS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Simpson Strong-Tie Co., Inc.
   2. USP Structural Connectors.

B. Allowable Design Loads: Provide products with allowable design loads, as published by manufacturer, that meet or exceed those indicated of products of manufacturers listed. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.

   1. Use for interior locations unless otherwise indicated.

D. Hot-Dip, Heavy-Galvanized Steel Sheet: ASTM A 653/A 653M; structural steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); G185 coating designation; and not less than 0.036 inch thick.
   1. Use for wood-preservative-treated lumber and where indicated.

E. Stainless-Steel Sheet: ASTM A 666, Type 304.
   1. Use for exterior locations and where indicated.
2.8 MISCELLANEOUS MATERIALS

A. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber or rubberized-asphalt compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.025 inch.

B. Adhesives for Gluing Furring to Concrete or Masonry: Formulation complying with ASTM D 3498 that is approved for use indicated by adhesive manufacturer.

C. Water-Repellent Preservative: NWWDA-tested and -accepted formulation containing 3-iodo-2-propynyl butyl carbamate, combined with an insecticide containing chloropyrifos as its active ingredient.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry to other construction; scribe and cope as needed for accurate fit. Locate furring, nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.

B. Framing Standard: Comply with AF&PA's WCD 1, “Details for Conventional Wood Frame Construction,” unless otherwise indicated.

C. Framing with Engineered Wood Products: Install engineered wood products to comply with manufacturer's written instructions.

D. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. Install fire-retardant treated plywood backing panels with classification marking of testing agency exposed to view.

E. Metal Framing Anchors: Install metal framing anchors to comply with manufacturer's written instructions. Install fasteners through each fastener hole.

F. Install sill sealer gasket to form continuous seal between sill plates and foundation walls.

G. Do not splice structural members between supports unless otherwise indicated.

H. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
   1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches o.c.

I. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

J. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.
1. Use inorganic boron for items that are continuously protected from liquid water.
2. Use copper naphthenate for items not continuously protected from liquid water.

K. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
   1. NES NER-272 for power-driven fasteners.

L. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.

M. For exposed work, arrange fasteners in straight rows parallel with edges of members, with fasteners evenly spaced, and with adjacent rows staggered.
   1. Use common nails unless otherwise indicated. Drive nails snug but do not countersink nail heads.

3.2 WOOD BLOCKING, AND NAILER INSTALLATION
A. Install where indicated and where required for screeding or attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.

B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.

C. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.

3.3 WOOD FURRING INSTALLATION
A. Install level and plumb with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.

B. Furring to Receive Gypsum Board as indicated.

3.4 CEILING JOIST AND RAFTER FRAMING INSTALLATION
A. Ceiling Joists: Install ceiling joists with crown edge up and complying with requirements specified above for floor joists. Face nail to ends of parallel rafters.
   1. Where ceiling joists are at right angles to rafters, provide additional short joists parallel to rafters from wall plate to first joist; nail to ends of rafters and to top plate and nail to first joist or anchor with framing anchors or metal straps. Provide 1-by-8-inch nominal- size or 2-by-4-inch nominal- size stringers spaced 48 inches o.c. crosswise over main ceiling joists.

3.5 FIELD QUALITY CONTROL
A. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports according to the "Statement of Special Inspections".
B. Testing agency will report test results promptly and in writing to Contractor and Architect.

C. Repair or Remove and replace work where test results indicate that it does not comply with specified requirements.

D. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.6 PROTECTION

A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

B. Protect rough carpentry from weather. If, despite protection, rough carpentry becomes [wet] [sufficiently wet that moisture content exceeds that specified], apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION
SECTION 061516
WOOD ROOF DECKING

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 laminated wood roof decking system.
B. Related Requirements:
   1. Section 061000 "Rough Carpentry" for dimension lumber items associated with wood roof decking.
   2. Section 061600 "Sheathing" for plywood applied over wood roof decking.
   3. Section 074113 "Metal Roof Panels" for rigid roof insulation.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. For laminated wood roof decking, include installation instructions and data on lumber, adhesives, and fabrication.
B. Samples: 24 inches long, showing the range of variation to be expected in appearance of wood roof decking.

1.4 DELIVERY, STORAGE, AND HANDLING
A. Schedule delivery of wood roof decking to avoid extended on-site storage and to avoid delaying the Work.
B. Store materials under cover and protected from weather and contact with damp or wet surfaces. Provide for air circulation within and around stacks and under temporary coverings. Stack wood roof decking with surfaces that are to be exposed in the final Work protected from exposure to sunlight.

PART 2 - PRODUCTS

2.1 WOOD ROOF DECKING
A. Species: Southern pine or Douglas Fir
B. Roof Decking Nominal Size: as indicated

C. Roof Decking Configuration: For laminated wood roof decking indicated to be of diaphragm design and construction, provide tongue-and-groove configuration that complies with research/evaluation report.

D. Face Grade: Custom or Supreme: Clear face is required. Occasional pieces may contain a small knot or minor characteristic that does not detract from the overall appearance. Design values shall be equal to or greater than Southern pine No. 1.

E. Moisture Content: Provide wood roof decking with 15 percent maximum moisture content at time of dressing.

F. Face Surface: Rough sanded.

G. Edge Pattern: Vee grooved.

H. Finish: Manufacturer's standard, oven-dried, acrylic semi-transparent factory finish; color 902.

2.2 ACCESSORY MATERIALS

A. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV, 1.6-lb/cu. ft. minimum density, square edged.

   1. Thickness: Per Architect Drawings

B. Fasteners for Wood Roof Decking: Self-Drilling screws as indicated

C. Fastener Material: Hot-dip galvanized steel.

D. Installation Adhesive: For laminated wood roof decking indicated to be of diaphragm design and construction, provide adhesive that complies with research/evaluation report.

E. Sealants: Latex, complying with ASTM C 834 Type OP, Grade NF and with applicable requirements in Section 079200 "Joint Sealants," recommended by sealant manufacturer and manufacturer of substrates for intended application.

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

      a. BASF Building Systems; Sonolac.
      b. Bostik, Inc; Chem-Calk 600.
      c. Pecora Corporation; AC-20+.
      d. Tremco Incorporated; Tremflex 834.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine support framing in areas to receive wood roof decking for compliance with installation tolerances and other conditions affecting performance of wood roof decking.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION
A. Install laminated wood roof decking to comply with manufacturer's written instructions.
   1. Locate end joints for lay-up indicated.
   2. Fasten each course of laminated wood roof decking at each support as indicated.
   3. Glue adjoining roof decking courses together by applying a 3/8-inch bead of adhesive to the top of tongues, according to research/evaluation report.

B. Anchor wood roof decking, where supported on walls as indicated.

C. Where preservative-treated roof decking must be cut during erection, apply a field-treatment preservative to comply with AWPA M4.
   1. For solid-sawn roof decking, use inorganic boron (SBX).
   2. For laminated roof decking, use copper naphthenate.

D. Apply joint sealant to seal roof decking at exterior walls at the following locations:
   1. Between roof decking and supports located at exterior walls.
   2. Between roof decking and exterior walls that butt against underside of roof decking.
   3. Between tongues and grooves of roof decking over exterior walls and supports at exterior walls.

3.3 INSULATION INSTALLATION
A. Nailer Strips: Mechanically fasten 4-inch nominal width wood nailer strips of same thickness as insulation perpendicular to sloped roof deck at the following spacing:
   1. 48 inches apart for roof slopes greater than 3 inches per 12 inches.

B. Install insulation with long joints of insulation in a continuous straight line, with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch with insulation.
   1. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.

C. Install insulation under area of roofing to achieve required thickness.

D. Adhered Insulation: Install insulation and adhere to substrate as follows:
   1. Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

E. Install plywood or OSB sheathing over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches in each direction. Loosely butt sheathing panels together and fasten to roof deck. Tape joints if required by roofing system manufacturer.
1. Fasten sheathing to resist uplift pressure at corners, perimeter, and field of roof.

3.4 ADJUSTING

A. Repair damaged surfaces and finishes after completing erection. Replace damaged roof decking if repairs are not approved by Architect.

3.5 PROTECTION

A. Provide water-resistive barrier over roof decking as the Work progresses to protect roof decking until roofing is applied.

END OF SECTION
SECTION 061600
SHEATHING

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. Wall sheathing.
   2. Roof sheathing.

B. Related Requirements:
   1. Division 06 Section “Rough Carpentry” for plywood backing panels.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Stack panels flat with spacers beneath and between each bundle to provide air circulation. Protect sheathing from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 SHEATHING

A. Plywood Roof Sheathing: Exterior, Structural I
   1. Span Rating: Not less than 32/16.
   2. Nominal Thickness: Not less than 5/8 inch.

B. Plywood Exterior Wall Sheathing: Exterior, Structural I.

C. Span Rating: Not less than 24/16

D. Nominal Thickness: Not less than 7/16 inch.

2.2 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
   1. For roof sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.

B. Nails: ASTM F 1667.
PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.

B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.

C. Securely attach to substrate by fastening as indicated, complying with the following:
   1. NES NER-272 for power-driven fasteners.
   2. Table 2304.9.1, "Fastening Schedule," in ICC's "International Building Code."

D. Use common wire nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections. Install fasteners without splitting wood.

E. Coordinate wall and roof sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.

F. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

3.2 WOOD STRUCTURAL PANEL INSTALLATION


B. Fastening Methods: Fasten panels as indicated below and as indicated by drawings.
   1. Wall and Roof Sheathing:
      a. Nail to wood framing.
      b. Space panels 1/8 inch apart at edges and ends.

C. Comply with manufacturer’s written instructions.

3.3 FIELD QUALITY CONTROL

A. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports according to the "Statement of Special Inspections."

B. Testing agency will report test results promptly and in writing to Contractor and Architect.
C. Remove and replace work where test results indicate that it does not comply with specified requirements.

D. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

END OF SECTION
SECTION 061753
SHOP-Fabricated WOOD TRUSSES

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. Wood roof trusses.
2. Wood girder trusses.
3. Wood truss bracing.
4. Metal truss accessories.
B. Related Requirements:
1. Division 06 Section "Sheathing" for roof sheathing and subflooring.
2. Division 31 Section "Termite Control" for site application of borate treatment to wood trusses.
C. Allowances: Provide wood truss bracing under the Metal-Plate-Connected Truss Bracing Allowance as specified in Division 01 Section "Allowances."

1.3 DEFINITIONS
A. Metal-Plate-Connected Wood Trusses: Planar structural units consisting of metal-plate-connected members fabricated from dimension lumber and cut and assembled before delivery to Project site.

1.4 ACTION SUBMITTALS
A. Product Data: For wood-preservative-treated lumber, fire-retardant-treated lumber, metal-plate connectors, metal truss accessories, and fasteners.
1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.

4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to truss fabricator.

5. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

B. Shop Drawings: Show fabrication and installation details for trusses.

1. Show location, pitch, span, camber, configuration, and spacing for each type of truss required.

2. Indicate sizes, stress grades, and species of lumber.

3. Indicate locations of permanent bracing required to prevent buckling of individual truss members due to design loads.

4. Indicate locations, sizes, and materials for permanent bracing required to prevent buckling of individual truss members due to design loads.

5. Indicate type, size, material, finish, design values, orientation, and location of metal connector plates.

6. Show splice details and bearing details.

C. Delegated-Design Submittal: For metal-plate-connected wood trusses indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Material Certificates: For dimension lumber specified to comply with minimum specific gravity. Indicate species and grade selected for each use and specific gravity.

B. Product Certificates: For metal-plate-connected wood trusses, signed by officer of truss fabricating firm.

C. Evaluation Reports: For the following, from ICC-ES:

1. Wood-preservative-treated lumber.

2. Fire-retardant-treated wood.

3. Metal-plate connectors.

4. Metal truss accessories.

1.6 QUALITY ASSURANCE

A. Metal Connector-Plate Manufacturer Qualifications: A manufacturer that is a member of TPI and that complies with quality-control procedures in TPI 1 for manufacture of connector plates.

1. Manufacturer's responsibilities include providing professional engineering services needed to assume engineering responsibility.

2. Engineering Responsibility: Preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.

B. Fabricator Qualifications: Shop that participates in a recognized quality-assurance program that complies with quality-control procedures in TPI 1 and that involves third-party inspection by
an independent testing and inspecting agency acceptable to Architect and authorities having jurisdiction [and] [is certified for chain of custody by an FSC-accredited certification body].

C. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Handle and store trusses to comply with recommendations in TPI BCSI, "Building Component Safety Information: Guide to Good Practice for Handling, Installing, Restraining, & Bracing Metal Plate Connected Wood Trusses."

1. Store trusses flat, above ground, and adequately supported to prevent lateral bending.
2. Protect trusses from weather by covering with waterproof sheeting, securely anchored.
3. Provide for air circulation around stacks and under coverings.

B. Inspect trusses showing discoloration, corrosion, or other evidence of deterioration. Discard and replace trusses that are damaged or defective.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Division 01 Section "Quality Requirements," to design metal-plate-connected wood trusses.

B. Structural Performance: Provide metal-plate-connected wood trusses capable of withstanding design loads within limits and under conditions indicated. Comply with requirements in TPI 1 unless more stringent requirements are specified below.

1. Design Loads: As indicated.
2. Maximum Deflection Under Design Loads:


C. Comply with applicable requirements and recommendations of the following publications:

1. TPI 1, "National Design Standard for Metal Plate Connected Wood Truss Construction."
2. TPI DSB, "Recommended Design Specification for Temporary Bracing of Metal Plate Connected Wood Trusses."

2.2 DIMENSION LUMBER

A. Certified Wood: For metal-plate-connected wood trusses and permanent bracing, provide materials produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, ”FSC Principles and Criteria for Forest Stewardship."

B. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. For exposed lumber indicated to receive a stained or natural finish, omit grade stamp and provide certificates of grade compliance issued by grading agency.
3. Provide dressed lumber, S4S.
4. Provide dry lumber with 19 percent maximum moisture content at time of dressing.

C. Minimum Chord Size for Roof Trusses: 2 by 6 inches nominal for top chords and 2 by 6 inches nominal for bottom chords.

D. Minimum Specific Gravity for Top Chords: 0.50.

E. Permanent Bracing: Provide wood bracing that complies with requirements for miscellaneous lumber in Division 06 Section "Rough Carpentry."

2.3 WOOD-PRESERVATIVE-TREATED LUMBER

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with the ground, Use Category UC3b for exterior construction not in contact with the ground, and Use Category UC4a for items in contact with the ground.

1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
2. For exposed trusses indicated to receive a stained or natural finish, use chemical formulations that do not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.

B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

1. For exposed trusses indicated to receive a stained or natural finish, mark end or back of each piece.

D. Application: Treat all trusses.

2.4 FIRE-RETARDANT-TREATED WOOD

A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-
test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Lumber by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.

1. Use treatment that does not promote corrosion of metal fasteners.
2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D 2898. Use for exterior locations and where indicated.
3. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D 3201 at 92 percent relative humidity. Use where exterior type is not indicated.
4. Design Value Adjustment Factors: Treated lumber shall be tested according to ASTM D 5664 and design value adjustment factors shall be calculated according to ASTM D 6841. For enclosed roof framing, framing in attic spaces, and where high-temperature fire-retardant treatment is indicated, provide material with adjustment factors of not less than 0.85 modulus of elasticity and 0.75 for extreme fiber in bending for Project's climatological zone.

C. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent.

D. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.

1. For exposed trusses and bracing indicated to receive a stained or natural finish, mark end or back of each piece.

E. For exposed trusses indicated to receive a stained or natural finish, use chemical formulations that do not bleed through, contain colorants, or otherwise adversely affect finishes.

F. Application: Treat all trusses unless otherwise indicated.

2.5 METAL CONNECTOR PLATES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Alpine Engineered Products, Inc.; an ITW company.
2. Cherokee Metal Products, Inc.; Masengill Machinery Company.
3. MiTek Industries, Inc.; a subsidiary of Berkshire Hathaway Inc.
4. Robbins Engineering, Inc.

B. Source Limitations: Obtain metal connector plates from single manufacturer.

C. General: Fabricate connector plates to comply with TPI 1.
D. Hot-Dip Galvanized-Steel Sheet: ASTM A 653/A 653M; Structural Steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); G60 coating designation; and not less than 0.036 inch thick.
   1. Use for interior locations unless otherwise indicated.

E. Hot-Dip Heavy-Galvanized-Steel Sheet: ASTM A 653/A 653M; Structural Steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); G185 coating designation; and not less than 0.036 inch thick.
   1. Use for wood-preservative-treated lumber and where indicated.

F. Stainless-Steel Sheet: ASTM A 666, Type 304, and not less than 0.035 inch thick.
   1. Use for exterior locations, wood-preservative-treated lumber.

2.6 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
   1. Provide fasteners for use with metal framing anchors that comply with written recommendations of metal framing manufacturer.
   2. Where trusses are exposed to weather, in ground contact, made from pressure-preservative treated wood, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.

B. Nails, Brads, and Staples: ASTM F 1667.

2.7 METAL FRAMING ANCHORS AND ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide products indicated on Drawings or comparable product by one of the following:

   1. Cleveland Steel Specialty Co.
   2. KC Metals Products, Inc.
   3. Phoenix Metal Products, Inc.
   4. Simpson Strong-Tie Co., Inc.
   5. USP Structural Connectors.

C. Allowable Design Loads: Provide products with allowable design loads, as published by manufacturer, that meet or exceed those of basis-of-design products of products of manufacturers listed. Manufacturer’s published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.

2.8 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: SSPC-Paint 20, with dry film containing a minimum of 94 percent zinc dust by weight.

B. Protective Coatings: SSPC-Paint 22, epoxy-polyamide primer.

2.9 FABRICATION

A. Cut truss members to accurate lengths, angles, and sizes to produce close-fitting joints.

B. Fabricate metal connector plates to sizes, configurations, thicknesses, and anchorage details required to withstand design loads for types of joint designs indicated.

C. Assemble truss members in design configuration indicated; use jigs or other means to ensure uniformity and accuracy of assembly with joints closely fitted to comply with tolerances in TPI 1. Position members to produce design camber indicated.

D. Connect truss members by metal connector plates located and securely embedded simultaneously in both sides of wood members by air or hydraulic press.

2.10 SOURCE QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform special inspections.

1. Provide special inspector with access to fabricator's documentation of detailed fabrication and quality-control procedures that provide a basis for inspection control of the workmanship and the fabricator's ability to conform to approved construction documents and referenced standards.
2. Provide special inspector with access to places where wood trusses are being fabricated to perform inspections.

B. Correct deficiencies in Work that special inspections indicate does not comply with the Contract Documents.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install wood trusses only after supporting construction is in place and is braced and secured.

B. If trusses are delivered to Project site in more than one piece, assemble trusses before installing.

C. Hoist trusses in place by lifting equipment suited to sizes and types of trusses required, exercising care not to damage truss members or joints by out-of-plane bending or other causes.

D. Install and brace trusses according to TPI recommendations and as indicated.

E. Install trusses plumb, square, and true to line and securely fasten to supporting construction.

F. Space trusses as indicated; adjust and align trusses in location before permanently fastening.

G. Anchor trusses securely at bearing points; use metal truss tie-downs or floor truss hangers as applicable. Install fasteners through each fastener hole in metal framing anchors according to manufacturer’s fastening schedules and written instructions.

H. Securely connect each truss ply required for forming built-up girder trusses.

1. Anchor trusses to girder trusses as indicated.

I. Install and fasten permanent bracing during truss erection and before construction loads are applied. Anchor ends of permanent bracing where terminating at walls or beams.

1. Install bracing to comply with Division 06 Section “Rough Carpentry”.

J. Install wood trusses within installation tolerances in TPI 1.

K. Do not alter trusses in field. Do not cut, drill, notch, or remove truss members.

L. Replace wood trusses that are damaged or do not meet requirements.

1. Damaged trusses may be repaired according to truss repair details signed and sealed by the qualified professional engineer responsible for truss design, when approved by Architect.
3.2 REPAIRS AND PROTECTION

A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

B. Protect wood trusses from weather. If, despite protection, wood trusses become wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

C. Repair damaged galvanized coatings on exposed surfaces with galvanized repair paint according to ASTM A 780 and manufacturer’s written instructions.

D. Protective Coating: Clean and prepare exposed surfaces of metal connector plates. Brush apply primer, when part of coating system, and one coat of protective coating.

1. Apply materials to provide minimum dry film thickness recommended by coating system manufacturer.

END OF SECTION
SECTION 06 20 00
FINISH CARPENTRY

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Finish carpentry items.
B. Tongue and groove plywood
C. Plywood ceilings

1.02 RELATED REQUIREMENTS
A. Section 09 91 23 - Interior Painting: Painting and finishing of finish carpentry items.

1.03 REFERENCE STANDARDS
A. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards; 2014.

1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
B. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, and accessories.
   1. Scale of Drawings: 1-1/2 inch to 1 foot, minimum.
   2. Provide the information required by AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS).
C. Samples: Submit two samples of wood trim 8 inch long.

1.05 QUALITY ASSURANCE
A. Fabricator Qualifications: Company specializing in fabricating the products specified in this section with minimum five years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING
A. Protect work from moisture damage.

PART 2 PRODUCTS

2.01 FINISH CARPENTRY ITEMS
A. Quality Standard: Custom Grade, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless noted otherwise.
B. Interior Woodwork Items:
   1. Ceilings; Install and prepare for paint finish.

2.02 WOOD-BASED COMPONENTS
A. Wood fabricated from old growth timber is not permitted.

2.03 FASTENINGS
A. Adhesive for Purposes Other Than Laminate Installation: Suitable for the purpose; not containing formaldehyde or other volatile organic compounds.
B. Fasteners: Of size and type to suit application.

2.04 ACCESSORIES
A. Wood Filler: Solvent base, tinted to match surface finish color.

2.05 FABRICATION
A. Shop assemble work for delivery to site, permitting passage through building openings.
B. When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide trim for scribing and site cutting.

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify adequacy of backing and support framing.

3.02 INSTALLATION
A. Install work in accordance with AWI/AWMAC/WI (AWS) requirements for custom grade installation.
B. Set and secure materials and components in place, plumb and level.
C. Carefully scribe work abutting other components, with maximum gaps of 1/32 inch. Do not use additional overlay trim to conceal larger gaps.

3.03 PREPARATION FOR SITE FINISHING
A. Set exposed fasteners. Apply wood filler in exposed fastener indentations. Sand work smooth.
B. Site Finishing: See Section 09 90 00.
C. Before installation, prime paint surfaces of items or assemblies to be in contact with cementitious materials.

3.04 TOLERANCES
A. Maximum Variation from True Position: 1/16 inch.
B. Maximum Offset from True Alignment with Abutting Materials: 1/32 inch.

END OF SECTION
SECTION 07 21 19
FOAMED-IN-PLACE INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Foamed-in-place insulation.
      1. In exterior framed roofs.

1.02 REFERENCE STANDARDS

1.03 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide product description, insulation properties, overcoat properties, and preparation requirements.
   C. Manufacturer's Installation Instructions: Indicate special procedures, and perimeter conditions requiring special attention.

1.04 QUALITY ASSURANCE
   A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with not less than three years of documented experience.
   B. Applicator Qualifications: Company specializing in performing work of the type specified, with minimum three years experience.

1.05 REGULATORY REQUIREMENTS
   A. Conform to applicable code for flame and smoke limitations.

1.06 FIELD CONDITIONS
   A. Do not apply foam when temperature is below that specified by the manufacturer for ambient air and substrate.
   B. Do not apply foam when temperature is within 5 degrees F of dew point.

PART 2 PRODUCTS

2.01 MATERIALS
   A. Foamed-In-Place Insulation: Medium-density, rigid or semi-rigid, open cell polyurethane foam; foamed on-site, using blowing agent of water or non-ozone-depleting gas.
      1. Aged Thermal Resistance: R-value of 5 (deg F hr sq ft)/Btu, minimum, when tested at 1 inch thickness in accordance with ASTM C518 after aging for 180 days at 41 degrees F.
      2. Water Vapor Permeance: Vapor retarder; 2 perm, maximum, when tested at intended thickness in accordance with ASTM E96/E96M, desiccant method.
      3. Water Absorption: Less than 2 percent by volume, maximum, when tested in accordance with ASTM D2842.
4. Air Permeance: 0.004 cfm/sq ft, maximum, when tested at intended thickness in accordance with ASTM E2178 or ASTM E283 at 1.5 psf.
5. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/450, maximum, when tested in accordance with ASTM E84.

2.02 ACCESSORIES
   A. Primer: As required by insulation manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify work within construction spaces or crevices is complete prior to insulation application.
   B. Verify that surfaces are clean, dry, and free of matter that may inhibit insulation or overcoat adhesion.

3.02 PREPARATION
   A. Mask and protect adjacent surfaces from over spray or dusting.
   B. Apply primer in accordance with manufacturer's instructions.

3.03 APPLICATION
   A. Apply insulation in accordance with manufacturer's instructions.
   B. Apply insulation by spray method, to a uniform monolithic density without voids.
   C. Apply to achieve a thermal resistance R-value of 38 at underside of all roofs.
   D. Apply overcoat monolithically, without voids to fully cover foam insulation at all locations where Foam-In-Place Insulation is not directly covered with gypsum board.
   E. Patch damaged areas.
   F. Where applied to voids and gaps assure space for expansion to avoid pressure on adjacent materials that may bind operable parts.
   G. Trim excess away for applied trim or remove as required for continuous sealant bead.

3.04 PROTECTION
   A. Do not permit subsequent construction work to disturb applied insulation.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Asphalt shingle roofing.
B. Flexible sheet membranes for underlayment.
C. Associated metal flashings and accessories.

1.02 RELATED REQUIREMENTS
A. Section 06 10 00 - Rough Carpentry: Roof sheathing.

1.03 REFERENCE STANDARDS

1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data indicating material characteristics.
C. Shop Drawings: For metal flashings, indicate specially configured metal flashings.
D. Samples: Submit two samples of each shingle color indicating color range and finish texture/pattern; for color selection.
E. Manufacturer's Installation Instructions: Indicate installation criteria and procedures.

1.05 QUALITY ASSURANCE
A. Perform Work in accordance with the recommendations of NRCA Steep Roofing Manual.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Asphalt Shingles:

2.02 ASPHALT SHINGLES
A. Asphalt Shingles: Asphalt-coated glass felt, mineral granule surfaced, complying with ASTM D3462.
   1. Fire Resistance: Class A.
   2. Wind Resistance (Uplift): Class H, when tested in accordance with ASTM D7158/D7158M.

2.03 SHEET MATERIALS
2. Water Vapor Permeance: 0.067 perm, when tested in accordance with ASTM E96/E96M Procedure A (desiccant method).

2.04 ACCESSORIES
A. Nails: Standard round wire shingle type, of hot-dipped zinc coated steel, 10 wire gage, 0.1019 inch Shank diameter, 3/8 inch head diameter, of sufficient length to penetrate through roof sheathing or 3/4 inch into roof sheathing or decking.

2.05 METAL FLASHINGS
A. Metal Flashings: Provide sheet metal eave edge, gable edge, ridge, dormer flashing, and other flashing indicated.
   1. Form sections square and accurate to profile, in maximum possible lengths, free from distortion or defects detrimental to appearance or performance.
   2. Hem exposed edges of flashings minimum 1/4 inch on underside.
B. Aluminum Sheet Metal: Prefinished aluminum, 0.016 inch minimum thickness; PVC coating, color as selected for drip edge.

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify existing conditions prior to beginning work.
B. Verify that roof penetrations and plumbing stacks are in place and flashed to deck surface.
C. Verify roof openings are correctly framed.
D. Verify deck surfaces are dry, free of ridges, warps, or voids.

3.02 PREPARATION
A. Seal roof deck joints wider than 1/16 inch as recommended by shingle manufacturer.
B. Broom clean deck surfaces before installing underlayment.

3.03 INSTALLATION - UNDERLAYERMENT
A. Underlayment: Install underlayment perpendicular to slope of roof, with ends and edges weather lapped minimum 6 inches. Stagger end laps of each consecutive layer. Nail in place. Weather lap minimum 6 inches over eave protection.
B. Items projecting through or mounted on roof: Weather lap and seal watertight with plastic cement.

3.04 INSTALLATION - METAL FLASHING AND ACCESSORIES
A. Install flashings in accordance with manufacturer's instructions and NRCA (RM) applicable requirements.
B. Weather lap joints minimum 2 inches and seal weather tight with plastic cement.
C. Secure in place with nails at 8 inches on center. Conceal fastenings.
D. Items Projecting Through or Mounted on Roofing: Flash and seal weather tight with plastic cement.

3.05 INSTALLATION - SHINGLES
A. Install shingles in accordance with manufacturer's instructions manufacturer's instructions and NRCA (RM) applicable requirements.
   1. Fasten individual shingles using 2 nails per shingle, or as required by code, whichever is greater.
   2. Fasten strip shingles using 4 nails per strip, or as required by code, whichever is greater.
B. Place shingles in straight coursing pattern with 5 inch weather exposure to produce double thickness over full roof area. Provide double course of shingles at eaves.
C. Project first course of shingles 3/4 inch beyond fascia boards.
D. Extend shingles 1/2 inch beyond face of gable edge fascia boards.

E. Extend shingles on both slopes across valley in a weave pattern and fasten. Extend shingles a minimum of 12 inches beyond valley center line to achieve woven valley, concealing the valley protection.

F. Cap hips with individual shingles, maintaining 5 inch weather exposure. Place to avoid exposed nails.

G. Coordinate installation of roof mounted components or work projecting through roof with weather tight placement of counterflashings.

H. Complete installation to provide weather tight service.

3.06 PROTECTION

A. Do not permit traffic over finished roof surface.

END OF SECTION
SECTION 07 46 46  
FIBER CEMENT SIDING

PART 1  GENERAL

1.01  SECTION INCLUDES
A. Wood-fiber cement siding.

1.02  RELATED REQUIREMENTS
A. Section 07 21 00 – Thermal Insulation: Siding substrate.
B. Section 07 25 00 - Weather Barriers: Weather barrier under siding.
C. Section 07 90 05 - Joint Sealers.
D. Section 09 90 00 - Painting and Coating: Field painting.

1.03  REFERENCE STANDARDS

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. Manufacturer's requirements for related materials to be installed by others.
   2. Preparation instructions and recommendations.
   3. Storage and handling requirements and recommendations.
   4. Installation methods.
   5. Provide fasteners and fastener pattern to meet code wind requirements.
C. Maintenance Instructions: Periodic inspection recommendations and maintenance procedures.
D. Warranty: Submit copy of manufacturer’s warranty, made out in Owner’s name, showing that it has been registered with manufacturer.

1.05  QUALITY ASSURANCE
A. Installer Qualifications: Company specializing in performing work of the type specified in this section with minimum 3 years of experience.

1.06  DELIVERY, STORAGE, AND HANDLING
A. Store products under waterproof cover and elevated above grade, on a flat surface.

PART 2  PRODUCTS

2.01  PANELS
A. Panels: Individual panels made of cement and cellulose fiber formed under high pressure with integral surface texture, complying with ASTM C1186 Type A Grade II; with machined edges, for nail attachment.
   2. Texture: Smooth.
   3. Length: 8 or 10 feet
   4. Width (Height): 4 feet.
   5. Thickness: 0.5/16 inches.
   7. Warranty: 30 year limited; transferable.
   8. Siding Manufacturers:
b. Substitutions: Product meeting the specifications and code compliance with wind speed.

2.02 ACCESSORIES
A. Trim: Smooth, rounded edges. Sizes as indicated
B. Battens: 2 inch width, 3/4 inch thick
C. Fasteners: Stainless, galvanized, corrosion resistant; length as required to penetrate minimum 1-1/4 inch. Provide fasteners required to meet code wind requirements.
D. Joint Sealer: As specified in Section 07 90 05.

PART 3 EXECUTION
3.01 PREPARATION
A. Examine substrate and clean and repair as required to eliminate conditions that would be detrimental to proper installation.
B. Verify that weather barrier has been installed over substrate completely and correctly; where required.
C. Do not begin until unacceptable conditions have been corrected.
D. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION
A. Install sheet metal flashing:

3.03 INSTALLATION
A. Install in accordance with manufacturer's instructions and recommendations.
   1. Read warranty and comply with all terms necessary to maintain warranty coverage.
   2. Use trim details indicated on drawings.
   3. Touch up all field cut edges with primer before installing.
   4. Pre-drill nail holes if necessary to prevent breakage.
B. Over Wood and Wood-plywood Sheathing: Fasten siding through sheathing into studs.
C. Allow space for thermal movement between both ends of siding panels that butt against trim, 1/8 inch; seal joint between panel and trim with specified sealant.
D. Joints in Horizontal Siding: Avoid joints in lap siding except at corners; where joints are inevitable stagger joints between successive courses.
E. Joints in Vertical Siding: Install Z-flashing in horizontal joints between successive courses of vertical siding.
F. Do not install siding less than 6 inches from surface of ground nor closer than 1 inch to roofs, patios, porches, and other surfaces where water may collect.
G. Exterior Soffit Vents: Install according to manufacturer's written instructions and in locations shown on the drawings. Provide vent area shown on drawings.
H. After installation, seal all joints except lap joints of lap siding. Seal around all penetrations. Paint all exposed cut edges.

3.04 PROTECTION
A. Protect installed products until completion of project.
B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION
SECTION 07 62 00
SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Fabricated sheet metal items, including flashings, counter flashings, gutters, and downspouts.
B. Sealants for joints within sheet metal fabrications.

1.02 RELATED REQUIREMENTS
A. Section 06 10 00 - Rough Carpentry: Wood nailers for sheet metal work.
B. Section 07 25 00 - Weather Barriers: Coordinate with weather barrier installation.
C. Section 07 46 46 - Fiber Cement Siding, Trim and Soffits: Flashings associated with fiber cement siding.
D. Section 07 92 00 - Joint Sealants: Sealing non-lap joints between sheet metal fabrications and adjacent construction.

1.03 REFERENCE STANDARDS

1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Shop Drawings: Indicate material profile, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details.
C. Samples: Submit two samples 6 by 6 inch in size illustrating metal finish color.

1.05 QUALITY ASSURANCE
A. Perform work in accordance with SMACNA (ASMM) and CDA A4050 requirements and standard details, except as otherwise indicated.

1.06 DELIVERY, STORAGE, AND HANDLING
A. Stack material to prevent twisting, bending, and abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.
B. Prevent contact with materials that could cause discoloration or staining.

PART 2 PRODUCTS

2.01 SHEET MATERIALS
A. Pre-Finished Aluminum: ASTM B209 (ASTM B209M); 20 gage, (0.032 inch) thick; plain finish shop pre-coated with modified silicone coating.
   1. Fluoropolymer Coating: High Performance Organic Finish, AAMA 2604; multiple coat, thermally cured fluoropolymer finish system.
   2. Color: To match adjacent surfaces.
2.02 ACCESSORIES
A. Fasteners: Galvanized steel, with soft neoprene washers.
B. Primer: Zinc chromate type.
C. Sealant to be Concealed in Completed Work: Non-curing butyl sealant.
D. Sealant to be Exposed in Completed Work: ASTM C920; elastomeric sealant, 100 percent silicone with minimum movement capability of plus/minus 25 percent and recommended by manufacturer for substrates to be sealed; clear.
E. Sealant: Type specified in Section 07 90 05.
F. Plastic Cement: ASTM D4586, Type I.

2.03 FABRICATION
A. Form sections true to shape, accurate in size, square, and free from distortion or defects.
B. Form pieces in longest possible lengths.
C. Hem exposed edges on underside 1/2 inch; miter and seam corners.
D. Form material with flat lock seams, except where otherwise indicated; at moving joints, use sealed lapped, bayonet-type or interlocking hooked seams.
E. Fabricate corners from one piece with minimum 18 inch long legs; seam for rigidity, seal with sealant.
F. Fabricate flashings to allow toe to extend 2 inches over roofing gravel. Return and brake edges.

2.04 GUTTER AND DOWNSPOUT FABRICATION
A. Gutters: Profile as indicated.
B. Downspouts: Rectangular profile.
C. Gutter and downspouts to be made of same material as standing seam roofing.
D. Accessories: Profiled to suit gutters and downspouts.
   2. Downspout Supports: Brackets.
E. Downspout Extenders: Same material and finish as downspouts.
F. Seal metal joints.

2.05 ACCESSORIES
A. Fasteners: Galvanized steel.
B. Primer: Zinc chromate type.
C. Concealed Sealants: Non-curing butyl sealant.
D. Exposed Sealants: ASTM C920; elastomeric sealant, with minimum movement capability as recommended by manufacturer for substrates to be sealed; color to match adjacent material.
E. Plastic Cement: ASTM D4586/D4586M, Type I.

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify window openings, door openings, roof openings, curbs, pipes, sleeves, ducts, and vents through roof are solidly set, reglets in place, and nailing strips located.
B. Verify roofing termination and base flashings are in place, sealed, and secure.

3.02 INSTALLATION
A. Install pan flashings, head flashings and base flashings in coordination with fluid-applied waterproofing and weather barriers. Provide back dam and end dams at window pan flashing.
B. Secure flashings in place using concealed fasteners.
C. Apply plastic cement compound between metal flashings and felt flashings.
D. Fit flashings tight in place; make corners square, surfaces true and straight in planes, and lines accurate to profiles.

E. Seal metal joints watertight.

F. Secure gutters and downspouts in place with concealed fasteners.

G. Slope gutters 1/4 inch per 10 feet, minimum.

END OF SECTION
SECTION 07 90 05
JOINT SEALERS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Sealants and joint backing.

1.02 REFERENCE STANDARDS

1.03 ADMINISTRATIVE REQUIREMENTS
A. Coordinate the work with other sections referencing this section.

1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data indicating sealant chemical characteristics, performance criteria, and substrate preparation.
C. Manufacturer's Installation Instructions: Indicate surface preparation.

1.05 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.06 MOCK-UP
A. Construct mock-up with specified sealant types and with other components noted.

1.07 FIELD CONDITIONS
A. Maintain temperature and humidity recommended by the sealant manufacturer during and after installation.

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.

PART 2 PRODUCTS

2.01 SEALANTS
A. General Purpose Exterior Sealant: Polyurethane; ASTM C920, Grade NS, Class 25 minimum; Uses M, G, and A; single component.
   1. Color: Match adjacent 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. Joints at fiber cement siding, trim and soffits.
      e. Other exterior joints for which no other sealant is indicated.
B. 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.
C. General Purpose Interior Sealant: Acrylic emulsion latex; ASTM C834, Type OP, Grade NF single component, paintable.
   1. Color: Match adjacent finished surfaces.

D. Tile Sealant: White silicone; ASTM C920, 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.

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 1667, closed cell PVC; 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 that could 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 C1193.
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 C1193.
C. Measure joint dimensions and size joint backers to achieve width-to-depth ratio, neck dimension, and surface bond area as recommended by manufacturer.
D. Install bond breaker where joint backing is not used.
E. Install sealant free of air pockets, foreign embedded matter, ridges, and sags.
F. Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.
G. Tool joints concave.

3.04 CLEANING
A. Clean adjacent soiled surfaces.

3.05 PROTECTION
A. Protect sealants until cured.

END OF SECTION
PART 1  GENERAL

1.01  SECTION INCLUDES
   A. Non-fire-rated hollow metal frames.

1.02  RELATED REQUIREMENTS
   A. Section 08 71 00 - DOOR HARDWARE.
   B. Section 09 90 00 - Painting and Coating: Field painting.

1.03  REFERENCE STANDARDS
   D. ANSI/SDI A250.8 - Specifications for Standard Steel Doors and Frames (SDI-100); 2014.
   F. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2015.
   I. BHMA A156.115 - American National Standard for Hardware Preparation in Steel Doors and Steel Frames; 2014.
   L. NAAMM HMMA 831 - Hardware Locations for Hollow Metal Doors and Frames; 2011.

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; and one copy of referenced standards/guidelines.
   C. Shop Drawings: Details of each opening, showing elevations, glazing, frame profiles, and any indicated finish requirements.
   D. Installation Instructions: Manufacturer’s published instructions, including any special installation instructions relating to this project.

1.05  QUALITY ASSURANCE
   A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
B. Copies of Documents at Project Site: Maintain at the project site a copy of each referenced document that prescribes installation requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Comply with NAAMM HMMA 840 or ANSI/SDI A250.8 (SDI-100) in accordance with specified requirements.

B. Protect with resilient packaging; avoid humidity build-up under coverings; prevent corrosion and adverse effects on factory applied painted finish.

PART 2 PRODUCTS

2.01 FRAMES

A. Requirements for All Frames:
   1. Steel used for fabrication of doors and frames shall comply with one or more of the following requirements; Galvannealed steel conforming to ASTM A653/A653M, cold-rolled steel conforming to ASTM A1008/A1008M, or hot-rolled pickled and oiled (HRPO) steel conforming to ASTM A1011/A1011M, Commercial Steel (CS) Type B for each.
   2. Accessibility: Comply with ICC A117.1 and ADA Standards.
   3. Door Top Closures: Flush end closure channel, with top and door faces aligned.
   4. Hardware Preparations, Selections and Locations: Comply with NAAMM HMMA 830 and NAAMM HMMA 831 or BHMA A156.115 and ANSI/SDI A250.8 (SDI-100) in accordance with specified requirements.
   5. Zinc Coating for Typical Interior and Exterior Locations: Provide metal components zinc-coated (galvanized) and/or zinc-iron alloy-coated (galvannealed) by the hot-dip process in accordance with ASTM A653/A653M, with manufacturer's standard coating thickness, unless noted otherwise for specific hollow metal doors and frames.
      a. Based on SDI Standards: Provide at least A40/ZF120 (galvannealed) when necessary, coating not required for typical interior door applications, and at least A60/ZF180 (galvannealed) for corrosive locations.
   6. Finish: Factory primed, for field finishing.

2.02 HOLLOW METAL DOORS

A. Door Finish: Factory primed and field finished.

B. Interior Doors, Non-Fire Rated:
   1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
      a. Level 3 - Extra Heavy-duty.
      b. Physical Performance Level A, 1,000,000 cycles; in accordance with ANSI/SDI A250.4.
      c. Model 1 - Full Flush.
      d. Door Face Metal Thickness: 16 gage, 0.053 inch, minimum.
      e. Zinc Coating: A60/ZF180 galvannealed coating; ASTM A653/A653M.

2.03 HOLLOW METAL FRAMES

A. Comply with standards and/or custom guidelines as indicated for corresponding door in accordance with applicable door frame requirements.

B. General:
   1. Finish: Factory primed, for field finishing.

C. Interior Door Frames, Non-Fire Rated: Full profile/continuously welded type.
   1. Frame Metal Thickness: 18 gage, 0.042 inch, minimum.

D. Frames in Masonry Walls: Size to suit masonry coursing with head member 4 inch high to fill opening without cutting masonry units.

2.04 FINISHES

A. Primer: Rust-inhibiting, complying with ANSI/SDI A250.10, door manufacturer's standard.
2.05 ACCESSORIES
   A. Grout for Frames: Portland cement grout with maximum 4 inch slump for hand troweling; thinner pumpable grout is prohibited.
   B. 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.
   C. Temporary Frame Spreaders: Provide for factory- or shop-assembled frames.

2.06 FINISHES
   A. Primer: Rust-inhibiting, complying with ANSI/SDI 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.
   C. Verify that finished walls are in plane to ensure proper door alignment.

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 doors and frames in accordance with manufacturer's instructions and related requirements of specified door and frame standards or custom guidelines indicated.
   B. Coordinate frame anchor placement with wall construction.
   C. Grout frames in masonry construction, using hand trowel methods; brace frames so that pressure of grout before setting will not deform frames.
   D. Install door hardware as specified in Section 08 71 00.
   E. Comply with glazing installation requirements of Section 08 80 00.
   F. Touch up damaged factory finishes.

3.04 TOLERANCES
   A. Clearances Between Door and Frame: Comply with related requirements of specified door and frame standards or custom guidelines indicated.
   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.

3.06 SCHEDULE
   A. Refer to Door and Frame Schedule on the drawings.

END OF SECTION
SECTION 08 16 13
FIBERGLASS REINFORCED PLASTIC (FRP) DOORS

PART 1  GENERAL
1.01  SECTION INCLUDES
   A. Fiberglass doors.
   B. Glazing.

1.02  RELATED REQUIREMENTS
   A. Section 08 71 00 - DOOR HARDWARE.

1.03  REFERENCE STANDARDS
   E. ASTM D635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position; 2014.

1.04  ADMINISTRATIVE REQUIREMENTS
   A. Coordination: Obtain hardware templates from hardware manufacturer prior to starting fabrication.

1.05  SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide manufacturer’s standard details, installation instructions, hardware and anchor recommendations.
   C. Shop Drawings: Indicate layout and profiles; include assembly methods.
      1. Indicate product components, including hardware reinforcement locations and preparations, accessories, finish colors, patterns, and textures.
      2. Indicate wall conditions, door and frame elevations, sections, materials, gages, finishes, location of door hardware by dimension, and details of openings; use same reference numbers indicated on drawings to identify details and openings.
D. Selection Samples: Submit two complete sets of color chips, illustrating manufacturer's available finishes, colors, and textures.

E. Test Reports: Submit certified test reports from qualified independent testing agency indicating doors comply with specified performance requirements.

F. Manufacturer's Qualification Statement.

G. Maintenance Data: Include instructions for repair of minor scratches and damage.

H. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer; include detailed terms of warranty.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with not less than ten years of documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in manufacturer’s original, unopened, undamaged containers with identification labels intact.

B. Store materials in original packaging, under cover, protected from exposure to harmful weather conditions and from direct contact with water.
   1. Store at temperature and humidity conditions recommended by manufacturer.
   2. Do not use non-vented plastic or canvas shelters.
   3. Immediately remove wet wrappers.

C. Store in position recommended by manufacturer, elevated minimum 4 inch above grade, with minimum 1/4 inch space between doors.

1.08 WARRANTY

A. Provide five (5) year manufacturer warranty covering materials and workmanship, including degradation or failure due to chemical contact.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Pultruded Fiberglass Reinforced Plastic (FRP) Doors:
   1. Special-Lite, Inc; AF-100 Door, AF-150 Frame: www.special-lite.com/sle.
   2. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 DOOR AND FRAME ASSEMBLIES

A. Door and Frame Assemblies: Factory-fabricated, prepared and machined for hardware.
   1. Physical Endurance: Swinging door cycle test to ANSI/SDI A250.4, Level A (1,000,000 cycles) minimum; tested with hardware and fasteners intended for use on project.
   2. Screw-Holding Capacity: Tested to 890 lbs, minimum.
   3. Surface Burning Characteristics: Flame spread index (FSI) of 0 to 25, Class A, and smoke developed index (SDI) of 450 or less, when tested in accordance with ASTM E84.
   4. Flammability: Self-extinguishing when tested in accordance with ASTM D635.
   5. Sizes: As indicated on drawings.
   7. Clearance Between Bottom of Door and Finished Floor: 1/2 inch, maximum; not less than 1/4 inch clearance to threshold.

2.03 COMPONENTS

A. Doors: Fiberglass construction with reinforced core.
   2. Core Material: Polyurethane foam, minimum 6 pcf density.
   3. Construction:
      a. Pultruded as single monolithic fiberglass reinforced plastic (FRP) panel.
b. Molded in one piece including through color gel coating on each side; manufacturer's standard subframe, core and faces fused during curing; hardware reinforcements.

4. Face Sheet Texture: Smooth.
5. Subframe and Reinforcements: Manufacturer's standard materials.
6. Waterproof Integrity: Provide factory fabricated edges, cut-outs, and hardware preparations of fiberglass reinforced plastic (FRP); provide cut-outs with joints sealed independently of glazing, louver inserts, or trim.
7. Hardware Preparations: Factory reinforce, machine, and prepare for door hardware including field installed items; provide solid blocking for each item; field cutting, drilling or tapping is not permitted; obtain manufacturer's hardware templates for preparation as necessary.

2.04 PERFORMANCE REQUIREMENTS
A. Provide door assemblies that have been designed and fabricated in compliance with specified performance requirements.

B. Wind-Borne-Debris Resistance: Identical full-size glazed assembly without auxiliary protection, per IBC 2015 for Large and Small Missile impact and pressure cycling at design wind pressure.

C. Forced Entry Resistance: Pass in accordance with AAMA 1304 test method, 300lb Pull Test.

D. Water Leakage: No uncontrolled leakage on interior face when tested in accordance with ASTM E331 at differential pressure of 7.5 psf.

E. Air Leakage: Maximum of 0.1 cu ft/min/sq ft at 6.27 psf differential pressure, when tested in accordance with ASTM E283.

F. Physical Endurance, AAMA 920-11: 2,00,00 cycles, no damage.

G. Fiberglass Reinforced Plastic (FRP) Face Sheet Properties:
1. IZOD Impact Resistance: ASTM D256, 7 ft lbf/inch of width, minimum, with notched izod.
2. Tensile Strength at Break: ASTM D638, 12,300 psi, minimum.
3. Water Absorption: ASTM D570, 0.16 percent, maximum, after 24 hours at 74 degrees F.
4. Flexural Strength: ASTM D790, 27,000 psi, minimum.

2.05 FINISHES
A. Painted: Two-part aliphatic polyurethane, low VOC industrial coating.
1. Thickness: Minimum 5 mils wet thickness.
2. Impact Resistance, ASTM-D2794: 140 in-lbs (direct), 50 in-lbs (reverse) @ 5 mils thickness.
3. Color: As selected by Architect from manufacturer's full line of colors.

2.06 ACCESSORIES
A. Stops for Glazing: Fiberglass, unless otherwise indicated or required by fire rating; provided by door manufacturer to fit factory made openings, with color and texture to match door; fasteners shall maintain waterproof integrity.
1. Exterior Doors: Provide non-removable stops on exterior side with continuous compression gasket weatherseal.
2. Glazed Openings: Provide removable stops on interior side.
3. Opening Sizes and Shapes: As indicated on drawings.

B. Glazing:
1. Fully tempered float glass, minimum inch thick required to meet specifications and IBC 2015, clear.

C. Door Hardware: As specified in Section 08 71 00.
PART 3  EXECUTION

3.01  EXAMINATION
A. Verify actual dimensions of openings by field measurements before door fabrication; show recorded measurements on shop drawings.
B. Do not begin installation until substrates have been properly prepared.
C. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02  INSTALLATION
A. Install in accordance with manufacturer's instructions; do not penetrate frames with anchors.
B. Install exterior doors in accordance with ASTM E2112.
C. Install door hardware as specified in Section 08 71 00.
D. Set units plumb, level, and true-to-line, without warping or racking doors, and with specified clearances; anchor in place.
E. Set thresholds in continuous bed of sealant.
F. Separate aluminum and other metal surfaces from sources of corrosion of electrolytic action at points of contact with other materials.
G. Repair or replace damaged installed products.

3.03  ADJUSTING
A. Lubricate, test, and adjust doors to operate easily, free from warp, twist or distortion, and to fit watertight for entire perimeter.
B. Adjust hardware for smooth and quiet operation.
C. Adjust doors to fit snugly and close without sticking or binding.

3.04  CLEANING
A. Clean installed products in accordance with manufacturer’s instructions prior to owner’s acceptance.

3.05  PROTECTION
A. Protect installed products from damage until Date of Substantial Completion.

END OF SECTION
SECTION 08 43 13
ALUMINUM-FRAMED STOREFRONTS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Aluminum-framed storefront, with vision glass.
B. Aluminum doorframes.
C. Weatherstripping.

1.02 RELATED REQUIREMENTS
A. Section 07 25 00 - Weather Barriers: Sealing framing to weather barrier installed on adjacent construction.
B. Section 07 92 00 - Joint Sealants: Sealing joints between frames and adjacent construction.
C. Section 08 16 13 – Fiberglass Reinforced Plastic (FRP) Doors
D. Section 08 71 00 – Door hardware
E. Section 08 80 00 - Glazing: Glass and glazing accessories.

1.03 REFERENCE STANDARDS
A. AAMA CW-10 - Care and Handling of Architectural Aluminum From Shop to Site; 2015.

1.04 ADMINISTRATIVE REQUIREMENTS
A. Coordinate with installation of other components that comprise the exterior enclosure.

1.05 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide component dimensions, describe components within assembly, anchorage and fasteners, glass and infill, internal drainage details.
C. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related Work, attachment requirements to meet IBC wind load and impact resistance requirements, expansion and contraction joint location and details, and field welding required.
D. Manufacturer's Certificate: Certify that the products supplied meet or exceed the specified requirements.
E. Design Data: Provide framing member structural and physical characteristics, engineering calculations, and dimensional limitations.
F. Hardware Schedule: Complete itemization of each item of hardware to be provided for each door, cross-referenced to door identification numbers in Contract Documents.
G. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.
1.06 QUALITY ASSURANCE
   A. Manufacturer Qualifications: Company specializing in performing work of type specified and with at least 5 years of documented experience.
   B. Installer Qualifications: Company specializing in performing work of type specified and with at least three years of experience.

1.07 DELIVERY, STORAGE, AND HANDLING
   A. Handle products of this section in accordance with AAMA CW-10.
   B. Protect finished aluminum surfaces with wrapping. Do not use adhesive papers or sprayed coatings that bond to aluminum when exposed to sunlight or weather.

1.08 FIELD CONDITIONS
   A. Do not install sealants when ambient temperature is less than 40 degrees F. Maintain this minimum temperature during and 48 hours after installation.

1.09 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. Provide five year manufacturer warranty against failure of glass seal on insulating glass units, including interpane dusting or misting. Include provision for replacement of failed units.
   D. Provide five year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. Aluminum-Framed Storefront and Doors:
      4. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 STOREFRONT
   A. Aluminum-Framed Storefront: Factory fabricated, factory finished aluminum framing members with infill, and related flashings, anchorage and attachment devices.
      1. Glazing Position: Centered (front to back).
      3. Finish: Class I clear anodic.
         a. Factory finish all surfaces that will be exposed in completed assemblies.
      5. Fabrication: Joints and corners flush, hairline, and weatherproof, accurately fitted and secured; prepared to receive anchors and hardware; fasteners and attachments concealed from view; reinforced as required for imposed loads.
      7. System Internal Drainage: Drain to the exterior by means of a weep drainage network any water entering joints, condensation occurring in glazing channel, and migrating moisture occurring within system.
      8. Expansion/Contraction: Provide for expansion and contraction within system components caused by cycling temperature range of 170 degrees F over a 12 hour period without causing detrimental effect to system components, anchorages, and other building elements.
      9. Movement: Allow for movement between storefront and adjacent construction, without damage to components or deterioration of seals.
10. Perimeter Clearance: Minimize space between framing members and adjacent construction while allowing expected movement.

B. Performance Requirements:
1. Wind Loads: Design and size components to withstand the specified load requirements without damage or permanent set, when tested in accordance with ASTM E330/E330M, using loads 1.5 times the design wind loads and 10 second duration of maximum load.
   a. Design Wind Loads: Comply with requirements of 2018 IBC. See design wind load pressures on the structural drawings.
   b. Member Deflection: Limit member deflection to flexure limit of glass in any direction, with full recovery of glazing materials.
2. Wind-Borne-Debris Resistance: Identical full-size glazed assembly without auxiliary protection, tested by independent agency in accordance with ASTM E1996 for Wind Zone 4 - Additional Protection for Large and Small Missile impact and pressure cycling at design wind pressure.
3. Water Penetration Resistance: No uncontrolled water on interior face, when tested in accordance with ASTM E331 at pressure differential of 8 psf.
4. Air Leakage: Maximum of 0.06 cu ft/min sq ft of wall area, when tested in accordance with ASTM E283 at 6.27 psf pressure differential across assembly.

2.03 COMPONENTS
A. Aluminum Framing Members: Tubular aluminum sections, thermally broken with interior section insulated from exterior, drainage holes and internal weep drainage system.
B. Glazing: As specified in Section 08 80 00.

2.04 MATERIALS
B. Fasteners: Stainless steel.
C. Exposed Flashings and Column Covers: Aluminum sheet, 20 gage, 0.032 inch minimum thickness; finish to match framing members.
D. Glazing Gaskets: Type to suit application to achieve weather, moisture, and air infiltration requirements.

2.05 FINISHES
A. Class I Clear Anodized Finish: AAMA 611 AA-M45C22A41 clear anodic coating not less than 0.7 mils thick.

2.06 HARDWARE
A. For each door, include weather stripping, sill sweep strip, and threshold.

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify dimensions, tolerances, and method of attachment with other work.
B. Verify that wall openings and adjoining air and vapor seal materials are ready to receive work of this section.
3.02 INSTALLATION
A. Install wall system in accordance with manufacturer's instructions.
B. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.
C. Provide alignment attachments and shims to permanently fasten system to building structure.
D. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.
E. Provide thermal isolation where components penetrate or disrupt building insulation.
F. Install sill flashings. Turn up ends and edges; seal to adjacent work to form water tight dam.
G. Where fasteners penetrate sill flashings, make watertight by seating and sealing fastener heads to sill flashing.
H. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.
I. Set thresholds in bed of sealant and secure.
J. Install hardware using templates provided.
K. Touch-up minor damage to factory applied finish; replace components that cannot be satisfactorily repaired.

3.03 TOLERANCES
A. Maximum Variation from Plumb: 0.06 inches every 3 ft non-cumulative or 1/16 inches per 10 ft, whichever is less.
B. Maximum Misalignment of Two Adjoining Members Abutting in Plane: 1/32 inch.

3.04 ADJUSTING
A. Adjust operating hardware and sash for smooth operation.

3.05 CLEANING
A. Remove protective material from pre-finished aluminum surfaces.
B. Wash down surfaces with a solution of mild detergent in warm water, applied with soft, clean wiping cloths. Take care to remove dirt from corners. Wipe surfaces clean.

3.06 PROTECTION
A. Protect installed products from damage until Date of Substantial Completion.

END OF SECTION
SECTION 08 56 53
SECURITY SLIDING WINDOWS

PART 1 GENERAL

1.1 SECTION INCLUDES
A. Flush-Mount Security Windows:
   1. Modular security walk-up windows.

1.2 RELATED SECTIONS
A. Section 07 62 00 – Sheet Metal Flashing and Trim.
B. Section 07 92 00 – Joint Sealants.
C. Section 08 43 13 – Aluminum-Framed Storefronts

1.3 REFERENCES
B. ASTM A 653 – Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
C. ASTM B 209 – Aluminum and Aluminum-Alloy Sheet and Plate.
D. ASTM B 221 – Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
F. ASTM C 1048 – Heat-Treated Flat Glass – Kind HS, Kind FT Coated and Uncoated Glass.
G. ASTM E 773 – Accelerated Weathering of Sealed Insulating Glass Units.
H. ASTM E 774 – Classification of the Durability of Sealed Insulating Glass Units.

1.4 SUBMITTALS
A. Comply with Section 01 30 00– Administrative Requirements.
B. Product Data: Submit manufacturer's product data, including materials, components, fabrication, finish, and installation instructions.
C. Shop Drawings: Submit manufacturer's shop drawings, including plans, elevations, sections, and details, indicating dimensions, tolerances, materials, fabrication, glazing, fasteners, hardware, finish, electrical wiring diagrams, options, and accessories.
D. Samples: Submit manufacturer's samples of standard finishes.
E. Manufacturer's Certification: Submit manufacturer's certification that materials comply with specified requirements and are suitable for intended application.
F. Manufacturer's Project References: Submit list of successfully completed security window projects, including project name and location, name of architect, and type and quantity of security windows installed.
G. Operation and Maintenance Manual: Submit manufacturer's operation and maintenance manual, including operation, maintenance, adjustment, and cleaning instructions, trouble shooting guide and parts list.
H. Warranty: Submit manufacturer's standard warranty.

1.5 QUALITY ASSURANCE
A. Manufacturer's Qualifications: Minimum of 10 years successful experience continuously manufacturing security windows.

1.6 DELIVERY, STORAGE, AND HANDLING
A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.
B. Storage: Store materials in clean, dry area indoors in accordance with manufacturer's printed instructions.
C. Handling: Protect materials and finish from damage during handling and installation.
PART 2  PRODUCTS

2.1 MANUFACTURER:
B. Or Approved Equal.

2.2 FLUSH-MOUNT SECURITY WINDOWS
   1. Approvals:
      b. Miami-Dade County Product Approval N.O.A. No. 10-0224.01, Large and Small Missile: 11/16-inch Secur-Temp 4 Glazing, ASTM C 1036
   2. Window Dimensions: 47-1/2 inches wide by 43-1/2 inches high by 4-1/2 inches deep
   4. Service Panel Type: Sliding, 1 panel.
   5. Opening Direction: Right to left & left to right. Customer View-Outside
   8. Galvanized Steel Sheet: ASTM A 653, G90.
   12. Lock: Self-latching Adams Rite MS1847 Series with Adams Rite 1000 Series turn.
   13. Glazing:
      a. 11/16" Secur-Tem 4 ASTM C 1036-91 Smash & Grab (Impact Rated)

2.4 FABRICATION
A. Assembly: Factory assembled, factory glazed.

2.5 ALUMINUM FINISH

PART 3  EXECUTION

3.1 EXAMINATION
A. Examine areas to receive security windows. Notify Architect of conditions that would adversely affect installation or subsequent use. Do not proceed with installation until unsatisfactory conditions are corrected.

3.2 PREPARATION
A. Ensure openings to receive security windows are plumb, level, square, accurately aligned, correctly located, and in tolerance.

3.3 INSTALLATION
A. Install security windows in accordance with manufacturer's printed installation instructions.
B. Install security windows plumb, level, square, true to line, and without warp or rack.
C. Install security window components weathertight.
D. Anchor security windows securely in place to supports. Use attachment methods permitting adjustment for construction tolerances, irregularities, alignment, and expansion and contraction.
E. Separate aluminum from other metal surfaces with bituminous coatings or other means approved by Architect.
F. Sheet Metal Flashing: Install sheet metal flashing as specified in Section 07 62 00.
G. Joint Sealants: Install joint sealants as specified in Section 07 90 05.
H. Repair minor damages to finish in accordance with manufacturer's printed installation instructions and as approved by Architect.
I. Remove and replace damaged components that cannot be successfully repaired as determined by Architect.

3.4 ADJUSTING
A. Adjust movable service panels to be weathertight in closed position.
B. Adjust movable service panels to function properly and for smooth operation without binding.

3.5 CLEANING
A. Clean security windows promptly after installation in accordance with manufacturer's printed installation instructions.
B. Remove excess joint sealant in accordance with sealant manufacturer's printed installation instructions.
C. Do not use harsh cleaning materials or methods that would damage glazing or finish.

3.6 PROTECTION
A. Protect installed security windows to ensure that, except for normal weathering, security windows will be without damage or deterioration at time of substantial completion.

END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:
1. Mechanical and electrified door hardware
2. Electronic access control system components

B. Section excludes:
1. Windows
2. Cabinets (casework), including locks in cabinets
3. Signage
4. Toilet accessories
5. Overhead doors

C. Related Sections:
1. Division 01 Section "Alternates" for alternates affecting this section.
2. Division 06 Section "Rough Carpentry"
3. Division 06 Section "Finish Carpentry"
4. Division 07 Section "Joint Sealants" for sealant requirements applicable to threshold installation specified in this section.
5. Division 08 Sections:
   a. "Metal Doors and Frames"
   b. "Flush Wood Doors"
   c. "Stile and Rail Wood Doors"
   d. "Interior Aluminum Doors and Frames"
   e. "Aluminum-Framed Entrances and Storefronts"
   f. "Stainless Steel Doors and Frames"
   g. "Special Function Doors"
   h. "Entrances"
6. Division 26 "Electrical" sections for connections to electrical power system and for low-voltage wiring.
7. Division 28 "Electronic Safety and Security" sections for coordination with other components of electronic access control system and fire alarm system.

1.02 REFERENCES

A. UL LLC
1. UL 10B - Fire Test of Door Assemblies
2. UL 10C - Positive Pressure Test of Fire Door Assemblies
3. UL 1784 - Air Leakage Tests of Door Assemblies
4. UL 305 - Panic Hardware

B. DHI - Door and Hardware Institute
1. Sequence and Format for the Hardware Schedule
2. Recommended Locations for Builders Hardware
3. Keying Systems and Nomenclature
4. Installation Guide for Doors and Hardware

C. NFPA – National Fire Protection Association

1. NFPA 70 – National Electric Code
4. NFPA 105 – Smoke and Draft Control Door Assemblies
5. NFPA 252 – Fire Tests of Door Assemblies

D. ANSI - American National Standards Institute

2. ANSI/BHMA A156.1 - A156.29, and ANSI/BHMA A156.31 - Standards for Hardware and Specialties
3. ANSI/BHMA A156.28 - Recommended Practices for Keying Systems
4. ANSI/WDMA I.S. 1A - Interior Architectural Wood Flush Doors
5. ANSI/SDI A250.8 - Standard Steel Doors and Frames

1.03 SUBMITTALS

A. General:

1. Submit in accordance with Conditions of Contract and Division 01 Submittal Procedures.
2. Prior to forwarding submittal:
   a. Review drawings and Sections from related trades to verify compatibility with specified hardware.
   b. Highlight, encircle, or otherwise specifically identify on submittals: deviations from Contract Documents, issues of incompatibility or other issues which may detrimentally affect the Work.

B. Action Submittals:

1. Product Data: Submit technical product data for each item of door hardware, installation instructions, maintenance of operating parts and finish, and other information necessary to show compliance with requirements.
2. Samples for Verification: If requested by Architect, submit production sample of requested door hardware unit in finish indicated and tagged with full description for coordination with schedule.
   a. Samples will be returned to supplier. Units that are acceptable to Architect may, after final check of operations, be incorporated into Work, within limitations of key coordination requirements.
3. Door Hardware Schedule:
   a. Submit concurrent with submissions of Product Data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate fabrication of other work critical in Project construction schedule.
b. Submit under direct supervision of a Door Hardware Institute (DHI) certified Architectural Hardware Consultant (AHC) or Door Hardware Consultant (DHC) with hardware sets in vertical format as illustrated by Sequence of Format for the Hardware Schedule published by DHI.

c. Indicate complete designations of each item required for each opening, include:
   1) Door Index: door number, heading number, and Architect's hardware set number.
   2) Quantity, type, style, function, size, and finish of each hardware item.
   3) Name and manufacturer of each item.
   4) Fastenings and other pertinent information.
   5) Location of each hardware set cross-referenced to indications on Drawings.
   6) Explanation of all abbreviations, symbols, and codes contained in schedule.
   7) Mounting locations for hardware.
   8) Door and frame sizes and materials.
   9) Degree of door swing and handing.
  10) Operational Description of openings with electrified hardware covering egress, ingress (access), and fire/smoke alarm connections.

4. Key Schedule:

   a. After Keying Conference, provide keying schedule that includes levels of keying, explanations of key system's function, key symbols used, and door numbers controlled.
   b. Use ANSI/BHMA A156.28 "Recommended Practices for Keying Systems" as guideline for nomenclature, definitions, and approach for selecting optimal keying system.
   c. Provide 3 copies of keying schedule for review prepared and detailed in accordance with referenced DHI publication. Include schematic keying diagram and index each key to unique door designations.
   d. Index keying schedule by door number, keyset, hardware heading number, cross keying instructions, and special key stamping instructions.
   e. Provide one complete bitting list of key cuts and one key system schematic illustrating system usage and expansion. Forward bitting list, key cuts and key system schematic directly to Owner, by means as directed by Owner.
   f. Prepare key schedule by or under supervision of supplier, detailing Owner's final keying instructions for locks.

C. Informational Submittals:

1. Provide Qualification Data for Supplier, Installer and Architectural Hardware Consultant.
2. Provide Product Data:

   a. Certify that door hardware approved for use on types and sizes of labeled fire-rated doors complies with listed fire-rated door assemblies.
   b. Include warranties for specified door hardware.

D. Closeout Submittals:

1. Operations and Maintenance Data: Provide in accordance with Division 01 and include:

   a. Complete information on care, maintenance, and adjustment; data on repair and replacement parts, and information on preservation of finishes.
   b. Catalog pages for each product.
   c. Final approved hardware schedule edited to reflect conditions as installed.
   d. Final keying schedule
e. Copy of warranties including appropriate reference numbers for manufacturers to identify project.
f. As-installed wiring diagrams for each opening connected to power, both low voltage and 110 volts.

E. Inspection and Testing:

1. Submit written reports to the Owner and Authority Having Jurisdiction (AHJ) of the results of functional testing and inspection for:
   a. Fire door assemblies, in compliance with NFPA 80.
   b. Required egress door assemblies, in compliance with NFPA 101.

1.04 QUALITY ASSURANCE

A. Qualifications and Responsibilities:

1. Supplier: Recognized architectural hardware supplier with a minimum of 5 years documented experience supplying both mechanical and electromechanical door hardware similar in quantity, type, and quality to that indicated for this Project. Supplier to be recognized as a factory direct distributor by the manufacturer of the primary materials with a warehousing facility in the Project’s vicinity. Supplier to have on staff, a certified Architectural Hardware Consultant (AHC) or Door Hardware Consultant (DHC) available to Owner, Architect, and Contractor, at reasonable times during the Work for consultation.
2. Installer: Qualified tradesperson skilled in the application of commercial grade hardware with experience installing door hardware similar in quantity, type, and quality as indicated for this Project.
3. Architectural Hardware Consultant: Person who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project and meets these requirements:
   a. For door hardware: DHI certified AHC or DHC.
   b. Can provide installation and technical data to Architect and other related subcontractors.
   c. Can inspect and verify components are in working order upon completion of installation.
   d. Capable of producing wiring diagram and coordinating installation of electrified hardware with Architect and electrical engineers.
4. Single Source Responsibility: Obtain each type of door hardware from single manufacturer.

B. Certifications:

1. Fire-Rated Door Openings:
   a. Provide door hardware for fire-rated openings that complies with NFPA 80 and requirements of authorities having jurisdiction.
   b. Provide only items of door hardware that are listed products tested by UL LLC, Intertek Testing Services, or other testing and inspecting organizations acceptable to authorities having jurisdiction for use on types and sizes of doors indicated, based on testing at positive pressure and according to NFPA 252 or UL 10C and in compliance with requirements of fire-rated door and door frame labels.
2. Smoke and Draft Control Door Assemblies:
   a. Provide door hardware that meets requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105
   b. Comply with the maximum air leakage of 0.3 cfm/sq. ft. (3 cu. m per minute/sq. m) at tested pressure differential of 0.3-inch wg (75 Pa) of water.

3. Electrified Door Hardware
   a. Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction.

4. Accessibility Requirements:
   a. Comply with governing accessibility regulations cited in "REFERENCES" article 087100. 1.02.D3 herein for door hardware on doors in an accessible route. This project must comply with all Federal Americans with Disability Act regulations and all Local Accessibility Regulations.

C. Pre-Installation Meetings

1. Keying Conference
   a. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including:
      1) Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
      2) Preliminary key system schematic diagram.
      3) Requirements for key control system.
      4) Requirements for access control.
      5) Address for delivery of keys.

2. Pre-installation Conference
   a. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
   b. Inspect and discuss preparatory work performed by other trades.
   c. Inspect and discuss electrical roughing-in for electrified door hardware.
   d. Review sequence of operation for each type of electrified door hardware.
   e. Review required testing, inspecting, and certifying procedures.
   f. Review questions or concerns related to proper installation and adjustment of door hardware.

3. Electrified Hardware Coordination Conference:
   a. Prior to ordering electrified hardware, schedule and hold meeting to coordinate door hardware with security, electrical, doors and frames, and other related suppliers.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up for hardware delivered to Project site. Promptly replace products damaged during shipping.
B. Tag each item or package separately with identification coordinated with final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package. Deliver each article of hardware in manufacturer's original packaging.

C. Maintain manufacturer-recommended environmental conditions throughout storage and installation periods.

D. Provide secure lock-up for door hardware delivered to Project. Control handling and installation of hardware items so that completion of Work will not be delayed by hardware losses both before and after installation.

E. Handle hardware in manner to avoid damage, marring, or scratching. Correct, replace or repair products damaged during Work. Protect products against malfunction due to paint, solvent, cleanser, or any chemical agent.

F. Deliver keys to manufacturer of key control system for subsequent delivery to Owner.

1.06 COORDINATION

A. Coordinate layout and installation of floor-recessed door hardware with floor construction. Cast anchoring inserts into concrete.

B. Installation Templates: Distribute for doors, frames, and other work specified to be factory or shop 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.

C. Security: Coordinate installation of door hardware, keying, and access control with Owner's security consultant.

D. Electrical System Roughing-In: Coordinate layout and installation of electrified door hardware with connections to power supplies and building safety and security systems.

1.07 WARRANTY

A. Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within published warranty period.

1. Warranty does not cover damage or faulty operation due to improper installation, improper use or abuse.

2. Warranty Period: Beginning from date of Substantial Completion, for durations indicated in manufacturer's published listings.

1.08 MAINTENANCE

A. Furnish complete set of special tools required for maintenance and adjustment of hardware, including changing of cylinders.

B. Turn over unused materials to Owner for maintenance purposes.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. The Owner requires use of certain products for their unique characteristics and project suitability to ensure continuity of existing and future performance and maintenance standards. After investigating available product offerings, the Awarding Authority has elected to prepare proprietary specifications. These products are specified with the notation: "No Substitute."
1. Where "No Substitute" is noted, submittals and substitution requests for other products will not be considered.

B. Approval of manufacturers and/or products other than those listed as "Scheduled Manufacturer" or "Acceptable Manufacturers" in the individual article for the product category shall be in accordance with QUALITY ASSURANCE article, herein.

C. Approval of products from manufacturers indicated in "Acceptable Manufacturers" is contingent upon those products providing all functions and features and meeting all requirements of scheduled manufacturer's product.

D. Where specified hardware is not adaptable to finished shape or size of members requiring hardware, furnish suitable types having same operation and quality as type specified, subject to Architect's approval.

2.02 MATERIALS

A. Fabrication

1. Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. provide screws according to manufacturer’s recognized installation standards for application intended.

2. Finish exposed screws to match hardware finish, or, if exposed in surfaces of other work, to match finish of this other work including prepared for paint surfaces to receive painted finish.

3. Provide concealed fasteners wherever possible for hardware units exposed when door is closed. Coordinate with "Metal Doors and Frames", "Flush Wood Doors", "Stile and Rail Wood Doors" to ensure proper reinforcements. Advise the Architect where visible fasteners, such as thru bolts, are required.

B. Provide screws, bolts, expansion shields, drop plates and other devices necessary for hardware installation.

1. Where fasteners are exposed to view: Finish to match adjacent door hardware material.

2.03 HINGES

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:
   a. Ives 5BB series

2. Acceptable Manufacturers and Products:
   a. No Substitute

B. Requirements:

1. Provide hinges conforming to ANSI/BHMA A156.1.
2. Provide five knuckle, ball bearing hinges.
3. 1-3/4 inch (44 mm) thick doors, up to and including 36 inches (914 mm) wide:
   a. Exterior: Standard weight, bronze or stainless steel, 4-1/2 inches (114 mm) high
   b. Interior: Standard weight, steel, 4-1/2 inches (114 mm) high
4. 1-3/4 inch (44 mm) thick doors over 36 inches (914 mm) wide:
   a. Exterior: Heavy weight, bronze/stainless steel, 5 inches (127 mm) high
   b. Interior: Heavy weight, steel, 5 inches (127 mm) high

5. 2 inches or thicker doors:
   a. Exterior: Heavy weight, bronze or stainless steel, 5 inches (127 mm) high
   b. Interior: Heavy weight, steel, 5 inches (127 mm) high

6. Adjust hinge width for door, frame, and wall conditions to allow proper degree of opening.

7. Provide three hinges per door leaf for doors 90 inches (2286 mm) or less in height, and one additional hinge for each 30 inches (762 mm) of additional door height.

8. Hinge Pins: Except as otherwise indicated, provide hinge pins as follows:
   a. Steel Hinges: Steel pins
   b. Non-Ferrous Hinges: Stainless steel pins
   c. Out-Swinging Exterior Doors: Non-removable pins
   d. Out-Swinging Interior Lockable Doors: Non-removable pins
   e. Interior Non-lockable Doors: Non-rising pins

9. Provide hinges with electrified options as scheduled in the hardware sets. Provide with number and gage of wires enough to accommodate electric function of specified hardware. Locate electric hinge at second hinge from bottom or nearest to electrified locking component. Provide mortar guard for each electrified hinge specified.

2.04 FLUSH BOLTS

A. Manufacturers:
   1. Scheduled Manufacturer:
      a. Ives
   2. Acceptable Manufacturers:
      a. No Substitute

B. Requirements:
   1. Provide automatic, constant latching, and manual flush bolts with forged bronze or stainless-steel face plates, extruded brass levers, and with wrought brass guides and strikes. Provide 12 inch (305 mm) steel or brass rods at doors up to 90 inches (2286 mm) in height. For doors over 90 inches (2286 mm) in height increase top rods by 6 inches (152 mm) for each additional 6 inches (152 mm) of door height. Provide dust-proof strikes at each bottom flush bolt.

2.05 MORTISE LOCKS

A. Manufacturers and Products:
   1. Scheduled Manufacturer and Product:
a. Schlage L9000 series

2. Acceptable Manufacturers and Products:
   a. No Substitute

B. Requirements:

1. Provide mortise locks conforming to ANSI/BHMA A156.13 Series 1000, Grade 1, and UL Listed for 3-hour fire doors.
2. Indicators: Where specified, provide indicator window measuring a minimum 2-inch x 1/2 inch with 180-degree visibility. Provide messages color-coded with full text and/or symbols, as scheduled, for easy visibility.
3. Provide locks manufactured from heavy gauge steel, containing components of steel with a zinc dichromate plating for corrosion resistance.
4. Provide lock case that is multi-function and field reversible for handing without opening case. Cylinders: Refer to "KEYING" article, herein.
5. Provide locks with standard 2-3/4 inches (70 mm) backset with full 3/4 inch (19 mm) throw stainless steel mechanical anti-friction latchbolt. Provide deadbolt with full 1-inch (25 mm) throw, constructed of stainless steel.
6. Provide standard ASA strikes unless extended lip strikes are necessary to protect trim. Provide electrified options as scheduled in the hardware sets. Where scheduled, provide switches and sensors integrated into the locks and latches.
7. Provide motor based electrified locksets that comply with the following requirements:
   a. Universal input voltage – single chassis accepts 12 or 24VDC to allow for changes in the field without changing lock chassis.
   b. Fail Safe/Fail Secure – changing mode between electrically locked (fail safe) and electrically unlocked (fail secure) is field selectable without opening the lock case.
   c. Low maximum current draw – maximum 0.4 amps to allow for multiple locks on a single power supply.
   d. Low holding current – maximum 0.01 amps to produce minimal heat, eliminate “hot levers” in electrically locked applications, and to provide reliable operation in wood doors that provide minimal ventilation and air flow.
   e. Connections – provide quick-connect Molex system standard.
8. Lever Trim: Solid brass, bronze, or stainless steel, cast or forged in design specified, with wrought roses and external lever spring cages. Provide thru-bolted levers with 2-piece spindles.
   a. Lever Design: 06A

2.06 CYLINDERS

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:
   a. Schlage Everest 29 Primus XP

2. Acceptable Manufacturers and Products:
   a. No Substitute
B. Requirements:

1. Provide cylinders/cores, compliant with ANSI/BHMA A156.5; latest revision; cylinder face finished to match lockset, manufacturer’s series as indicated. Refer to “KEYING” article, herein.
2. Provide cylinders in the below-listed configuration(s), distributed throughout the Project as indicated.
   a. High Security: dual-locking cylinder with permanent core requiring restricted, patented keyway. Dual-locking mechanism with interlocking finger pin(s) to check for patented features on keys.

2.07 CYLINDERS

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:
   a. Schlage Everest 29 T
2. Acceptable Manufacturers and Products:
   a. No Substitute

B. Requirements:

1. Provide cylinders/cores compliant with ANSI/BHMA A156.5; latest revision; cylinder face finished to match lockset; manufacturer’s series as indicated. Refer to “KEYING” article, herein.
2. Provide cylinders in the below-listed configuration(s), distributed throughout the Project as indicated.

2.08 CYLINDERS

A. Manufacturers:

1. Scheduled Manufacturer and Product:
   a. Schlage Everest 29T
2. Acceptable Manufacturers and Products:
   a. No Substitute

B. Requirements:
1. Provide cylinders/cores to match Owner’s existing key system, compliant with ANSI/BHMA A156.5; latest revision; cylinder face finished to match lockset, manufacturer's series as indicated. Refer to “KEYING” article, herein.

2.09 KEYING

A. Scheduled System:

1. New factory registered system:
   a. Provide a factory registered keying system, complying with guidelines in ANSI/BHMA A156.28, incorporating decisions made at keying conference.

B. Requirements:

1. Construction Keying:
   a. Replaceable Construction Cores.
      1) Provide temporary construction cores replaceable by permanent cores, furnished in accordance with the following requirements.
         a) 3 construction control keys
         b) 12 construction change (day) keys.
      2) Owner or Owner’s Representative will replace temporary construction cores with permanent cores.

2. Permanent Keying:
   a. Provide permanent cylinders/cores keyed by the manufacturer according to the following key system.
      1) Master Keying system as directed by the Owner.
   b. Forward bitting list and keys separately from cylinders, by means as directed by Owner. Failure to comply with forwarding requirements will be cause for replacement of cylinders/cores involved at no additional cost to Owner.
   c. Provide keys with the following features:
      1) Material: Nickel silver; minimum thickness of .107-inch (2.3mm)
      2) Patent Protection: Keys and blanks protected by one or more utility patent(s).
      3) Geographically Exclusive: Where High Security or Security cylinders/cores are indicated, provide nationwide, geographically exclusive key system complying with the following restrictions.
   d. Identification:
      1) Mark permanent cylinders/cores and keys with applicable blind code for identification. Do not provide blind code marks with actual key cuts.
      2) Identification stamping provisions must be approved by the Architect and Owner.
      3) Stamp cylinders/cores and keys with Owner’s unique key system facility code as established by the manufacturer; key symbol and embossed or stamped with “DO NOT DUPLICATE” along with the “PATENTED” or patent number to enforce the patent protection.
      4) Failure to comply with stamping requirements will be cause for replacement of keys involved at no additional cost to Owner.
      5) Forward permanent cylinders/cores to Owner, separately from keys, by means as directed by Owner.
e. Quantity: Furnish in the following quantities.
   1) Change (Day) Keys: 3 per cylinder/core.
   2) Permanent Control Keys: 3.

2.10 KEY CONTROL SYSTEM

A. Manufacturers:

   1. Scheduled Manufacturer:
      a. Telkee

   2. Acceptable Manufacturers:
      a. HPC
      b. Lund

B. Requirements:

   1. Provide key control system, including envelopes, labels, tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet, all as recommended by system manufacturer, with capacity for 150% of number of locks required for Project.
      a. Provide complete cross index system set up by hardware supplier, and place keys on markers and hooks in cabinet as determined by final key schedule.
      b. Provide hinged-panel type cabinet for wall mounting.

2.11 DOOR CLOSERS

A. Manufacturers and Products:

   1. Scheduled Manufacturer and Product:
      a. LCN 4050A series

   2. Acceptable Manufacturers and Products:
      a. No Substitute

B. Requirements:

   1. Provide door closers conforming to ANSI/BHMA A156.4 Grade 1 requirements by BHMA certified independent testing laboratory. ISO 9000 certify closers. Stamp units with date of manufacture code.
   2. Provide door closers with fully hydraulic, full rack and pinion action with cast aluminum cylinder.
   3. Closer Body: 1-1/2-inch (38 mm) diameter with 11/16-inch (17 mm) diameter heat-treated pinion journal and full complement bearings.
   4. Hydraulic Fluid: Fireproof, passing requirements of UL10C, and all weather requiring no seasonal closer adjustment for temperatures ranging from 120 degrees F to -30 degrees F.
5. Spring Power: Continuously adjustable over full range of closer sizes, and providing reduced opening force as required by accessibility codes and standards.
6. Hydraulic Regulation: By tamper-proof, non-critical valves, with separate adjustment for latch speed, general speed, and back check.
7. Pressure Relief Valve (PRV) Technology: Not permitted.
8. Provide stick on templates, special templates, drop plates, mounting brackets, or adapters for arms as required for details, overhead stops, and other door hardware items interfering with closer mounting.

2.12 DOOR TRIM

A. Manufacturers:

1. Scheduled Manufacturer:
   a. Ives

2. Acceptable Manufacturers:
   a. No Substitute

B. Requirements:

1. Provide push plates, push bars, pull plates, pulls, and hands-free reversible door pulls with diameter and length as scheduled.

2.13 PROTECTION PLATES

A. Manufacturers:

1. Scheduled Manufacturer:
   a. Ives

2. Acceptable Manufacturers:
   a. No Substitute

B. Requirements:

1. Provide protection plates with a minimum of 0.050 inch (1 mm) thick, beveled four edges as scheduled. Furnish with sheet metal or wood screws, finished to match plates.
2. Sizes plates 2 inches (51 mm) less width of door on single doors, pairs of doors with a mullion, and doors with edge guards. Size plates 1 inch (25 mm) less width of door on pairs without a mullion or edge guards.
3. At fire rated doors, provide protection plates over 16 inches high with UL label.

2.14 OVERHEAD STOPS AND OVERHEAD STOP/HOLDERS

A. Manufacturers:

1. Scheduled Manufacturers:
a. Glynn-Johnson

2. Acceptable Manufacturers:
   a. No Substitute

B. Requirements:
   1. Provide overhead stop at any door where conditions do not allow for a wall stop or floor stop presents tripping hazard.
   2. Provide friction type at doors without closer and positive type at doors with closer.

2.15 DOOR STOPS AND HOLDERS

A. Manufacturers:
   1. Scheduled Manufacturer:
      a. Ives
   2. Acceptable Manufacturers:
      a. No Substitute

B. Provide door stops at each door leaf:
   1. Provide wall stops wherever possible. Provide concave type where lockset has a push button of thumbturn.
   2. Where a wall stop cannot be used, provide universal floor stops.
   3. Where wall or floor stop cannot be used, provide overhead stop.
   4. Provide roller bumper where doors open into each other and overhead stop cannot be used.

2.16 THRESHOLDS, SEALS, DOOR SWEEPS, AUTOMATIC DOOR BOTTOMS, AND GASKETING

A. Manufacturers:
   1. Scheduled Manufacturer:
      a. Zero International
   2. Acceptable Manufacturers:
      a. No Substitute

B. Requirements:
   1. Provide thresholds, weather-stripping, and gasketing systems as specified and per architectural details. Match finish of other items.
   2. Smoke- and Draft-Control Door Assemblies: Where smoke- and draft-control door assemblies are required, provide door hardware that meets requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105.
3. Provide door sweeps, seals, astragals, and auto door bottoms only of type where resilient or flexible seal strip is easily replaceable and readily available.
4. Size thresholds 1/2 inch (13 mm) high by 5 inches (127 mm) wide by door width unless otherwise specified in the hardware sets or detailed in the drawings.

2.17 SILENCERS

A. Manufacturers:
   1. Scheduled Manufacturer:
      a. Ives
   2. Acceptable Manufacturers:
      a. No Substitute

B. Requirements:
   1. Provide "push-in" type silencers for hollow metal or wood frames.
   2. Provide one silencer per 30 inches (762 mm) of height on each single frame, and two for each pair frame.
   3. Omit where gasketing is specified.

2.18 FINISHES

A. FINISH: BHMA 626/652 (US26D); EXCEPT:
   1. Hinges at Exterior Doors: BHMA 630 (US32D)
   2. Aluminum Geared Continuous Hinges: BHMA 628 (US28)
   4. Protection Plates: BHMA 630 (US32D)
   5. Overhead Stops and Holders: BHMA 630 (US32D)
   6. Door Closers: Powder Coat to Match
   7. Wall Stops: BHMA 630 (US32D)
   8. Latch Protectors: BHMA 630 (US32D)
   9. Weatherstripping: Clear Anodized Aluminum
   10. Thresholds: Mill Finish Aluminum

PART 3 - EXECUTION

3.01 EXAMINATION

A. Prior to installation of hardware, 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. Verify doors, frames, and walls have been properly reinforced for hardware installation.
B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.
C. Submit a list of deficiencies in writing and proceed with installation only after unsatisfactory conditions have been corrected.
3.02 INSTALLATION

A. Mount door hardware units at heights to comply with the following, unless otherwise indicated or required to comply with governing regulations.

2. Custom Steel Doors and Frames: HMMA 831.
3. Interior Architectural Wood Flush Doors: ANSI/WDMA I.S. 1A
4. Installation Guide for Doors and Hardware: DHI TDH-007-20

B. Install door hardware in accordance with NFPA 80, NFPA 101 and provide post-install inspection, testing as specified in section 1.03.E unless otherwise required to comply with governing regulations.

C. Install each hardware item in compliance with manufacturer's instructions and recommendations, using only fasteners provided by manufacturer.

D. Do not install surface mounted items until finishes have been completed on substrate. Protect all installed hardware during painting.

E. Set units level, plumb and true to line and location. Adjust and reinforce attachment substrate as necessary for proper installation and operation.

F. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

G. Install operating parts so they move freely and smoothly without binding, sticking, or excessive clearance.

H. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than quantity recommended by manufacturer for application indicated.

I. Lock Cylinders:
   1. Install construction cores to secure building and areas during construction period.
   2. Replace construction cores with permanent cores as indicated in keying section.
   3. Furnish permanent cores to Owner for installation.

J. Wiring: Coordinate with Division 26, ELECTRICAL and Division 28 ELECTRONIC SAFETY AND SECURITY sections for:
   1. Conduit, junction boxes and wire pulls.
   2. Connections to and from power supplies to electrified hardware.
   3. Connections to fire/smoke alarm system and smoke evacuation system.
   4. Connection of wire to door position switches and wire runs to central room or area, as directed by Architect.
   5. Connections to panel interface modules, controllers, and gateways.

K. Key Control System: Tag keys and place them on markers and hooks in key control system cabinet, as determined by final keying schedule.

L. Door Closers: Mount closers on room side of corridor doors, inside of exterior doors, and stair side of stairway doors from corridors. Mount closers so they are not visible in corridors, lobbies and other public spaces unless approved by Architect.

M. Closer/Holders: Mount closer/holders on room side of corridor doors, inside of exterior doors, and stair side of stairway doors.

N. Power Supplies: Locate power supplies as indicated or, if not indicated, above accessible ceilings or in equipment room, or alternate location as directed by Architect.

O. Thresholds: Set thresholds in full bed of sealant complying with requirements specified in Division 07 Section "Joint Sealants."
P. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they may impede traffic or present tripping hazard.
Q. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
R. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.
S. Door Bottoms and Sweeps: Apply to bottom of door, forming seal with threshold when door is closed.

3.03 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.

1. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.

B. Occupancy Adjustment: Approximately three to six months after date of Substantial Completion, examine and readjust each item of door hardware, including adjusting operating forces, as necessary to ensure function of doors and door hardware.

3.04 CLEANING AND PROTECTION

A. Clean adjacent surfaces soiled by door hardware installation.
B. Clean operating items per manufacturer's instructions to restore proper function and finish.
C. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of Substantial Completion.

3.05 DOOR HARDWARE SCHEDULE

A. The intent of the hardware specification is to specify the hardware for interior and exterior doors, and to establish a type, continuity, and standard of quality. However, it is the door hardware supplier's responsibility to thoroughly review existing conditions, schedules, specifications, drawings, and other Contract Documents to verify the suitability of the hardware specified.
B. Discrepancies, conflicting hardware, and missing items are to be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application.
C. Hardware items are referenced in the following hardware schedule. Refer to the above specifications for special features, options, cylinders/keying, and other requirements.
D. Hardware Sets:
79218 X-47936 Version 1

Legend:
- Link to catalog cut sheet
- Electrified Opening

Hardware Group No. 1 - SINGLE, EXTERIOR, O/S, GANG RESTROOM

For use on Door #/(s):
101 103

Provide each SGL door(s) with the following:

<table>
<thead>
<tr>
<th>QTY</th>
<th>DESCRIPTION</th>
<th>CATALOG NUMBER</th>
<th>FINISH</th>
<th>MFR</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>HINGE</td>
<td>5BB1HW 4.5 X 4.5</td>
<td>652</td>
<td>IVE</td>
</tr>
<tr>
<td>1</td>
<td>CLASSROOM DEAD LOCK</td>
<td>L463T</td>
<td>626</td>
<td>SCH</td>
</tr>
<tr>
<td>1</td>
<td>FSIC CORE</td>
<td>23-030 EV29 S</td>
<td>626</td>
<td>SCH</td>
</tr>
<tr>
<td>1</td>
<td>PUSH PLATE</td>
<td>8200 6&quot; X 16&quot;</td>
<td>630</td>
<td>IVE</td>
</tr>
<tr>
<td>1</td>
<td>PULL PLATE</td>
<td>8303 10&quot; 6&quot; X 16&quot;</td>
<td>630</td>
<td>IVE</td>
</tr>
<tr>
<td>1</td>
<td>SURFACE CLOSER</td>
<td>4050A SHCUSH</td>
<td>689</td>
<td>LCN</td>
</tr>
<tr>
<td>1</td>
<td>KICK PLATE</td>
<td>8400 10&quot; X 2&quot; LDW B-CS</td>
<td>630</td>
<td>IVE</td>
</tr>
<tr>
<td>1</td>
<td>MOP PLATE</td>
<td>8400 4&quot; X 1&quot; LDW B-CS</td>
<td>630</td>
<td>IVE</td>
</tr>
<tr>
<td>1</td>
<td>FLOOR STOP</td>
<td>FS18L</td>
<td>689</td>
<td>LCN</td>
</tr>
<tr>
<td>1</td>
<td>GASKETING</td>
<td>139A-S</td>
<td>A</td>
<td>ZER</td>
</tr>
<tr>
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<td>DOOR SWEEP</td>
<td>39A</td>
<td>A</td>
<td>ZER</td>
</tr>
<tr>
<td>1</td>
<td>THRESHOLD</td>
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<td>A</td>
<td>ZER</td>
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<tr>
<td>3</td>
<td>SILENCER</td>
<td>SR64/SR65 AS REQ'D</td>
<td>GRY</td>
<td>IVE</td>
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Hardware Group No. 2 - SINGLE, EXTERIOR, I/S

For use on Door #/(s):
106A 107A 107B

Provide each SGL door(s) with the following:

<table>
<thead>
<tr>
<th>QTY</th>
<th>DESCRIPTION</th>
<th>CATALOG NUMBER</th>
<th>FINISH</th>
<th>MFR</th>
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</thead>
<tbody>
<tr>
<td>3</td>
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<td>652</td>
<td>IVE</td>
</tr>
<tr>
<td>1</td>
<td>STOREROOM LOCK</td>
<td>L9080T 06A</td>
<td>626</td>
<td>SCH</td>
</tr>
<tr>
<td>1</td>
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<td>23-030 EV29 S</td>
<td>626</td>
<td>SCH</td>
</tr>
<tr>
<td>1</td>
<td>SURFACE CLOSER</td>
<td>4050 REG</td>
<td>689</td>
<td>LCN</td>
</tr>
<tr>
<td>1</td>
<td>KICK PLATE</td>
<td>8400 10&quot; X 2&quot; LDW B-CS</td>
<td>630</td>
<td>IVE</td>
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<tr>
<td>1</td>
<td>MOP PLATE</td>
<td>8400 4&quot; X 1&quot; LDW B-CS</td>
<td>630</td>
<td>IVE</td>
</tr>
<tr>
<td>1</td>
<td>WALL STOP</td>
<td>WS406/407 CCV</td>
<td>626</td>
<td>IVE</td>
</tr>
<tr>
<td>1</td>
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<td>A</td>
<td>ZER</td>
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<td>A</td>
<td>ZER</td>
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<tr>
<td>1</td>
<td>THRESHOLD</td>
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<td>A</td>
<td>ZER</td>
</tr>
<tr>
<td>3</td>
<td>SILENCER</td>
<td>SR64/SR65 AS REQ'D</td>
<td>GRY</td>
<td>IVE</td>
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Hardware Group No. 3 - SINGLE, EXTERIOR, O/S
For use on Door #102

Provide each SGL door(s) with the following:

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<td>HINGE 5BB1 4.5 X 4.5</td>
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<td>1</td>
<td>STOREROOM LOCK L9080T 06A</td>
<td>626 SCH</td>
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<tr>
<td>1</td>
<td>FSIC CORE 23-030 EV29 S</td>
<td>626 SCH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>SURFACE CLOSER 4050 REG</td>
<td>689 LCN</td>
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<td></td>
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<tr>
<td>1</td>
<td>KICK PLATE 8400 10&quot; X 2&quot; LDW B-CS</td>
<td>630 IVE</td>
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</tr>
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<td>SILENCER SR64/SR65 AS REQ'D</td>
<td>GRY IVE</td>
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Hardware Group No. 4 - SINGLE, STOREROOM/MECH ROOM/IT
For use on Door #105, 109, 110

Provide each SGL door(s) with the following:

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<td></td>
</tr>
<tr>
<td>1</td>
<td>STOREROOM LOCK L9080T 06A</td>
<td>626 SCH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>FSIC CORE 23-030 EV29 S</td>
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<td></td>
<td></td>
</tr>
<tr>
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<td>SURFACE CLOSER 4050A H</td>
<td>689 LCN</td>
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<tr>
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<td>630 IVE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>MOP PLATE 8400 4&quot; X 1&quot; LDW B-CS</td>
<td>630 IVE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>WALL STOP WS406/407 CCV</td>
<td>626 IVE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>SILENCER SR64/SR65 AS REQ'D</td>
<td>GRY IVE</td>
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Hardware Group No. 5 - SINGLE, I/S, OFFICE
For use on Door #108

Provide each SGL door(s) with the following:

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<th>DESCRIPTION</th>
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<th>FINISH</th>
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<td>HINGE 5BB1 4.5 X 4.5</td>
<td>652 IVE</td>
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<td></td>
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<tr>
<td>1</td>
<td>OFFICE/ENTRY LOCK L9050T 06A 09-544</td>
<td>626 SCH</td>
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</tr>
<tr>
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<td>FSIC CORE 23-030 EV29 S</td>
<td>626 SCH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>SURFACE CLOSER 4050A H</td>
<td>689 LCN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>KICK PLATE 8400 10&quot; X 2&quot; LDW B-CS</td>
<td>630 IVE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>MOP PLATE 8400 4&quot; X 1&quot; LDW B-CS</td>
<td>630 IVE</td>
<td></td>
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</tr>
<tr>
<td>1</td>
<td>WALL STOP WS406/407 CCV</td>
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<tr>
<td>3</td>
<td>SILENCER SR64/SR65 AS REQ'D</td>
<td>GRY IVE</td>
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Hardware Group No. 6 - SINGLE, EXTERIOR, O/S, FAMILY RESTROOM

For use on Door #104:

Provide each SGL door(s) with the following:

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<td>IVE</td>
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<td>FAC RESTRM W/IND</td>
<td>L9486T 06A 09-544 L583-375</td>
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<td>SCH</td>
</tr>
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<td>FSIC CORE</td>
<td>23-030 EV29 S</td>
<td>626</td>
<td>SCH</td>
</tr>
<tr>
<td>1</td>
<td>SURFACE CLOSER</td>
<td>4050A SCUSH</td>
<td>689</td>
<td>LCN</td>
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<tr>
<td>1</td>
<td>KICK PLATE</td>
<td>8400 10&quot; X 2&quot; LDW B-CS</td>
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<td>IVE</td>
</tr>
<tr>
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<td>MOP PLATE</td>
<td>8400 4&quot; X 1&quot; LDW B-CS</td>
<td>630</td>
<td>IVE</td>
</tr>
<tr>
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<td>A</td>
<td>ZER</td>
</tr>
<tr>
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<td>DOOR SWEEP</td>
<td>39A</td>
<td>A</td>
<td>ZER</td>
</tr>
<tr>
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<td>THRESHOLD</td>
<td>655A-V3-224</td>
<td>A</td>
<td>ZER</td>
</tr>
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Hardware Group No. 7 - PAIR, EXTERIOR, O/S

For use on Door #106B:

Provide each PR door(s) with the following:

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<th>QTY</th>
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END OF SECTION
SECTION 08 80 00
GLAZING

PART 1 GENERAL
1.01 SECTION INCLUDES
   A. Glass.
   B. Glazing compounds and accessories.

1.02 RELATED REQUIREMENTS
   A. Section 07 90 05 - Joint Sealers: Sealant and back-up material.
   B. Section 08 12 13 - Hollow Metal Frames: Glazed borrowed lites.
   C. Section 08 14 16 - FLUSH WOOD DOORS: Glazed lites in doors.
   D. Section 08 43 13 - Aluminum-Framed Storefronts: Glazing furnished by storefront manufacturer.

1.03 REFERENCE STANDARDS
   J. GANA (GM) - GANA Glazing Manual; 2009.

1.04 ADMINISTRATIVE REQUIREMENTS
   A. Preinstallation Meeting: Convene a preinstallation meeting one week before starting work of this section; require attendance by all affected installers.

1.05 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data on Glass Types: Provide structural, physical and environmental characteristics, size limitations, special handling or installation requirements.
   C. Product Data on Glazing Compounds: Provide chemical, functional, and environmental characteristics, limitations, special application requirements. Identify available colors.
   D. Samples: Submit two samples 5 by 5 inch in size of glass units.
   E. Certificates: Certify that products meet or exceed specified requirements.
   F. Manufacturer’s Certificate: Certify that the glass meets or exceeds specified requirements.

1.06 QUALITY ASSURANCE
   A. Perform Work in accordance with GANA Glazing Manual and GANA Sealant Manual for glazing installation methods.
B. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience.

1.07 Mock-Up
A. See Section 04 20 10 for, for mockup requirements.
B. Locate where directed by Architect.

1.08 Field Conditions
A. Do not install glazing when ambient temperature is less than 50 degrees F.
B. Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.

1.09 Warranty
A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
B. Sealed Insulating Glass Units: Provide a five (5) year warranty to include coverage for seal failure, interpane dusting or misting, including replacement of failed units.
C. Laminated Glass: Provide a five (5) year warranty to include coverage for delamination, including replacement of failed units.

PART 2 Products

2.01 Insulating Glass Units (refer to drawings for locations)
A. Type GL-1 - Sealed Insulating Glass Units: Vision glass, double glazed.
   2. Outboard Lite: Annealed float glass, 1/4 inch thick, minimum.
      a. Tint: Clear.
      b. Coating: Low-E type, on #2 surface.
   3. 1/2 inch air space.
   4. Inboard Lite: Laminated float glass, 9/16 inch thick, minimum.
      a. Outboard Lite: Class 1 (clear) float glass, 1/4" thick, minimum.
      b. Interlayer: 0.060 Salflex HP by Solutia or equal.
      c. Inboard Lite: Class 1 (clear) float glass, 1/4" thick, minimum.
      d. Tint: Clear.
   5. Total Thickness: 1-5/16 inch.
   7. Glazing Method: standard with manufacturer to meet impact/wind requirements.
   8. Wind-Borne-Debris Resistance: Identical full-size glazed assembly without auxiliary protection, tested by independent agency in accordance with ASTM E1996 for Wind Zone 4, Basic Protection, for Large and Small Missile impact and pressure cycling at design wind pressure.
B. Type GL-2 - Sealed Insulating Glass Units: Vision glass, double glazed.
   2. Outboard Lite: Fully tempered float glass, 1/4 inch thick, minimum.
      a. Tint: Clear
      b. Coating: Low-E type, on #2 surface.
   3. 1/2 inch air space.
   4. Inboard Lite: Laminated float glass, 9/16 inch thick, minimum.
      a. Outboard Lite: Class 1 (clear) float glass, 1/4" thick, minimum.
      b. Interlayer: 0.060 Salflex HP by Solutia or equal.
      c. Inboard Lite: Class 1 (clear) float glass, 1/4" thick, minimum.
      d. Tint: Clear.
   5. Total Thickness: 1-5/16 inch.
   7. Glazing Method: standard with manufacturer to meet impact/wind requirements.
8. Wind-Borne-Debris Resistance: Identical full-size glazed assembly without auxiliary protection, tested by independent agency in accordance with ASTM E1996 for Wind Zone 4, Basic Protection, for Large and Small Missile impact and pressure cycling at design wind pressure.

C. Type GL-3 - Sealed Insulating Glass Units: Privacy glass, double
   2. Outboard Lite: Annealed float glass, 1/4 inch thick, minimum.
      a. Tint: frosted for privacy
      b. Coating: Low-E type, on #2 surface.
   3. 1/2 inch air space.
   4. Inboard Lite: Laminated float glass, 9/16 inch thick, minimum.
      a. Outboard Lite: Class 1 (clear) float glass, 1/4” thick, minimum.
      b. Interlayer: 0.060 Salflex HP by Solutia or equal.
      c. Inboard Lite: Class 1 (clear) float glass, 1/4” thick, minimum.
      d. Tint: Frosted for privacy.
   5. Total Thickness: 1-5/16 inch.
   7. Glazing Method: standard with manufacturer to meet impact/wind requirements.
   8. Wind-Borne-Debris Resistance: Identical full-size glazed assembly without auxiliary protection, tested by independent agency in accordance with ASTM E1996 for Wind Zone 4, Basic Protection, for Large and Small Missile impact and pressure cycling at design wind pressure.

2.02 GLAZING UNITS
   A. Single Exterior Vision Glazing (GL-4):
      1. Type: Laminated fully tempered float glass.
      2. Tint: Clear.
      3. Thickness: 9/16 inch.

2.03 EXTERIOR GLAZING ASSEMBLIES
   A. Performance Criteria: Select type and thickness of glass to withstand dead and live loads caused by positive and negative wind pressure acting normal to plane of glass.
      1. Design Pressure: In accordance with applicable codes. See structural drawings for design pressures.
      2. Use the procedure specified in ASTM E1300 to determine glass type and thickness.
      3. Limit glass deflection to 1/200 or flexure limit of glass, whichever is less, with full recovery of glazing materials.
      4. Glass thicknesses listed are minimum.
   B. Air and Vapor Seals: Provide completed assemblies that maintain continuity of building enclosure vapor retarder and air barrier:
      1. In conjunction with vapor retarder and joint sealer materials described in other sections.
      2. To maintain a continuous air barrier and vapor retarder throughout the glazed assembly from glass pane to heel bead of glazing sealant.

2.04 GLASS MATERIALS
   A. Float Glass: Provide float glass based glazing unless noted otherwise.
      1. Annealed Type: ASTM C1036, Type I - Transparent Flat, Class 1 - Clear, Quality-Q3.
      2. Heat-Strengthened and Fully Tempered Types: ASTM C1048, Kind HS and Kind FT.
      3. Tinted Types: ASTM C1036, Class 2 - Tinted, color and performance characteristics as indicated.
      4. Thicknesses: As indicated; for exterior glazing comply with requirements indicated for wind load design regardless of thickness indicated.
   B. Laminated Glass: Float glass laminated in accordance with ASTM C1172.
      1. Laminated Safety Glass: Comply with 16 CFR 1201 test requirements for Category II.
      2. Plastic Interlayer:
a. Polyvinyl Butyral (PVB) Interlayer: 0.060 inch thick, minimum.
b. Ionoplast Interlayer: 0.060 inch thick, minimum.

2.05 SEALED INSULATING GLASS UNITS
A. Sealed Insulating Glass Units: Types as indicated.
   1. Application: Exterior, except as otherwise indicated.
   2. Durability: Certified by an independent testing agency to comply with ASTM E2190.
   3. Edge Spacers: Aluminum, bent and soldered corners.
   4. Edge Seal: Glass to elastomer with supplementary silicone sealant.
   5. Edge Seal Color: Black.
   6. Purge interpane space with dry hermetic air.

2.06 GLAZING COMPOUNDS
A. Butyl Sealant: Single component; ASTM C920, Grade NS, Class 12-1/2, Uses M and A, Shore A hardness of 10 to 20; black color.
B. Silicone Sealant: Single component; neutral curing; capable of water immersion without loss of properties; non-bleeding, non-staining; ASTM C920, Type S, Grade NS, Class 25, Uses M, A, and G; with cured Shore A hardness range of 15 to 25; color as selected.

2.07 GLAZING ACCESSORIES
A. Setting Blocks: Neoprene, 80 to 90 Shore A durometer hardness; ASTM C864 Option II. Length of 0.1 inch for each square foot of glazing or minimum 4 inch x width of glazing rabbet space minus 1/16 inch x height to suit glazing method and pane weight and area.
B. Spacer Shims: Neoprene, 50 to 60 Shore A durometer hardness; ASTM C864 Option II. Minimum 3 inch long x one half the height of the glazing stop x thickness to suit application, self adhesive on one face.
C. Glazing Tape, Back Bedding Mastic Type: Preformed, butyl-based, 100 percent solids compound with integral resilient spacer rod applicable to application indicated; hardness range of 5 to 30 cured Shore A durometer; coiled on release paper; black color.
D. Glazing Gaskets: Resilient silicone extruded shape to suit glazing channel retaining slot; ASTM C864 Option II; Black color.
E. Glazing Clips: Manufacturer's standard type.

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify that openings for glazing are correctly sized and within tolerance.
B. Verify that surfaces of glazing channels or recesses are clean, free of obstructions that may impede moisture movement, weeps are clear, and ready to receive glazing.

3.02 PREPARATION
A. Clean contact surfaces with solvent and wipe dry.
B. Seal porous glazing channels or recesses with substrate compatible primer or sealer.
C. Prime surfaces scheduled to receive sealant.
D. Install sealants in accordance with ASTM C1193 and GANA Sealant Manual.
E. Install sealants in accordance with manufacturer's instructions.

3.03 INSTALLATION - EXTERIOR/INTERIOR DRY METHOD (GASKET GLAZING)
A. Place setting blocks at 1/4 points with edge block no more than 6 inch from corners.
B. Rest glazing on setting blocks and push against fixed stop with sufficient pressure on gasket to attain full contact.
C. Install removable stops without displacing glazing gasket; exert pressure for full continuous contact.

3.04 INSTALLATION - EXTERIOR DRY METHOD (TAPE AND GASKET SPLINE GLAZING)
A. Cut glazing tape to length; install on glazing pane. Seal corners by butting tape and sealing junctions with butyl sealant.
B. Place setting blocks at 1/4 points with edge block no more than 6 inch from corners.
C. Rest glazing on setting blocks and push against fixed stop with sufficient pressure to attain full contact.
D. Install removable stops without displacing glazing spline. Exert pressure for full continuous contact.
E. Trim protruding tape edge.

3.05 INSTALLATION - EXTERIOR WET/DRY METHOD (PREFORMED TAPE AND SEALANT)
A. Cut glazing tape to length and set against permanent stops, 3/16 inch below sight line. Seal corners by butting tape and dabbing with butyl sealant
B. Apply heel bead of butyl sealant along intersection of permanent stop with frame ensuring full perimeter seal between glass and frame to complete the continuity of the air and vapor seal.
C. Place setting blocks at 1/4 points with edge block no more than 6 inch from corners.
D. Rest glazing on setting blocks and push against tape and heel bead of sealant with sufficient pressure to attain full contact at perimeter of pane or glass unit.
E. Install removable stops, with spacer strips inserted between glazing and applied stops 1/4 inch below sight lines.
   1. Place glazing tape on glazing pane of unit with tape flush with sight line.
F. Install removable stops, with spacer strips inserted between glazing and applied stops, 1/4 inch below sight line. Place glazing tape on glazing pane or unit with tape flush with sight line.
G. Fill gap between glazing and stop with manufacturer's recommended type sealant to depth equal to bite of frame on glazing, but not more than 3/8 inch below sight line.
H. Apply cap bead of manufacturer's recommended type sealant along void between the stop and the glazing, to uniform line, flush with sight line. Tool or wipe sealant surface smooth.

3.06 INSTALLATION - EXTERIOR WET METHOD (SEALANT AND SEALANT)
A. Place setting blocks at 1/4 points and install glazing pane or unit.
B. Install removable stops with glazing centered in space by inserting spacer shims both sides at 24 inch intervals, 1/4 inch below sight line.
C. Fill gaps between glazing and stops with manufacturer's recommended type sealant to depth of bite on glazing, but not more than 3/8 inch below sight line to ensure full contact with glazing and continue the air and vapor seal.
D. Apply sealant to uniform line, flush with sight line. Tool or wipe sealant surface smooth.

3.07 INSTALLATION - INTERIOR DRY METHOD (TAPE AND TAPE)
A. Cut glazing tape to length and set against permanent stops, projecting 1/16 inch above sight line.
B. Place setting blocks at 1/4 points with edge block no more than 6 inch from corners.
C. Rest glazing on setting blocks and push against tape for full contact at perimeter of pane or unit.
D. Place glazing tape on free perimeter of glazing in same manner described above.
E. Install removable stop without displacement of tape. Exert pressure on tape for full continuous contact.
F. Knife trim protruding tape.

3.08 CLEANING
A. Remove glazing materials from finish surfaces.
B. Remove labels after Work is complete.
C. Clean glass and adjacent surfaces.

3.09 SCHEDULE
A. See Drawings

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Tile for wall base applications
   B. Accessories

1.02 RELATED REQUIREMENTS
   A. Section 07 90 05 - Joint Sealers

1.03 REFERENCE STANDARDS

1.04 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide manufacturers' data sheets on tile, mortar, grout, and accessories. Include instructions for using grouts and adhesives.
   C. Samples: Provide samples of each tile type.
   D. Maintenance Data: Include recommended cleaning methods, cleaning materials, stain removal methods, and polishes and waxes.

1.05 QUALITY ASSURANCE
   A. Maintain one copy of and ANSI A108/A118/A136.1 and TCNA (HB) on site.
   B. Manufacturer Qualifications: Company specializing in manufacturing the types of products specified in this section, with minimum 5 years of documented experience.
   C. Installer Qualifications: Company specializing in performing tile installation, with minimum of 5 years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING
   A. Protect adhesives from freezing or overheating in accordance with manufacturer's instructions.
PART 2 PRODUCTS

2.01 TILE
A. Product Description: ANSI A137.1
   1. Type, Size, Color and Finish: to be selected by Architect from manufacturer’s standards.
   2. Top Edge: Bullnosed.
   3. Internal Corner: Coved.
   4. External Corner: Bullnosed
   5. Moisture Absorption: 0 to 0.5 percent

2.02 SETTING MATERIALS
A. Provide setting materials made by the same manufacturer as grout.
B. Epoxy Adhesive and Mortar Bond Coat: ANSI A118.3.

2.03 GROUTS
A. Epoxy Grout: ANSI A118.3 chemical resistant and water-cleanable epoxy grout.
   1. Color(s): As scheduled.

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify that sub-floor surfaces are smooth and flat within the tolerances specified for that type of work and are ready to receive tile.
B. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive tile.
C. Verify that sub-floor surfaces are dust-free and free of substances that could impair bonding of setting materials to sub-floor surfaces.
D. Verify that concrete sub-floor surfaces are ready for tile installation by testing for moisture emission rate and alkalinity; obtain instructions if test results are not within the following limits:
   1. Moisture emission rate: Not greater than 3 lb per 1000 sq ft per 24 hours when tested using calcium chloride moisture test kit for 72 hours.
E. Verify that required floor-mounted utilities are in correct location.

3.02 PREPARATION
A. Protect surrounding work from damage.
B. Vacuum clean surfaces and damp clean.
C. Seal substrate surface cracks with filler. Level existing substrate surfaces to acceptable flatness tolerances.

3.03 INSTALLATION - GENERAL
A. Install tile and grout in accordance with applicable requirements of ANSI A108.1A thru A108.13, manufacturer's instructions, and TCNA (HB) recommendations.
B. Cut and fit tile to penetrations through tile, leaving sealant joint space. Form corners and bases neatly.
C. Place tile joints uniform in width, subject to variance in tolerance allowed in tile size. Make grout joints without voids, cracks, excess mortar or excess grout, or too little grout.
D. Provide 95% mortar coverage minimum for thin set tile installation.
E. Install non-ceramic trim in accordance with manufacturer's instructions.
F. Install thresholds where indicated.
G. Sound tile after setting. Replace hollow sounding units.
H. Keep expansion joints free of adhesive or grout.
I. Prior to grouting, allow installation to completely cure; minimum of 48 hours.
J. Grout tile joints. Use standard grout unless otherwise indicated.
K. Apply sealant to junction of tile and dissimilar materials.
3.07 INSTALLATION - WALL BASE

B. Over CMU - install in accordance with TCNA (HB) Method W243, thin-set with dry-set or latex-Portland cement bond coat, unless otherwise indicated.

3.08 CLEANING

A. Clean tile and grout surfaces.

3.09 PROTECTION

A. Do not permit traffic over finished floor surface for 4 days after installation.

END OF SECTION
PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

1.2 SUMMARY

A. Section includes: Furnishing of all labor, materials, services and equipment necessary for the supply and installation of SentryGuard to polished concrete and terrazzo substrates, above-grade on the dry side of substrates, as indicated on drawings and as specified herein.

1. Related Sections:
   a. Section 03 30 00 – Cast-in-Place Concrete
   b. Section 09 30 19 - Masonry Pavers
   c. Section 09 90 00 - Paints and Coatings

1.3 REFERENCES

Applicable Standards: The following standards are referenced herein.

1. American Society for Testing and Materials (ASTM)

1.4 SYSTEM DESCRIPTION

A. SentryGuard coatings are a hybrid organic / inorganic, protective barrier that provides a thin protective film over concrete and terrazzo surfaces. SilTanium coatings are applied in liquid form at room temperature. SilTanium coatings protect against wear, staining and produce an easier substrate to clean and maintain. This process increases surface coefficient of friction, and seals against the penetration of liquids, thus reducing the smell and staining, as it reverses the capillary action of the substrate. Substrate remains in a semi-permeable (breathable) condition.

B. SentryGuard coatings are applied as a protective barrier to the exterior of concrete and terrazzo.

1.5 SYSTEM PERFORMANCE REQUIREMENTS

A. Testing Requirements: SilTanium coatings shall be tested in accordance with the following standards and conditions, and the testing results shall meet or exceed the performance requirements as specified herein.


2. Independent Laboratory: Testing shall be performed by an independent laboratory meeting the requirements of ASTM C1028 (“Standard Test Method for Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal
Dynamometer Pull-Meter Method) and certified by the United States Bureau of Standards. Testing laboratory shall obtain all tile samples.

1.6 Submittals
1. Product Technical Data Sheet
2. Material Safety Data Sheet
3. Samples. Provide three 12-inch square samples of SilTanium Supreme installed over new or existing substrate as defined in section 1.4 B.
4. Test Reports: Submit for acceptance complete test reports from approved independent testing laboratories certifying that coating system conforms to performance characteristics and testing requirements specified herein.
5. Manufacturer’s Certification: Provide certificates signed by manufacturer or manufacturer’s representative certifying that the materials to be installed comply in all respects with the requirements of this specification, and that the applicator is certified and approved to install the materials in accordance with manufacturer’s specifications. Contact SilTanium Corporation for a current listing of certified applicators. SilTanium Corporation, 5697 Highway 20, Cartersville, GA 30121 Fax 770-387-2728, phone 770-231-7225, or email tmcniff@siltanium.com.
6. Manufacturer’s Field Report: Provide copy of report from manufacturer’s representative confirming that the surfaces to which SilTanium Supreme is to be applied are in a condition suitable to receive same.

1.7 QUALITY ASSURANCE
A. Manufacturer: Provide products of manufacturer with no less than 3-years experience in manufacturing the SentryGuard coating materials for the required work. Manufacturers that cannot provide the performance test data specified herein will not be considered for the project.
B. Applicator: Floor Coating applicator shall be certified at a Field Tech Level in the installation of SentryGuard coating materials as demonstrated by previous successful installations, and shall be approved by the manufacturer in writing.
C. Pre-Installation Conference: Prior to installation of SilTanium Coatings, conduct meeting with applicator, installers of work adjacent to, Architect/Engineer, owner’s representative, and SilTanium Corporation’s representative to verify and review the following:
   2. Manufacturer’s product data including application instructions.
   3. Substrate conditions, and procedures for substrate preparation and SilTanium installation.
   4. Installation scheduling, timing, and coordination with adjacent trades.
D. Technical Consultation: The SilTanium Corporation representative shall provide technical consultation on coating application.
E. Compliance: Comply with manufacturer’s product data regarding condition of substrate to receive coating, weather conditions before and during installation, and protection of the installed coating system.
1.8 WARRANTY

A. Manufacturer’s Warranty: Manufacturer shall provide standard product warranty executed by authorized company official. Term of warranty shall be 1-year from Date of Substantial Completion.

B. Applicator’s Warranty: Applicator shall warrant the coating installation against defects caused by faulty workmanship or materials for a period of 1-year from Date of Substantial Completion. The warranty will cover the surfaces treated and will bind the applicator to repair, at his expense, any and all failures of the treated surfaces which are not due to structural weaknesses or other causes beyond applicator’s control such as fire, earthquake, tornado and hurricane and other environmental issues contained within the structure. The warranty shall read as follows:

1. Warranty: The applicator warrants that, upon completion of the work, surfaces treated with the SentryGuard coating will be and will remain free from failure resulting from defective workmanship or materials for a period of 1-year from Date of Substantial Completion. In the event that failure occurs within the warranty period from such causes, the applicator shall, at his sole expense, repair, replace or otherwise correct such defective workmanship or materials. Applicator shall not be liable for consequential damages and applicator’s liability shall be limited to repair, replacement or correcting of defective workmanship or materials. Warranty full details available on SilTanium Technical Data Sheet. Applicator shall have no responsibility with respect to failure or other defects caused by structural failure or movement of the structure, or any other causes beyond Applicator’s control including poor post-maintenance.

PART 2 - PRODUCTS

2.1 Protective Floor Sealant Coating

A. Proprietary Products: SentryGuard coating materials as follows:

1. SilTanium Corporation, SilTanium Coatings
2. Substitutions: No substitutions permitted.
3. Source Quality: Obtain proprietary SilTanium products from the single manufacturer.

B. Protective Floor Coating: ASTM C-1027, ASTM C-1028, ASTM D 968-05

Installation: 0.5 to 1.5 mil wet film thickness yielding a 0.25 to 0.5 mil dry film thickness

C. Wearing Surface: smooth

D. Slip Resistance: Per ANSI A326.3 standard, measured on a Bot 3000e Tribometer
   1) Dry >0.70
   2) Wet >0.60

2.2 MIXES
A. Coverage: Proportions (by Volume) for example:
   1. 2,000+ square feet per gallon polished concrete or terrazzo

2.3 INSTALLATION ACCESSORIES

A. Cleaning Compounds: Provided or approved by product manufacturer for applications indicated.
   1. High pH Degreaser (StepOne or equal)

B. Removal Compounds: Provided or approved by product manufacturer for applications indicated.
   1. DiLimonene based cleaner with 4-10% active ingredient (SS Refresh or equal)

C. Protective Masking Barrier:
   1. Plastic, Paper and or Tape

PART 3 - EXECUTION

3.1 EXAMINATION

A. Site Visit: Prior to SilTitanium installation, arrange visit to project site with manufacturer's representative. Representative shall inspect and certify that surfaces are in acceptable condition to receive treatment.

B. Verification of Substrates: Verify that surfaces are sound and clean, and that form release agents, dirt, dust and debris and other materials are removed.

C. Examination for Defects: Examine surfaces to be coated for form tie holes and structural defects such as honeycombing, rock pockets, faulty construction joints and cracks. Such defects to be repaired in accordance to manufacturer's product data.

3.2 PREPARATION

A. Remove fixtures and similar items that are not to be coated. Mask items that cannot be removed. Reinstall items in each area after coating is fully cured.

B. Surface Preparation: Clean and prepare substrates according to ASTM F 710. Verify that substrates are dry and free of curing compounds, sealers, and hardeners. Prepare all surfaces in an area before beginning coating in that area. Schedule coating so cleaning operations will not damage newly coated surfaces.

3.3 APPLICATION

A. Apply coatings by low-pressure spray and approved micro-fiber applicator pad or other applicators according to coating manufacturer’s written instructions.

B. Maintain a wet edge at all times.
C. Transparent (Clear) Finish: Use four coats installed east west on first coat, north south on second and repeat up to four coats to produce a smooth surface film of even luster. Provide a finish free of laps, runs, cloudiness, color irregularity, brush marks, orange peel, or other surface imperfections. Burnish with a Cure pad if elevated gloss desired. After 72 hours, burnish clean substrate with a 3,000-grit diamond pad with a propane burnisher or 11,000-grit diamond pad with an electric burnisher) to remove scratches or elevate shine if desired.

3.4 CURING

**Drying and Cure Time at 72°F @ 50% RH**

- Dry to Touch: 8-10 minutes between coats
- Hard Dry (foot use): 30 minutes
- Full Cure: 72 hours

3.5 INTERFACE WITH OTHER MATERIALS

A. Utilized as a protective wear and chemical barrier over paints (latex, epoxy, urethane, acrylic)

3.6 PROTECTION

A. Do not allow foot traffic for 30 minutes.

B. Do not clean for 24 hours.

3.7 CLEANING

A. Tile and Grout: Neutral, rinse-less cleaning solution or diluted non-DiLimonene based degreaser formula agitate with soft bristle brush, extract, rinse extract, dry with floor fans.

3.8 MAINTENANCE- Yearly cleaning with red pad on 170 rpm swing machine and a diluted non-DiLimonene based degreaser formula (recommend StepOne). Burnish with a diamond pad if necessary. Remove with SS Refresh and reapply if required.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES

A. Interior paint and coating commercial systems including surface preparation.
B. Exterior paint and coating systems including surface preparation.

1.2 RELATED SECTIONS

A. Section 03 30 00 - Cast-in-Place Concrete.
B. Section 04 20 00 - Unit Masonry: Concrete Masonry Units (CMU) and brick.
C. Section 05 50 00 - Metal Fabrications.
D. Section 06 20 00 - Finish Carpentry.
E. Section 06 40 00 - Architectural Woodwork.
F. Section 08 11 13.16 - Custom Hollow Metal Doors and Frames.
G. Section 23 05 00 - Common Work Results for HVAC.
H. Section 26 05 00 - Common Work Results for Electrical.

1.3 REFERENCES

A. Steel Structures Painting Council (SSPC):
   1. SSPC-SP 1 - Solvent Cleaning.
   2. SSPC-SP 2 - Hand Tool Cleaning.
   3. SSPC-SP 3 - Power Tool Cleaning.
   4. SSPC-SP5/NACE No. 1, White Metal Blast Cleaning.
   5. SSPC-SP6/NACE No. 3, Commercial Blast Cleaning.
   6. SSPC-SP7/NACE No. 4, Brush-Off Blast Cleaning.
   7. SSPC-SP10/NACE No. 2, Near-White Blast Cleaning.
   8. SSPC-SP11, Power Tool Cleaning to Bare Metal.
   10. SSPC-SP 13 / NACE No. 6 Surface Preparation for Concrete.

B. Material Safety Data Sheets / Environmental Data Sheets: Per manufacturer's MSDS/EDS for specific VOCs (calculated per 40 CFR 59.406). VOCs may vary by base and sheen.

1.4 SUBMITTALS

A. Submit under provisions of Section 01 30 00 - Administrative Requirements.
B. Product Data: For each paint system indicated, including.
   1. Product characteristics.
   2. Surface preparation instructions and recommendations.
   3. Primer requirements and finish specification.
   4. Storage and handling requirements and recommendations.
5. Application methods.
6. Cautions for storage, handling and installation.

C. Verification Samples: For each finish product specified, submit samples that represent actual product, color, and sheen.

D. Coating Maintenance Manual: Upon conclusion of project, the Contractor or paint manufacturer/supplier shall furnish a coating maintenance manual, such as Sherwin-Williams, "Custodian Project Color and Product Information" report or equal. Manual shall include an Area Summary with finish schedule, Area Detail designating where each product/color/finish was used, product data pages, Material Safety Data Sheets, care and cleaning instructions, touch-up procedures, and color samples of each color and finish used.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A firm or individual experienced in applying paints and coatings similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.

B. Paint exposed surfaces. If a color of finish, or a surface is not specifically mentioned, Architect will select from standard products, colors and sheens available.

C. Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels unless indicated.

D. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
   1. Finish surfaces for verification of products, colors and sheens.
   2. Finish area designated by Architect.
   3. Provide samples that designate primer and finish coats.
   4. Compatibility and Adhesion: Check after one week of drying and curing by testing in accordance with ASTM D3359; Adhesion by tape test. If coating system is incompatible, additional surface preparation up to and including complete removal may be required.
   5. Do not proceed with remaining work until the Architect approves the mock-up.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver manufacturer's unopened containers to the work site. Packaging shall bear the manufacturer's name, label, and the following list of information.
   1. Product name, and type (description).
   2. Application and use instructions.
   4. VOC content.
   5. Environmental handling.
   6. Batch date.
   7. Color number.

B. Storage: Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

C. Store materials in an area that is within the acceptable temperature range, per manufacturer's instructions. Protect from freezing.

D. Handling: Maintain a clean, dry storage area, to prevent contamination or damage to the coatings.
1.7 PROJECT CONDITIONS
   A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's recommended limits.

1.8 EXTRA MATERIALS
   A. Furnish extra paint materials from the same production run as the materials applied and in the quantities described below. Package with protective covering for storage and identify with labels describing contents. Deliver extra materials to Owner.
   B. Furnish Owner with an additional one percent of each material and color, but not less than 1 gal (3.8 l) or 1 case, as appropriate.

PART 2 PRODUCTS

2.1 MANUFACTURERS
   A. Basis of Design Manufacturer: Sherwin-Williams
   B. Substitutions must be pre-approved

2.2 APPLICATIONS/SCOPE
   A. Interior Paint and Coating Commercial Systems:
      1. Masonry: CMU, split face.
      2. Metal: Hollow metal doors/frames, misc metal.
   B. Exterior Paint and Coating Systems:
      2. Masonry: CMU, split face.
      3. Metal: Hollow metal doors/frames, misc metal.

2.3 PAINT MATERIALS - GENERAL
   A. Paints and Coatings:
      1. Unless otherwise indicated, provide factory-mixed coatings. When required, mix coatings to correct consistency in accordance with manufacturer's instructions before application. Do not reduce, thin, or dilute coatings or add materials to coatings unless such procedure is specifically described in manufacturer's product instructions.
      2. For opaque finishes, tint each coat including primer coat and intermediate coats, one-half shade lighter than succeeding coat, with final finish coat as base color. Or follow manufactures product instructions for optimal color conformance.
   B. Primers: Where the manufacturer offers options on primers for a particular substrate, use primer categorized as "best" by the manufacturer.
   C. Coating Application Accessories: Provide all primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials required, per manufacturer's specifications.
   D. Color: Refer to Finish Schedule for paint colors, and as selected.

2.4 INTERIOR PAINT AND COATING COMMERCIAL SYSTEMS
A. Masonry: CMU, split face.
   1. Alkyd Systems; Waterbased:
      a. Semi-Gloss Finish:
         1) 1st Coat: S-W PrepRite Block Filler, B25W25 (75-125 sq ft/gal).
         3) 3rd Coat: S-W Pro Industrial Waterbased Alkyd Urethane Enamel Semi-Gloss, B53-1150 Series (4.0-5.0 mils wet, 1.4 - 1.7 mils dry per coat).

B. Metal: Hollow metal doors/frames, misc metal.
   1. Alkyd Systems; Waterbased:
      a. Semi-Gloss Finish:
         1) 1st Coat: S-W Pro Industrial Pro-Cryl Universal Primer, B66-1310 Series (5.0 mils wet, 2.0 mils dry).
         3) 3rd Coat: S-W Pro Industrial Waterbased Alkyd Urethane Enamel Semi-Gloss, B53-1150 Series (4.0-5.0 mils wet, 1.4 - 1.7 mils dry per coat).

C. Wood: Plywood & plywood T&G ceilings.
   1. Alkyd Systems; Waterbased:
      a. Semi-Gloss Finish:
         1) 1st Coat: S-W PrepRite ProBlock Interior Oil-Based Primer, B79W8810 (4 mils wet, 1.8 mils dry).
         3) 3rd Coat: S-W Pro Industrial Waterbased Alkyd Urethane Enamel Semi-Gloss, B53-1150 Series (4.0-5.0 mils wet, 1.4 - 1.7 mils dry per coat).

2.5 EXTERIOR PAINT AND COATING SYSTEMS

A. Hardie Board: Siding & soffit.
   1. Latex Systems:
      a. Satin Finish:
         1) 1st Coat: S-W Loxon Concrete and Masonry Primer Sealer, LX02W50 (5.3-8.0 mils wet, 2.1-3.2 dry).
         2) 2nd Coat: S-W Duration Exterior Acrylic Satin, K33 Series.
         3) 3rd Coat: S-W Duration Exterior Acrylic Satin, K33 Series (5.0 mils wet, 2.0 mils dry per coat).

B. Masonry: CMU, split face.
   1. Elastomeric System:
      a. Flat Finish:
         1) 1st Coat: S-W Loxon BlockSurfacer, A24W00200 (16.0 mils wet, 8.8 mils dry).
         2) 2nd Coat: S-W Loxon XP Waterproofing Masonry Coating Flat, LX11-50 Series.
         3) 3rd Coat: S-W Loxon XP Waterproofing Masonry Coating Flat, LX11-50 Series (14.5 – 18.5 mils wet, 6.5-8.4 mils dry per coat).

C. Metal: Hollow metal doors/frames, misc metal.
   1. Alkyd Systems; Waterbased:
      a. Semi-Gloss Finish:
         1) 1st Coat: S-W Pro Industrial Pro-Cryl Universal Primer, B66-1310 Series (5.0 mils wet, 2.0 mils dry).
PART 3 EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared; notify Architect of unsatisfactory conditions before proceeding. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

B. Proceed with work only after conditions have been corrected and approved by all parties, otherwise application of coatings will be considered as an acceptance of surface conditions.

C. Previously Painted Surfaces: Verify that existing painted surfaces do not contain lead based paints, notify Architect immediately if lead based paints are encountered.

3.2 SURFACE PREPARATION

A. General: Surfaces shall be dry and in sound condition. Remove oil, dust, dirt, loose rust, peeling paint or other contamination to ensure good adhesion.

1. Prior to attempting to remove mildew, it is recommended to test any cleaner on a small, inconspicuous area prior to use. Bleach and bleaching type cleaners may damage or discolor existing paint films. Bleach alternative cleaning solutions are advised.

2. Remove mildew before painting by washing with a solution of 1 part liquid household bleach and 3 parts of warm water. Apply solution and scrub the mildewed area. Allow solution to remain on the surface for 10 minutes. Rinse thoroughly with clean water and allow surface to dry before painting. Wear protective glasses or goggles, waterproof gloves, and protective clothing. Quickly wash off any of the mixture that comes in contact with your skin. Do not add detergents or ammonia to the bleach/water solution.

3. Remove items including but not limited to thermostats, electrical outlets, switch covers and similar items prior to painting. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.

4. No exterior painting should be done immediately after a rain, during foggy weather, when rain is predicted, or when the temperature is below 50 degrees F (10 degrees C), unless products are designed specifically for these conditions. On large expanses of metal siding, the air, surface and material temperatures must be 50 degrees F (10 degrees F) or higher to use low temperature products.

B. Aluminum: Remove all oil, grease, dirt, oxide and other foreign material by cleaning per SSPC-SP1, Solvent Cleaning.

C. Block (Cinder and Concrete): Remove all loose mortar and foreign material. Surface must be free of laitance, concrete dust, dirt, form release agents, moisture curing membranes, loose cement, and hardeners. Concrete and mortar must be cured at least 30 days at 75 degrees F (24 degrees C). The pH of the surface should be between 6 and 9 unless the products are...
designed to be used in high pH environments. On tilt-up and poured-in-place concrete, commercial detergents and abrasive blasting may be necessary to prepare the surface. Fill bug holes, air pockets, and other voids with a cement patching compound.

D. Concrete, SSPC-SP13 or NACE 6: This standard gives requirements for surface preparation of concrete by mechanical, chemical, or thermal methods prior to the application of bonded protective coating or lining systems. The requirements of this standard are applicable to all types of cementitious surfaces including cast-in-place concrete floors and walls, precast slabs, masonry walls, and shotcrete surfaces. An acceptable prepared concrete surface should be free of contaminants, laitance, loosely adhering concrete, and dust, and should provide a sound, uniform substrate suitable for the application of protective coating or lining systems.

E. Cement Composition Siding/Panels: Remove all surface contamination by washing with an appropriate cleaner, rinse thoroughly and allow to dry. Existing peeled or checked paint should be scraped and sanded to a sound surface. Pressure clean, if needed, with a minimum of 2100 psi pressure to remove all dirt, dust, grease, oil, loose particles, laitance, foreign material, and peeling or defective coatings. Allow the surface to dry thoroughly. The pH of the surface should be between 6 and 9 unless the products are designed to be used in high pH environments.

F. Copper and Stainless Steel: Remove all oil, grease, dirt, oxide and other foreign material by cleaning per SSPC-SP 2, Hand Tool Cleaning.

G. Exterior Composition Board (Hardboard): Some composition boards may exude a waxy material that must be removed with a solvent prior to coating. Whether factory primed or unprimed, exterior composition board siding (hardboard) must be cleaned thoroughly and primed with an alkyd primer.

H. Drywall - Exterior: Must be clean and dry. All nail heads must be set and spackled. Joints must be taped and covered with a joint compound. Spackled nail heads and tape joints must be sanded smooth and all dust removed prior to painting. Exterior surfaces must be spackled with exterior grade compounds.

I. Drywall - Interior: Must be clean and dry. All nail heads must be set and spackled. Joints must be taped and covered with a joint compound. Spackled nail heads and tape joints must be sanded smooth and all dust removed prior to painting.

J. Galvanized Metal: Clean per SSPC-SP1 using detergent and water or a degreasing cleaner to remove greases and oils. Apply a test area, priming as required. Allow the coating to dry at least one week before testing. If adhesion is poor, Brush Blast per SSPC-SP16 is necessary to remove these treatments.

K. Plaster: Must be allowed to dry thoroughly for at least 30 days before painting unless the products are designed to be used in high pH environments. Room must be ventilated while drying; in cold, damp weather, rooms must be heated. Damaged areas must be repaired with an appropriate patching material. Bare plaster must be cured and hard. Textured, soft, porous, or powdery plaster should be treated with a solution of 1 pint household vinegar to 1 gallon of water. Repeat until the surface is hard, rinse with clear water and allow to dry.

L. Steel: Structural, Plate, And Similar Items: Should be cleaned by one or more of the surface preparations described below. These methods are used throughout the world for describing methods for cleaning structural steel. Visual standards are available through the Society of Protective Coatings. A brief description of these standards together with numbers by which they can be specified follow.

1. Solvent Cleaning, SSPC-SP1: Solvent cleaning is a method for removing all visible oil, grease, soil, drawing and cutting compounds, and other soluble contaminants. Solvent
cleaning does not remove rust or mill scale. Change rags and cleaning solution frequently so that deposits of oil and grease are not spread over additional areas in the cleaning process. Be sure to allow adequate ventilation.

2. **Hand Tool Cleaning, SSPC-SP2**: Hand Tool Cleaning removes all loose mill scale, loose rust, and other detrimental foreign matter. It is not intended that adherent mill scale, rust, and paint be removed by this process. Before hand tool cleaning, remove visible oil, grease, soluble welding residues, and salts by the methods outlined in SSPC-SP1.

3. **Power Tool Cleaning, SSPC-SP3**: Power Tool Cleaning removes all loose mill scale, loose rust, and other detrimental foreign matter. It is not intended that adherent mill scale, rust, and paint be removed by this process. Before power tool cleaning, remove visible oil, grease, soluble welding residues, and salts by the methods outlined in SSPC-SP1.

4. **White Metal Blast Cleaning, SSPC-SP5 or NACE 1**: A White Metal Blast Cleaned surface, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter. Before blast cleaning, visible deposits of oil or grease shall be removed by any of the methods specified in SSPC-SP1 or other agreed upon methods.

5. **Commercial Blast Cleaning, SSPC-SP6 or NACE 3**: A Commercial Blast Cleaned surface, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter, except for staining. Staining shall be limited to no more than 33 percent of each square inch of surface area and may consist of light shadows, slight streaks, or minor discoloration caused by stains of rust, stains of mill scale, or stains of previously applied paint. Before blast cleaning, visible deposits of oil or grease shall be removed by any of the methods specified in SSPC-SP1 or other agreed upon methods.

6. **Brush-Off Blast Cleaning, SSPC-SP7 or NACE 4**: A Brush-Off Blast Cleaned surface, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, loose mill scale, loose rust, and loose paint. Tightly adherent mill scale, rust, and paint may remain on the surface. Before blast cleaning, visible deposits of oil or grease shall be removed by any of the methods specified in SSPC-SP1 or other agreed upon methods.

7. **Power Tool Cleaning to Bare Metal, SSPC-SP11**: Metallic surfaces that are prepared according to this specification, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, mill scale, rust, paint, oxide corrosion products, and other foreign matter. Slight residues of rust and paint may be left in the lower portions of pits if the original surface is pitted. Prior to power tool surface preparation, remove visible deposits of oil or grease by any of the methods specified in SSPC-SP1, Solvent Cleaning, or other agreed upon methods.

8. **Near-White Blast Cleaning, SSPC-SP10 or NACE 2**: A Near White Blast Cleaned surface, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter, except for staining. Staining shall be limited to no more than 5 percent of each square inch of surface area and may consist of light shadows, slight streaks, or minor discoloration caused by stains of rust, stains of mill scale, or stains of previously applied paint. Before blast cleaning, visible deposits of oil or grease shall be removed by any of the methods specified in SSPC-SP1 or other agreed upon methods.

9. **High- and Ultra-High Pressure Water Jetting for Steel and Other Hard Materials**: SSPC-SP12 or NACE 5: This standard provides requirements for the use of high- and ultra-high pressure water jetting to achieve various degrees of surface cleanliness. This standard is limited in scope to the use of water only without the addition of solid particles in the stream.

10. **Water Blasting, SSPC-SP12/NACE No. 5**: Removal of oil grease dirt, loose rust, loose mill scale, and loose paint by water at pressures of 2,000 to 2,500 psi at a flow of 4 to 14 gallons per minute.
M. Vinyl Siding, Architectural Plastics, EIFS and Fiberglass: Clean vinyl siding thoroughly by scrubbing with a warm, soapy water solution. Rinse thoroughly. Do not paint vinyl siding with any color darker than the original color unless the paint system features Sherwin-Williams VinylSafe technology. Painting with darker colors that are not Sherwin-Williams VinylSafe may cause siding to warp. Follow all painting guidelines of the vinyl manufacturer when painting. Only paint properly installed vinyl siding. Deviating from the manufacturer's painting guidelines may cause the warranty to be voided.

N. Stucco: Must be clean and free of any loose stucco. If recommended procedures for applying stucco are followed, and normal drying conditions prevail, the surface may be painted in 30 days. The pH of the surface should be between 6 and 9 unless the products are designed to be used in high pH environments such as Loxon.

O. Wood: Must be clean and dry. Prime and paint as soon as possible. Knots and pitch streaks must be scraped, sanded, and spot primed before a full priming coat is applied. Patch all nail holes and imperfections with a wood filler or putty and sand smooth.

3.3 INSTALLATION

A. Apply all coatings and materials with the manufacturer's specifications in mind. Mix and thin coatings according to manufacturer's recommendations.

B. Do not apply to wet or damp surfaces. Wait at least 30 days before applying to new concrete or masonry. Or follow manufacturer's procedures to apply appropriate coatings prior to 30 days. Test new concrete for moisture content. Wait until wood is fully dry after rain or morning fog or dew.

C. Apply coatings using methods recommended by manufacturer.

D. Uniformly apply coatings without runs, drips, or sags, without brush marks, and with consistent sheen.

E. Apply coatings at spreading rate required to achieve the manufacturers recommended dry film thickness.

F. Regardless of number of coats specified, apply as many coats as necessary for complete hide, and uniform appearance.

G. Inspection: The coated surface must be inspected and approved by the Architect just prior to the application of each coat.

3.4 PROTECTION

A. Protect finished coatings from damage until completion of project.

B. Touch-up damaged coatings after substantial completion, following manufacturer's recommendation for touch up or repair of damaged coatings. Repair any defects that will hinder the performance of the coatings.

END OF SECTION
SECTION 10 21 13.19
PLASTIC TOILET COMPARTMENTS

PART 1  GENERAL
1.01 SECTION INCLUDES
   A. Solid plastic toilet compartments.

1.02 RELATED REQUIREMENTS
   A. Section 06 10 00 - Rough Carpentry: Blocking and supports.
   B. Section 10 28 00 - Toilet Accessories.

1.03 REFERENCE STANDARDS

1.04 ADMINISTRATIVE REQUIREMENTS
   A. Coordination: Coordinate the work with placement of support framing and anchors in walls and ceilings.

1.05 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide data on panel construction, hardware, and accessories.
   C. Shop Drawings: Indicate partition plan, elevation views, dimensions, details of wall supports, door swings.
   D. Samples: Submit two samples of partition panels, 6 by 6 inch in size illustrating panel finish, color, and sheen.

PART 2  PRODUCTS
2.01 MANUFACTURERS
   A. Solid Plastic Toilet Compartments – Basis of Design:
      2. Substitutions: Section 01 60 00 - Product Requirements.

2.02 SOLID PLASTIC TOILET COMPARTMENTS
   A. Toilet Compartments: Factory fabricated doors, pilasters, and divider panels made of solid molded high density polyethylene (HDPE), tested in accordance with NFPA 286, floor-mounted unbraced.
      1. Color: As noted on the drawings.
   B. Doors:
      1. Thickness: 1 inch.
      2. Width: 24 inch.
      4. Height: 55 inch.
   C. Panels:
      1. Thickness: 1 inch.
      2. Height: 55 inch.
   D. Pilasters:
      1. Thickness: 1 inch.
      2. Width: As required to fit space; minimum 3 inch.

2.03 ACCESSORIES
   A. Pilaster Shoes: Formed chromed steel with satin finish, 3 inch high, concealing floor fastenings.
   B. Pilaster Brackets: Satin stainless steel.
C. Wall Brackets: Continuous type, satin stainless steel.
D. Attachments, Screws, and Bolts: Stainless steel, tamper proof type.
E. Hardware: Satin stainless steel:
   1. Pivot hinges, gravity type, adjustable for door close positioning; two per door.
   2. Door Latch: Slide type with exterior emergency access feature.
   3. Door strike and keeper with rubber bumper; mounted on pilaster in alignment with door latch.
   4. Coat hook with rubber bumper; one per compartment, mounted on door.
   5. Provide door pull for outswinging doors.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that field measurements are as indicated.
   B. Verify correct spacing of and between plumbing fixtures.
   C. Verify correct location of built-in framing, anchorage, and bracing.

3.02 INSTALLATION
   A. Install partitions secure, rigid, plumb, and level in accordance with manufacturer's instructions.
   B. Maintain 3/8 inch to 1/2 inch space between wall and panels and between wall and end pilasters.
   C. Attach panel brackets securely to walls using anchor devices.
   D. Attach panels and pilasters to brackets. Locate head rail joints at pilaster center lines.

3.03 TOLERANCES
   A. Maximum Variation From True Position: 1/4 inch.
   B. Maximum Variation From Plumb: 1/8 inch.

3.04 ADJUSTING
   A. Adjust and align hardware to uniform clearance at vertical edge of doors, not exceeding 3/16 inch.
   B. Adjust hinges to position doors in partial opening position when unlatched. Return out-swinging doors to closed position.
   C. Adjust adjacent components for consistency of line or plane.

END OF SECTION
SECTION 10 28 00
TOILET ACCESSORIES

PART 1  GENERAL

1.01  SECTION INCLUDES
A. Commercial toilet accessories.
B. Accessories for toilet rooms and utility rooms.
C. Diaper changing stations.
D. Adjustable height changing stations
D. Grab bars.

1.02  RELATED REQUIREMENTS
A. Section 06 10 00 - Rough Carpentry: Concealed blocking support.

1.03  REFERENCE STANDARDS

1.04  SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Submit data on accessories describing size, finish, details of function, and attachment methods.
C. Manufacturer's Installation Instructions: Indicate special procedures and conditions requiring special attention.

PART 2  PRODUCTS

2.01  MATERIALS
A. 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.
B. Stainless Steel Tubing: ASTM A269/A269M, Grade TP304 or TP316.
C. Mirror Glass: Tempered safety glass, ASTM C1048; and ASTM C1036 Type I, Class 1, Quality Q2, with silvering as required.
D. Fasteners, Screws, and Bolts: Hot dip galvanized; tamper-proof; security type.

2.02  FINISHES
A. Stainless Steel: No. 4 Brushed finish.

2.03  COMMERCIAL TOILET ACCESSORIES
A. Refer to Toilet Accessories Schedule on the drawings.

PART 3  EXECUTION

3.01  EXAMINATION
A. Verify existing conditions before starting work.
B. Verify exact location of accessories for installation.
C. Verify that field measurements are as indicated on drawings.

3.02  PREPARATION
A. Deliver inserts and rough-in frames to site for timely installation.
B. Provide templates and rough-in measurements as required.
3.03 INSTALLATION
   A. Install accessories in accordance with manufacturers' instructions in locations indicated on the drawings.
   B. Install plumb and level, securely and rigidly anchored to substrate.
   C. Mounting Heights: As required by accessibility regulations, unless otherwise indicated.

3.04 PROTECTION
   A. Protect installed accessories from damage due to subsequent construction operations.

END OF SECTION
SECTION 10 44 00
FIRE PROTECTION SPECIALTIES

PART 1  GENERAL
1.01  SECTION INCLUDES
   A. Fire extinguishers.
   B. Fire extinguisher cabinets.
   C. Accessories.

1.02  RELATED REQUIREMENTS
   A. Section 06 10 00 - Rough Carpentry: Wood blocking product and execution requirements.

1.03  REFERENCE STANDARDS
   C. UL (DIR) - Online Certifications Directory; current listings at database.ul.com.

1.04  SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide extinguisher operational features.
   C. Shop Drawings: Indicate locations of cabinets and cabinet physical dimensions.
   D. Product Data: Provide extinguisher operational features.
   E. Manufacturer's Installation Instructions: Indicate special criteria and wall opening coordination requirements.

PART 2  PRODUCTS
2.01  FIRE EXTINGUISHERS
   A. Fire Extinguishers - General: Comply with product requirements of NFPA 10 and applicable codes, whichever is more stringent.
      1. Provide extinguishers labeled by UL (DIR) or FM (AG) for purpose specified and as indicated.
   B. Multipurpose Dry Chemical Type Fire Extinguishers: Carbon steel tank, with pressure gage.
      2. Class: A:B:C type.
      3. Size: 10 pound.
      5. Temperature range: Minus 40 degrees F to 120 degrees F.

2.02  FIRE EXTINGUISHER CABINETS
   A. Cabinet Configuration: Semi-recessed type.
      1. Size to accommodate accessories.
      2. Trim: Flat square edge, with 1 1/2 inch max. wide face.
      3. Provide cabinet enclosure with right angle inside corners and seams, and with formed perimeter trim and door stiles.
   B. Door: 0.036 inch metal thickness, reinforced for flatness and rigidity with nylon catch. Hinge doors for 180 degree opening with two butt hinge.
   C. Door Glazing: Acrylic plastic, clear, 1/8 inch thick, flat shape and set in resilient channel glazing gasket.
   D. Cabinet Mounting Hardware: Appropriate to cabinet, with pre-drilled holes for placement of anchors.
   E. Weld, fill, and grind components smooth.
F. Finish of Cabinet Exterior Trim and Door: Baked enamel, color as selected.
G. Finish of Cabinet Interior: White colored enamel.

2.03 ACCESSORIES
   A. Extinguisher Brackets: Formed steel, chrome-plated.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify existing conditions before starting work.
   B. Verify rough openings for cabinet are correctly sized and located.

3.02 INSTALLATION
   A. Install in accordance with manufacturer's instructions.
   B. Install cabinet plumb and level.
   C. Installation Height: Fire extinguisher handle shall be 3'-10" above finished floor.
   D. Secure rigidly in place.

END OF SECTION
SECTION 12 36 00
COUNTERTOPS

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Countertops for architectural cabinet work.

1.02 RELATED REQUIREMENTS
   A. Section 06 41 00 - Architectural Wood Casework.

1.03 REFERENCE STANDARDS

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. Specimen warranty.
   C. Shop Drawings: Complete details of materials and installation; combine with shop drawings of cabinets and casework specified in other sections.
   D. Test Reports: Chemical resistance testing, showing compliance with specified requirements.
   E. Installation Instructions: Manufacturer's installation instructions and recommendations.

1.05 DELIVERY, STORAGE, AND HANDLING
   A. Store products in manufacturer's unopened packaging until ready for installation.
   B. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

PART 2 PRODUCTS

2.01 COUNTERTOPS
   A. Solid Surfacing Countertops: Solid surfacing sheet or plastic resin casting self-supporting over structural members.
      1. Flat Sheet Thickness: 1/2 inch, minimum.
      2. Solid Surfacing Sheet and Plastic Resin Castings: Complying with ISFA 2-01 and NEMA LD 3; acrylic or polyester resin, mineral filler, and pigments; homogenous, non-porous and capable of being worked and repaired using standard woodworking tools; no surface coating; color and pattern consistent throughout thickness.
         a. Surface Burning Characteristics: Flame spread index of 25, maximum; smoke developed index of 450, maximum; when tested in accordance with ASTM E84.
         b. Sinks and Bowls: Separate units for undercounter mounting; minimum 3/4 inch wall thickness.
         c. Finish on Exposed Surfaces: Matte, gloss rating of 5 to 20.
         d. Color and Pattern: Refer to finish schedule on drawings.
      3. Other Components Thickness: 1/2 inch, minimum.
      4. Back and End Splashes: Same sheet material, square top; minimum 4 inches high.

2.02 MATERIALS
   A. Adhesives: Chemical resistant waterproof adhesive as recommended by manufacturer of materials being joined.
   B. Joint Sealant: Mildew-resistant silicone sealant, white.
2.03 FABRICATION
   A. Fabricate tops and splashes in the largest sections practicable, with top surface of joints flush.
      1. Join lengths of tops using best method recommended by manufacturer.
      2. Fabricate to overhang fronts and ends of cabinets 1 inch except where top butts against cabinet or wall.
      3. Prepare all cutouts accurately to size; replace tops having improperly dimensioned or unnecessary cutouts or fixture holes.
   B. Provide back/end splash wherever counter edge abuts vertical surface unless otherwise indicated.
      1. Secure to countertop with concealed fasteners and with contact surfaces set in waterproof glue.
      2. Height: 4 inches, unless otherwise indicated.
   C. Solid Surfacing: Fabricate tops up to 144 inches long in one piece; join pieces with adhesive sealant in accordance with manufacturer's recommendations and instructions.
      1. Integral sinks: Shop-mount securely to countertop with adhesives, using flush configuration, as per manufacturer's instructions, and as detailed on drawings.

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.
   C. Verify that wall surfaces have been finished and mechanical and electrical services and outlets are installed in proper locations.

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. Securely attach countertops to cabinets using concealed fasteners. Make flat surfaces level; shim where required.
   B. Seal joint between back/end splashes and vertical surfaces.

3.04 TOLERANCES
   A. Variation From Horizontal: 1/8 inch in 10 feet, maximum.
   B. Offset From Wall, Countertops: 1/8 inch maximum; 1/16 inch minimum.
   C. Field Joints: 1/8 inch wide, maximum.

3.05 CLEANING
   A. Clean countertops surfaces thoroughly.

3.06 PROTECTION
   A. Protect installed products until completion of project.
   B. Touch-up, repair or replace damaged products before Date of Substantial Completion.

END OF SECTION
PART 1 - General

1.1 Imposed regulations:
A. Applicable provisions of the State and Local Codes and codes and standards in addition to those listed elsewhere in the contract documents are hereby imposed on a general basis for plumbing work.

1.2 Scope of work:
A. Provide all labor, materials, equipment and supervision to construct complete and operable plumbing systems as indicated on the drawings and specified herein. All materials and equipment used shall be new, undamaged and free from any defects.

1.3 Related documents and other information:
A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the portions of work specified in each and every Section of this Division, individually and collectively.

1.4 Existing services and facilities:
A. Damage to Existing Services: Existing services and facilities damaged by the Contractor through negligence or through use of faulty materials or workmanship shall be promptly repaired, replaced, or otherwise restored to previous conditions by the Contractor without additional cost to the Owner.
B. Interruption of Services: Interruptions of services necessary for connection to or modification of existing systems or facilities shall occur only at prearranged times approved by the Owner. Contractor shall provide no less than 14 days notice to owner when scheduling outages. Interruptions shall only occur after the provision of all temporary work and the availability of adequate labor and materials will assure that the duration of the interruption will not exceed the time agreed upon.

1.5 Product warranties:
A. Provide manufacturer's standard printed commitment in reference to a specific product and normal application, stating that certain acts of restitution will be performed for the Purchaser or Owner by the manufacturer, when and if the product fails within certain operational conditions and time limits. Where the warranty requirements of a specific specification section exceeds the manufacturer's standard warranty, the more stringent requirements will apply and modified manufacturer's warranty shall be provided. In no case shall the manufacturer's warranty be less than one (1) year.

1.6 Product substitutions:
A. General: Materials specified by manufacturer's name shall be used unless prior approval of
an alternate is given by addenda. Requests for substitutions must be received in the office of
the Architect at least 14 days prior to opening of bids. Refer to the general conditions for the
substitution request form and required documentation.

PART 2 - Not used

PART 3 - Execution

3.1 Product installation, general:

A. Except where more stringent requirements are indicated, comply with the product
manufacturer's installation instructions and recommendations, including handling, anchorage,
assemble, connections, cleaning and testing, charging, lubrication, startup, test operation and
shut-down of operating equipment. Consult with manufacturer's technical experts, for specific
instructions on unique product conditions and unforeseen problems.

B. Protection and Identification: Deliver products to project properly identified with names,
models numbers, types, grades, compliance labels and similar information needed for distinct
identifications; adequately packaged or protected to prevent deterioration during shipment,
storage and handling. Store in a dry, well ventilated, indoor space, except where prepared
and protected by the manufacturer specifically for exterior storage.

C. Permits and Tests: Provide labor, material and equipment to perform all tests required by the
governing agencies and submit a record of all tests to the Owner or his representative. Notify
the Architect five days in advance of any testing.

END OF SECTION
PART 1 - General

1.1 Quality assurance:

A. Retain or delete this article in all Sections of Project Manual.
B. Plumbing Coordination Drawings: Prepare a set of coordination drawings showing the coordination of the major elements, components, and systems of the Plumbing work, and showing the coordination of Plumbing work with other work. Prepare drawings at accurate scale and sufficiently large to show locations of every item, including clearances for installing, maintaining, insulating, breaking down equipment, replacing motors and similar requirements. Drawings shall indicate coordination with all other trades including, but not limited to, lighting, structural, plumbing, and architectural items. Prepare drawings to include plans, elevations, sections and details as needed to conclusively show successful coordination and integration of the work. Submit drawings for review by the Architect/Engineer and Owner.

1. Plans shall include dimensioned locations of all Floor Drains
2. Plans shall include locations of all ceiling and wall access panels required for equipment access (valves, for example).

C. Record Drawings: During construction operations, the Plumbing contractor shall faithfully make a record of all approved changes from the contract drawings, including accurate dimensions where applicable, and shall also record accurate dimensions locating all below-grade outside Plumbing utilities (whether changed or not) with reference to permanent above-grade objects. A minimum of two (2) dimensions from building reference points shall be provided and a bury depth indicated. At completion of the work, all such changes shall be recorded neatly with red ink by the Plumbing contractor on an unused set of the Plumbing contract drawings supplied by the architect.

D. Photographs: For all below-grade plumbing piping, photograph installation of trenches before backfilling. Submit to A/E for review and include in closeout documents to the Owner.

1.2 Related documents and other information:

A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the portions of work specified in each and every Section of this Division, individually and collectively.
B. Section 019100 - General Commissioning Requirements.
C. Commissioning Plan.

PART 2 - Products

1.1 Plumbing product coordination:

A. Power Characteristics: Refer to the electrical sections of the specifications and the electrical drawings for the power characteristics available for the operation of each power driven item of Plumbing equipment. The electrical design was based on the power requirements of the
Plumbing equipment manufacturer scheduled or specified as "basis of design." Any modifications to the electrical system that are required due to the use of an approved equivalent manufacturer shall be made at no additional cost to the owner. All changes must be clearly documented and submitted for review by the Architect/Engineer prior to purchasing equipment. Coordinate purchases to ensure uniform interface with electrical work. Refer to Division 26 specifications for additional coordination requirements.

B. Coordination of Options and Substitutions: When the contract documents permit the selection from several product options and it becomes necessary to authorize a substitution, do not proceed with purchase until coordination of interface to equipment has been checked and satisfactorily established.

PART 3 - Execution

1.1 Inspection and preparation:

A. Substrate Examination: The Installer of each element of the Plumbing work must examine the condition of the substrate to receive the work, the conditions under which the work will be performed, and must notify the Contractor in writing of conditions detrimental to the proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

B. Do not proceed with the installation of sleeves, anchors, hangers, roof penetrations and similar work until Plumbing coordination drawings have been processed and released for construction. Where work must be installed prior to that time in order to avoid a project delay, review proposed installation in a project coordination meeting including all parties involved with the interfacing of the work.

1.2 Cutting and patching:

A. Structural Limitations: Do not cut structural framing, walls, floors, decks and other members intended to withstand stress, except with the Architect's or Engineer's written authorization. Authorization will be granted only where there is no other reasonable method for completing the Plumbing work, and where the proposed cutting clearly does not materially weaken the structure.

B. Where authorized, cut opening through concrete (for pipe penetrations and similar services) by core drilling or sawing. Do not cut by hammer-driven chisel or drill.

C. Other work: Do not endanger or damage other work through the procedures and processes of cutting to accommodate Plumbing work. Review the proposed cutting with the Installer of the work to be cut, and comply with his recommendations to minimize damage. Where necessary, engage the original Installer or other specialists to execute the cutting in the recommended manner.

D. Where patching is required to restore other work, because of either cutting or other damage inflicted during the installation of Plumbing work, execute the patching in the manner recommended by the original Installer. Restore the other work in every respect, including the elimination of visual defects in exposed finishes, as judged by the Architect. Engage the original Installer to complete patching of the following categories of work:
   1. Exposed concrete finishes.
   2. Exposed masonry.
   3. Waterproofing and vapor barriers.
   4. Roofing, flashing and accessories.
   5. Interior exposed finishes and casework, where judged by the Architect to be difficult to achieve an acceptable match by other means.
1.3 Coordination of plumbing installation:

A. General: Sequence, coordinate and integrate the various elements of Plumbing work so that the Plumbing system will perform as indicated and be in harmony with the other work of the building. The Architect/Engineer will not supervise the coordination, which is the exclusive responsibility of the Contractor. Comply with the following requirements:

1. Install piping and similar services straight and true, aligned with other work and with overhead structures and allowing for insulation. Conceal where possible.
2. Arrange work to facilitate maintenance and repair or replacement of equipment. Locate services requiring maintenance on valves and similar units in front of services requiring less maintenance. Connect equipment for ease of disconnecting, with minimum of interference with other work.
3. Give the right-of-way to piping systems required to slope for drainage (over other service lines). Piping shall be located to avoid interference with ductwork and light fixtures.

B. Drawings: Conform with the arrangement indicated by the contract documents to the greatest extent possible, recognizing that portions of the work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, comply with the Architect's decision on resolution of the conflict.

C. Electrical Work: Coordinate the Plumbing work with electrical work, and properly interface with the electrical service. In general, and except as otherwise indicated, install Plumbing equipment ready for electrical connection. Refer to the electrical sections of the specifications for electrical connection of Plumbing equipment.

D. Utility Connections: Coordinate the connection of Plumbing systems with exterior underground utilities and services. Comply with the requirements of governing regulations, franchised service companies and controlling agencies.

1. Provide a single connection for each service except where multiple connections are indicated. Water, tap, meter, and vault cost shall be incurred by the Contractor.

1.4 Coordination of plumbing start-up:

A. Seasonal Requirements: Adjust and coordinate the timing of Plumbing system start-ups with seasonal variations, so that demonstration and testing of specified performance can be observed and recorded. Exercise proper care in off-season start-ups to ensure that systems and equipment will not be damaged by the operation.

END OF SECTION
PART 1 - General

1.1 Related documents

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

1.2 Summary

A. Section Includes:
   1. Sleeves.
   2. Stack-sleeve fittings.
   3. Sleeve-seal systems.
   4. Sleeve-seal fittings.
   5. Grout.

PART 2 - Products

2.1 Sleeves

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.


2.2 Stack-sleeve fittings

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   2. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.
   3. Approved equal.

B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.
   1. Underdeck Clamp: Clamping ring with setscrews.

2.3 Sleeve-seal systems

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Advance Products & Systems, Inc.
   2. CALPICO, Inc.
   3. GPT (Link-Seal).
   4. Metraflex Company (The).
   5. Pipeline Seal and Insulator, Inc.
6. Proco Products, Inc.
7. Approved equal.

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Carbon steel.
3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, Stainless steel of length required to secure pressure plates to sealing elements.

2.4 Wall sleeve fitting

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Presealed Systems.
2. Approved equal.

B. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

2.5 Grout

B. Characteristics: Nonshrink; 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 Sleeve installation

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

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

C. Pipes passing through interior partitions.

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

3.2 Stack-sleeve-fitting installation

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

1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Coordinate flashing with Architect/general contractor. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
3. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring.
4. Using grout, seal the space around outside of stack-sleeve fittings.

3.3 Sleeve-seal-system installation

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
B. Select type, size, and number of sealing elements required for piping material and size for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 Wall sleeve fitting installation

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

END OF SECTION
SECTION 22 05 19
METERS AND GAGES FOR PLUMBING 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. Bimetallic-actuated thermometers.
   2. Filled-system thermometers.
   4. Thermowells.
   5. Dial-type pressure gages.
   7. Test plugs.
   8. Test-plug kits.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of meter and gage, from manufacturer.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
   2. Case: Cast aluminum; 7-inch nominal size unless otherwise indicated.
   3. Tube: Glass with magnifying lens and blue or red organic liquid.
4. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
6. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.2 THERMOWELLS
A. Thermowells:
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Type: Stepped shank unless straight or tapered shank is indicated.
4. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
5. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
6. Bore: Diameter required to match thermometer bulb or stem.
7. Insertion Length: Length required to match thermometer bulb or stem.
8. Lagging Extension: Include on thermowells for insulated piping and tubing.
9. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

2.3 PRESSURE GAGES
A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
2. Case: Liquid-filled; cast aluminum or drawn steel; 6-inch nominal diameter.
3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
4. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
8. Window: Glass.
9. Ring: Metal.
10. Accuracy: Grade B, plus or minus 2 percent of middle half of scale range.

2.4 GAGE ATTACHMENTS
A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.
B. Valves: Brass or stainless-steel needle, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.
PART 3 - EXECUTION

3.1 INSTALLATION
   A. Install thermowells with socket extending one-third of pipe diameter and in vertical position in piping tees.
   B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
   C. Install thermowells with extension on insulated piping.
   D. Fill thermowells with heat-transfer medium.
   E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
   F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
   G. Install valve and snubber in piping for each pressure gage for fluids.
   H. Install test plugs in piping tees.
   I. Install thermometers in the following locations:
      1. Inlet and outlet of each water heater.
      2. Inlet and outlet of each circulating pump.
      3. Additional locations indicated in the documents.
   J. Install pressure gages in the following locations:
      1. Building water service entrance into building.
      2. Suction and discharge of each domestic water pump.

3.2 CONNECTIONS
   A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

3.3 ADJUSTING
   A. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE
   A. Thermometers shall be the following:
      1. Industrial-style, liquid-in-glass type.
   B. Thermometer stems shall be of length to match thermowell insertion length.
3.5  THERMOMETER SCALE-RANGE SCHEDULE
   A. Scale Range for Domestic Cold-Water Piping: 0 to 150 deg F and minus 20 to plus 70 deg C.
   B. Scale Range for Domestic Hot-Water Piping: 20 to 240 deg F and 0 to 150 deg C.

3.6  PRESSURE-GAGE SCHEDULE
   A. Pressure gages shall be the following:
      1. Liquid-filled, direct-mounted, metal case.

3.7  PRESSURE-GAGE SCALE-RANGE SCHEDULE
   A. Scale Range for Domestic Water Piping: 0 to 200 psi and 0 to 1400 kPa.

END OF SECTION 22 05 19
SECTION 22 05 23
GENERAL-DUTY VALVES FOR PLUMBING 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. Brass ball valves.
   2. Bronze ball valves.

B. Related Sections:
   1. Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
   2. Section 221116 "Domestic Water Piping" for valves applicable only to this piping.

1.3 DEFINITIONS

A. CWP: Cold working pressure.
B. EPDM: Ethylene propylene copolymer rubber.
C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
D. NRS: Nonrising stem.
E. OS&Y: Outside screw and yoke.
F. RS: Rising stem.
G. SWP: Steam working pressure.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve indicated.

1.5 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
B. ASME Compliance:
   1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
   2. ASME B31.1 for power piping valves.
   3. ASME B31.9 for building services piping valves.

C. NSF/ANSI Compliance: NSF 61 for valve materials for potable-water service.

D. NSF/ANSI Compliance: NSF 372 for low lead construction for potable-water service.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, and weld ends.
   3. Set gate and globe valves closed to prevent rattling.
   4. Set ball valves open to minimize exposure of functional surfaces.
   5. Set butterfly valves closed or slightly open.
   6. Block check valves in either closed or open position.

B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to valve schedule articles for applications of valves.

B. Standards: NSF/ANSI 61 & 372.

C. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

D. Valve Sizes: Same as upstream piping unless otherwise indicated.

E. Valve Actuator Types:
   1. Handwheel: For valves other than quarter-turn types.
   2. Handlever: For quarter-turn valves NPS 6 and smaller.

F. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
   1. Gate Valves: With rising stem.
2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

G. Valve-End Connections:
1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Solder Joint: With sockets according to ASME B16.18.
3. Threaded: With threads according to ASME B1.20.1.

H. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRASS BALL VALVES

A. Two-Piece, Full-Port, Brass Ball Valves with Stainless-Steel Trim:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Crane Co.; Crane Valve Group; Jenkins Valves.
   c. Flow-Tek, Inc.; a subsidiary of Bray International, Inc.
   d. Hammond Valve.
   e. Jamesbury; a subsidiary of Metso Automation.
   f. Kitz Corporation.
   g. Marwin Valve; a division of Richards Industries.
   h. Milwaukee Valve Company.
   i. RuB Inc.

2. Description:
   b. SWP Rating: 150 psig.
   c. CWP Rating: 600 psig.
   d. Body Design: Two piece.
   e. Body Material: Forged brass.
   f. Ends: Threaded.
   g. Seats: PTFE or TFE.
   h. Stem: Stainless steel.
   i. Ball: Stainless steel, vented.
   j. Port: Full.

2.3 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Apollo Valves.
   b. Crane Valves.
   c. Hammond Valve.
   d. Lance Valves; a division of Advanced Thermal Systems, Inc.
North Charleston Wannamaker County Park
Park Center Replacement

2.4 BRONZE GATE VALVES

A. Class 125, NRS Bronze Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. American Valve, Inc.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Crane Co.; Crane Valve Group; Jenkins Valves.
d. Crane Co.; Crane Valve Group; Stockham Division.
e. Hammond Valve.
f. Kitz Corporation.
g. Milwaukee Valve Company.
h. NIBCO INC.
i. Powell Valves.
j. Red-White Valve Corporation.
k. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
l. Zy-Tech Global Industries, Inc.

2. Description:

a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 200 psig.
d. Ends: Threaded[ or solder joint].
e. Stem: Bronze.
f. Disc: Solid wedge; bronze.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron[, bronze, or aluminum].

B. Class 125, RS Bronze Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. American Valve, Inc.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Crane Co.; Crane Valve Group; Jenkins Valves.
d. Crane Co.; Crane Valve Group; Stockham Division.
e. Hammond Valve.
f. Kitz Corporation.
g. Milwaukee Valve Company.
h. NIBCO INC.
i. Powell Valves.
j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
k. Zy-Tech Global Industries, Inc.

2. Description:
   a. Standard: MSS SP-80, Type 2.
   b. CWP Rating: 200 psig.
   d. Ends: Threaded or solder joint.
   e. Stem: Bronze.
   f. Disc: Solid wedge; bronze.
   g. Packing: Asbestos free.
   h. Handwheel: Malleable iron, bronze, or aluminum.

C. Class 150, NRS Bronze Gate Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Hammond Valve.
      b. Kitz Corporation.
      c. Milwaukee Valve Company.
      d. NIBCO INC.
      e. Powell Valves.
      f. Red-White Valve Corporation.
      g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
   a. Standard: MSS SP-80, Type 1.
   b. CWP Rating: 300 psig.
   d. Ends: Threaded.
   e. Stem: Bronze.
   f. Disc: Solid wedge; bronze.
   g. Packing: Asbestos free.
   h. Handwheel: Malleable iron, bronze, or aluminum.

D. Class 150, RS Bronze 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. Crane Co.; Crane Valve Group; Stockham Division.
      c. Hammond Valve.
d. Kitz Corporation.
e. Milwaukee Valve Company.
f. NIBCO INC.
g. Powell Valves.
h. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
i. Zy-Tech Global Industries, Inc.

2. Description:
   a. Standard: MSS SP-80, Type 2.
   b. CWP Rating: 300 psig.
   d. Ends: Threaded.
   e. Stem: Bronze.
   f. Disc: Solid wedge; bronze.
   g. Packing: Asbestos free.
   h. Handwheel: Malleable iron[, bronze, or aluminum].

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
   B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
   C. Examine threads on valve and mating pipe for form and cleanliness.
   D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
   E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION
   A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
   B. Locate valves for easy access and provide separate support where necessary.
   C. Install valves in horizontal piping with stem at or above center of pipe.
   D. Install valves in position to allow full stem movement.
3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball or gate valves.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.

3.5 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
2. Ball Valves: Two piece, regular port, brass or bronze with brass or bronze trim.
3. Bronze Gate Valves Class 150

END OF SECTION
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. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Thermal-hanger shield inserts.
4. Fastener systems.
5. Pipe positioning systems.
6. Equipment supports.

B. Related Sections:

1. Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment" for vibration isolation devices.

1.3 Definitions

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 Performance requirements

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment.

1.5 Action submittals

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

B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:

1. Trapeze pipe hangers.
2. Pipe stands.
3. Equipment supports.
PART 2 - Products

2.1 Metal pipe hangers and supports

A. Carbon-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
   2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
   3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
   4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

B. Stainless-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
   2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

C. Copper Pipe Hangers:
   1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.

2.2 Trapeze pipe hangers

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 Thermal-hanger shield inserts

A. Manufacturers: Subject to compliance with requirements available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Carpenter & Paterson, Inc.
   3. ERICO International Corporation.
   5. PHS Industries, Inc.
   6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
   7. Piping Technology & Products, Inc.
   8. Rilco Manufacturing Co., Inc.
   9. Value Engineered Products, Inc.
   10. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
   11. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
   12. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.4 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.
B. Mechanical-Expansion Anchors: Insert-wedge-type, anchors to match pipe material, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.5 Pipe positioning systems

A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.6 Equipment supports

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

2.7 Miscellaneous materials

A. Structural Steel: ASTM A 36/A 36M, carbon-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.

2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - Execution

3.1 Hanger and support installation

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
B. Metal 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 for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
3. Where insulated pipe is installed on top of trapeze, provide 12” long, 16 gauge galvanized steel saddle for the bottom half of insulation circumference between insulation and trapeze. Individual pipe clamps, if used on the trapeze, shall be sized to fit around the insulation and saddle outer diameter.
4. Where uninsulated copper pipe is installed on a trapeze hanger, the pipe shall be wrapped with and elastomer material and a unistrut p-2600 clamp or similar clamp containing an elastomer material. This shall be used to isolate the copper from contacting dissimilar material.

C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
D. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches 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.

E. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.

F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.


H. 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.

I. All hangers shall be braced per seismic specification.

J. Install lateral bracing with pipe hangers and supports to prevent swaying.

K. 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.

L. Load Distribution: Install hangers and supports so that 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 to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

N. Insulated Piping:

1. Attach clamps and spacers to piping.
   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
   c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:
   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
   b. NPS 4: 12 inches long and 0.06 inch thick.
   c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
   d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
   e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 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 bearing surface smooth.
C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 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/D1.1M 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 so contours of welded surfaces match adjacent contours.

3.4 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.

3.5 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.
B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 Hanger and support schedule

A. Comply with MSS SP-69 for pipe-hanger selections and applications unless otherwise specified.
B. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
C. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
D. Use carbon-steel pipe hangers and supports and metal trapeze pipe hangers and attachments for general service applications.
E. Use copper-plated pipe hangers and copper attachments for uninsulated copper piping and tubing.
F. For any other uninsulated pipe material, use elastomeric linings between the pipe and hangers or clamp if of dissimilar metal.
G. Use padded hangers for piping that is subject to scratching.
H. Use thermal-hanger shield inserts for insulated piping and tubing.
I. 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 uninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. 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.
3. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of uninsulated, stationary pipes NPS 1/2 to NPS 8.
J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

K. 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. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
4. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
2. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
3. C-Clamps (MSS Type 23): For structural shapes.
4. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
5. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
6. 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.
7. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
8. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

M. 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.

N. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
O. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
P. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.
Q. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION
SECTION 22 05 48
VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUBMITTALS
   A. Submit signed and sealed shop drawings from a professional engineer. Shop drawings to include project specific details, sketches, product data cut sheets.
   B. See drawings for additional requirements.

PART 2 - NOT USED.

PART 3 - EXECUTION

3.1 INSTALLATION
   A. Install in accordance with manufacturer’s instructions.
   B. Refer to the details and notes on the construction documents.

3.2 FIELD QUALITY CONTROL
   A. Inspect installation after installation and submit report.

END OF SECTION
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 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. Valve tags.
   5. Warning tags.

1.3 ACTION 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. 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.
   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.

B. Label Content: Include equipment's Drawing designation or unique equipment number.

C. 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 rivets or 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. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

C. 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 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
   1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
   2. Fasteners: Brass beaded chain.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch 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.

2.5 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
   1. Size: 3 by 5-1/4 inches minimum.
   2. Fasteners: Brass grommet and wire.
   3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."

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. 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.

B. Pipe Label Color Schedule:

1. Domestic Cold, Hot, and Return Water Piping:
   a. Background Color: Green.

2. Sanitary Waste and Storm Drainage and Vent Piping:
   a. Background Color: Green.

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:

1. Valve-Tag Size and Shape: 1-1/2 inches round
2. Valve-Tag Color: Natural
3. Letter Color: 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
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 insulating the following plumbing piping services:
      1. Domestic cold-water piping.
      2. Domestic hot-water piping.

1.3 Action submittals
   A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied, if any).
   B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
      1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
      2. Detail attachment and covering of heat tracing inside insulation.
      3. Detail insulation application at pipe expansion joints for each type of insulation.
      4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
      5. Detail removable insulation at piping specialties, equipment connections, and access panels.
      6. Detail application of field-applied jackets.
      7. Detail application at linkages of control devices.

1.4 Informational submittals
   A. Qualification Data: For qualified Installer.
   B. Field quality-control reports.

1.5 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. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing 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 agency.
      1. Insulation: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   C. Comply with the following applicable standards and other requirements specified for miscellaneous components:
1.6 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.

1.7 Coordination
   A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
   B. Coordinate clearance requirements with piping installer for piping 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.

1.8 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
   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,
   a. Pittsburgh Corning Corporation; Foamglas.

2. Block Insulation: ASTM C 552, Type I.
3. Special-Shaped Insulation: ASTM C 552, Type III.
4. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class I.
6. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

1. Products: Subject to compliance with requirements, provide one of the following
   a. Aeroflex USA, Inc.; Aerocel.
   b. Armacell LLC; AP Armaflex.
H. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Fibrex Insulations Inc.; Coreplus 1200.
   b. Johns Manville; Micro-Lok.
   c. Knauf Insulation; 1000-Degree Pipe Insulation.
   d. Manson Insulation Inc.; Alley-K.
   e. Owens Corning; Fiberglas Pipe Insulation.

2. Type I, 850 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 Adhesives

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Aeroflex USA, Inc.; Aeroseal.
   b. Armacell LLC;
   c. Foster Brand
   d. K-Flex USA; R-373 Conta

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide one of the following:
   b. Eagle Bridges - Marathon Industries; 225.
   d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."


1. Products: Subject to compliance with requirements, provide one of the following:
b. Eagle Bridges - Marathon Industries; 225.
d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Dow Corning Corporation; 739, Dow Silicone.
   d. Speedline Corporation; Polyco VP Adhesive.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services’ "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.3 Mastics

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:
   b. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.

C. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:
   b. Eagle Bridges - Marathon Industries; 570.
2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
3. Service Temperature Range: Minus 50 to plus 220 deg F.
4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.

2.4 Sealants

A. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:
   b. Eagle Bridges - Marathon Industries; 405.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
   d. Mon-Eco Industries, Inc.; 44-05.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
5. Color: Aluminum.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

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

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.5 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.
2.6 Field-applied jackets

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. 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.
   c. Proto Corporation; LoSmoke.
   d. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.


4. 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.

C. Metal Jacket:

1. Products: Subject to compliance with requirements, provide one of the following:
   b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
   c. RRR Products, Inc.; Insul-Mate.

   a. Sheet and roll stock ready for shop or field sizing.
   b. Finish and thickness are indicated in field-applied jacket schedule.
   d. Moisture Barrier for Outdoor Applications: 3-mil-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.
      7. Valve covers.
      8. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

3. Removable Insulation Jacket: Company specializing in manufacturing the products specified in this section with minimum two years documented experience.
   a. Products: Subject to compliance with requirements; provide ThermaXX LLC 16 Hamilton Street West Haven CT 06516.
   b. Insulation
1) For Box Type Jackets:
   a) High / Low-temperature insulation blanket formed of silica Aerogel and reinforced with a non-woven, glass-fiber batting.
   b) Insulation must be hydrophobic
   c) Estimation of Maximum Use Temperature 1200°F (650°C)

2) For Non Box Type Jackets
   a) Glass mat, type E needle fiber. ¼", ½" @ 9 LB/CF & 1" @ 11.3 LB/CF.
   b) Estimation of Maximum Use Temperature 1200°F (650°C)

3) All insulation material shall be Non-Asbestos
c. Jacket:
   1) Pipe Side
      a) PTFE Fiberglass Composite Jacketing. 16.5 oz/sq. yd minimum
      b) Estimation of Maximum Use Temperature 600°F (315°C)
   2) Exterior Side
      a) PTFE Fiberglass Composite Jacketing. 16.5 oz/sq. yd minimum
      b) Estimation of Maximum Use Temperature 600°F (315°C)

d. Thread:
   1) Begins to decomposite at about 800°F (400°C)
   2) Does not melt
   3) Diameter – 0.0114
   4) Break Point – 35 LBS

2.7 Tapes
A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. ABI, Ideal Tape Division; 428 AWF ASJ.
      b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
      c. Compac Corporation; 104 and 105.
      d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
   2. Width: 3 inches.
   3. Thickness: 11.5 mils.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lbf/inch in width.
   7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
   1. Products: Subject to compliance with requirements, provide one of the following:
2. **Width:** 2 inches.
3. **Thickness:** 6 mils.
4. **Adhesion:** 64 ounces force/inch in width.
5. **Elongation:** 500 percent.
6. **Tensile Strength:** 18 lbf/inch in width.

C. **Aluminum-Foil Tape:** Vapor-retarder tape with acrylic adhesive.

1. **Products:** Subject to compliance with requirements, provide one of the following:
   
   a. ABI, Ideal Tape Division; 488 AWF.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
   c. Compac Corporation; 120.
   d. Venture Tape; 3520 CW.

2. **Width:** 2 inches.
3. **Thickness:** 3.7 mils.
4. **Adhesion:** 100 ounces force/inch in width.
5. **Elongation:** 5 percent.
6. **Tensile Strength:** 34 lbf/inch in width.

### 2.8 Securements

A. **Bands:**

1. **Products:** Subject to compliance with requirements, provide one of the following:
   
   a. ITW Insulation Systems; Gerrard Strapping and Seals.
   b. RPR Products, Inc.; Insul-Mate Strapping and Seals.

2. **Stainless Steel:** ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch thick, 1/2 inch wide with closed seal.
3. **Aluminum:** ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with closed seal.

B. **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 tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. 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.
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 piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of 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-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.

3. Overlap jacket longitudinal seams at least 1-1/2 inches. 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 o.c.

   a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.

5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to 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 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.

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 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.
   4. Seal jacket to wall flashing with flashing sealant.

C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

D. 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 Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

E. Insulation Installation at Floor Penetrations:
   1. Pipe: Install insulation continuously through floor penetrations.
   2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "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, Strainers, 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 strainers 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. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.

6. 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.

7. 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.

8. 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.

9. 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. 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 Installation of flexible elastomeric insulation

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.

3.7 Installation of mineral-fiber insulation

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 o.c.
   4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, 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, 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.

3.8 Field-applied jacket installation
A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. 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.

B. Where metal jackets are indicated, install with 2-inch 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 o.c. and at end joints.

3.9 Removable insulation jacket installation
A. Double sewn lock stitch with a minimum 4 to 6 stitches per inch. Jackets shall be sewn with two (2) parallel rows of stitching using thread in section 1.3D. The thread must be able to withstand the skin temperatures without degradation.
B. Hog rings, staples and wire are not are not acceptable methods of closure.
C. No raw cut jacket edges shall be exposed.
D. Jackets shall be fastened using hook and loop (Velcro) straps and 1” Slide Buckles.
E. All stitching will be done with thread in section 1.3D.
F. Provide a permanently attached Aluminum or stainless steel nameplate on each jacket to identify its location, size and tag number.
G. Provide a stainless steel or brass grommet at the low point of each jacket, in wet areas for moisture drain (on horizontal jackets as required).
H. The insulation shall be designed to prevent sweating in the space between the cold metal surface and the inner layer of insulation. To this end, during jacket fabrication, the layers of insulating mat shall be placed in an overlapping pattern.
I. All jacket pieces which match mating seams must include an extended 2” flap constructed from the exterior fabric and shall be secured using hook & loop closure (i.e. Velcro TM) parallel to the seam.
J. Insulation must be sewn as integral part of the jacket to prevent shifting of the insulation.

3.10 Finishes
A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
3.11 Field quality control

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
B. Perform tests and inspections.
C. Tests and Inspections:
   1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.12 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. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.13 Indoor piping insulation schedule

A. Domestic Cold Water:
   1. NPS 1 and Smaller: Insulation shall be one of the following:
      a. Flexible Elastomeric: 3/4 inch thick.
      b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
   2. NPS 1-1/4 and Larger: Insulation shall be one of the following:
      a. Flexible Elastomeric: 1 inch thick.
      b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

B. Domestic Hot and Recirculated Hot Water:
   1. NPS 1-1/4 and Smaller: Insulation shall be one of the following:
      a. Flexible Elastomeric: 3/4 inch thick.
      b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
   2. NPS 1-1/2 and Larger: Insulation shall be one of the following:
      a. Flexible Elastomeric: 1 inch thick.
      b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

C. 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:
a. Flexible Elastomeric: 3/4 inch thick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

3.14 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. Piping, Concealed:

1. None.

C. Piping, Exposed:

1. Aluminum, Corrugated 0.024 inch thick.

3.15 Removable insulation jacket schedule

A. Install removable insulation jacket over all valves, steam traps, wye strainer, check valves and unions for size 1 ½ inches and larger.

END OF SECTION
PART 1 - General

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

1.2 Summary
   A. Section Includes:
      1. Aboveground domestic water pipes, tubes, and fittings inside buildings.

1.3 Action submittals
   A. Product Data: For each type of product indicated.

1.4 Informational submittals
   A. System purging and disinfecting activities report.
   B. Field quality-control reports.

1.5 Field conditions
   A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
      1. Notify Architect/Owner no fewer than five days in advance of proposed interruption of water service.
      2. Do not interrupt water service without Architect/Owner's written permission.

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.
   B. Potable-water piping and components shall comply with NSF 14 and NSF 61.

2.2 Copper tube and fittings
   A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.
   B. Soft Copper Tube: ASTM B 88, Type K and ASTM B 88, Type L water tube, annealed temper.
   C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
   E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
   F. Copper Unions:
      1. MSS SP-123.
      4. Solder-joint or threaded ends.
2.3 Piping joining materials

A. Pipe-Flange Gasket Materials:
   1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
   2. Full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
C. Solder Filler Metals: ASTM B 32, lead-free alloys.
D. Flux: ASTM B 813, water flushable.
E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.4 Transition fittings

A. General Requirements:
   1. Same size as pipes to be joined.
   2. Pressure rating at least equal to pipes to be joined.
   3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
C. Sleeve-Type Transition Coupling: AWWA C219.

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Cascade Waterworks Manufacturing.
   b. Dresser, Inc.: Piping Specialties Products.
   c. Ford Meter Box Company, Inc. (The).
   d. JCM Industries.
   e. Romac Industries, Inc.
   f. Smith-Blair, Inc.; a Sensus company.
   g. Viking Johnson.
   h. Or approved equal.

2.5 Dielectric fittings

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

B. Dielectric Unions:

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Capitol Manufacturing Company; member of the Phoenix Forge Group.
   b. Central Plastics Company.
   d. Jomar International.
   e. Matco-Norca.
   g. Watts; a division of Watts Water Technologies, Inc.
   h. Wilkins; a Zurn company.
   i. Or approved equal.

3. Pressure Rating: 250 psig minimum at 180 deg F.

PART 3 - Execution

3.1 Earthwork
   A. Comply with requirements in Section 312000 “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 ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA A 674 or AWWA C105/A21.5.
   D. Install underground copper tube in PE encasement according to ASTM A 674 or AWWA C105/A21.5.
   E. Install shutoff valve immediately upstream of each dielectric fitting.
   F. Install domestic water piping level and plumb. Provide drain with hose fitting at all low points where possible.
   G. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
   H. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
   I. 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.
   J. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
   K. Install piping to permit valve servicing.
   L. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.
   M. Install piping free of sags and bends.
   N. Install fittings for changes in direction and branch connections.
   O. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
   P. Install thermometers on inlet and outlet piping from each water heater.
   Q. Install sleeves for piping penetrations of walls, ceilings, and floors.
   R. Install sleeve seals for piping penetrations of concrete walls and slabs.
   S. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.3 Joint construction
   A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
   B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
   C. 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.
D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.

E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

F. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

G. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.4 Transition fitting installation

A. Install transition couplings at joints of dissimilar piping.

3.5 Dielectric fitting installation

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.

3.6 Hanger and support installation

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

B. Comply with requirements for pipe hanger, support products, and installation in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

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.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

E. 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.

F. Install supports for vertical copper tubing every 10 feet.

G. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.7 Connections

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

B. When installing piping adjacent to equipment and machines, allow space for 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 that required by plumbing code.

3.8 Identification

A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."
B. Label pressure piping with system operating pressure.

3.9 Field quality control

A. Perform the following tests and inspections:

1. Piping Inspections:
   a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
   b. 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:
      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 authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
   c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
   d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests:
   a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
   b. 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.
   c. Leave new, altered, extended, or replaced domestic water piping uncovered and un concealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   d. 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 it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
   e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
   f. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.
C. Prepare test and inspection reports.
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. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
   5. Remove and clean strainer screens. Close drain valves and replace drain plugs.
   6. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
   7. Check plumbing specialties and verify proper settings, adjustments, and operation.

Cleaning

A. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.
B. 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. Repeat procedures if biological examination shows contamination.
      e. Submit water samples in sterile bottles to authorities having jurisdiction.
C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

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.
C. Aboveground domestic water piping shall be the following:
   1. Hard copper tube, ASTM B 88, Type L; cast- or wrought-copper, solder-joint fittings; and soldered joints.
D. Under-building-slab, domestic water, building-service piping, NPS 2-1/2 and smaller, shall be the following:
   1. Soft copper tube, ASTM B 88, Type K; wrought-copper, solder-joint fittings; and brazed joints.
3.13 Valve schedule

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Use ball or gate valves for piping NPS 2 and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 and larger.
2. Throttling Duty: Use ball or globe valves for piping NPS 2 and smaller.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

END OF SECTION
PART 1 - General

1.1 Related documents

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

1.2 Summary

A. Section Includes:

1. Drain valves.
2. Water-hammer arresters.
3. Trap-seal primer valves.

B. Product Data: For each type of product.

2. Pressure Rating: 400-psig minimum CWP.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
8. Inlet: Threaded or solder joint.
10. Pressure Rating: 200-psig minimum CWP or Class 125.
   a. AMTROL, Inc.
   b. Josam Company.
   c. MIFAB, Inc.
   d. Precision Plumbing Products, Inc.
   e. Sioux Chief Manufacturing Company, Inc.
   g. Tyler Pipe; Wade Div.
   h. Watts Drainage Products.
14. Type: Metal bellows or Copper tube with piston.
   a. MIFAB, Inc.
   b. Precision Plumbing Products, Inc.
   c. Sioux Chief Manufacturing Company, Inc.
17. Body: Bronze.
18. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
19. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.

C. Install water-hammer arresters in water piping according to PDI-WH 201.
1. Flexible connectors.

1.3 Action submittals

A. Shop Drawings: For domestic water piping specialties.
   1. Include diagrams for power, signal, and control wiring.

1.4 Informational submittals

A. Field quality-control reports.

1.5 Closeout submittals

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

PART 2 - Products

2.1 General requirements for piping specialties

A. Potable-water piping and components shall comply with NSF 61

2.2 Performance requirements

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.3 Drain valves

A. Ball-Valve-Type, Hose-End Drain Valves:
   1. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

B. Stop-and-Waste Drain Valves:
   1. Drain: NPS 1/8 side outlet with cap.

2.4 Water-hammer arresters

A. Water-Hammer Arresters:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Zurn Industries, LLC; Plumbing Products Group; Specification Drainage Products.
   2. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.5 Trap-seal primer device

A. Supply-Type, Trap-Seal Primer Device:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

PART 3 - Execution

3.1 Installation

A. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

3.2 Connections

A. Comply with requirements for ground equipment in Section 260526 "Grounding and Bonding
B. Fire-retardant-treated-wood blocking is specified in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical connections.

3.3 Labeling and identifying

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. Supply-type, trap-seal primer valves.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

END OF SECTION
PART 1 - General

1.1 Related documents

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

1.2 Summary

A. Section Includes:

1. Pipe, tube, and fittings.
2. Specialty pipe fittings.
3. Encasement for underground metal piping.

B. Related Sections:

1. Section 221313 "Facility Sanitary Sewers" for sanitary sewerage piping and structures outside the building.

1.3 Performance requirements

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


B. Seismic Performance: Soil, storm, waste, and vent piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE 7-10.

1.4 Action submittals

A. Product Data: For each type of product indicated.
B. Shop Drawings: For coordination. Include plans, elevations, sections, and details.

1.5 Informational submittals

A. Seismic Qualification Certificates: For waste and vent piping, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control reports.

1.6 Quality assurance

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
1.7 Project conditions

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

1. Notify Architect/Owner no fewer than two days in advance of proposed interruption of sanitary waste service.
2. Do not proceed with interruption of sanitary waste service without Architect's/Owner's written permission.

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 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. Caulking 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.
B. Heavy-Duty, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ANACO-Husky.
   b. Charlotte Pipe & Foundry.
   c. MIFAB, Inc.
   d. Mission Rubber Company; a division of MCP Industries, Inc.
   e. Tyler Pipe.
   f. Or approved equal.

2. Standards: ASTM C 1540.
3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.4 Copper tube and fittings

A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.
B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
C. Hard Copper Tube: ASTM B 88, Type L, water tube, drawn temper.
D. Copper Pressure Fittings:

2. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

E. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

F. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

2.5 Specialty pipe fittings

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in OD’s or of different materials. Include end connections same size as and compatible with pipes to be joined.

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

3. Unshielded, Nonpressure Transition Couplings:

   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      
     2) Fernco Inc.
     3) Mission Rubber Company; a division of MCP Industries, Inc.
     4) Plastic Oddities; a division of Diverse Corporate Technologies, Inc.
     5) Or approved equal.


   c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

   d. Sleeve Materials:
      
     2) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

B. Dielectric fittings:

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

2. Dielectric Unions:

   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      
     1) Capitol Manufacturing Company.
     2) Central Plastics Company.
     3) Hart Industries International, Inc.
     4) Jomar International Ltd.
     5) Matco-Norca, Inc.
     7) Watts Regulator Co.; a division of Watts Water Technologies, Inc.
     8) Wilkins; a Zurn company.
     9) Or approved equal.

   b. Description:
1) Standard: ASSE 1079.
2) Pressure Rating: 125 psig minimum at 180 deg F.
3) End Connections: Solder-joint copper alloy and threaded ferrous.

3. Dielectric Flanges:
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Capitol Manufacturing Company.
      2) Central Plastics Company.
      3) Matco-Norca, Inc.
      4) Watts Regulator Co.; a division of Watts Water Technologies, Inc.
      5) Wilkins; a Zurn company.
      6) Or approved equal.

   b. Description:
      1) Standard: ASSE 1079.
      2) Factory-fabricated, bolted, companion-flange assembly.
      3) Pressure Rating: 125 psig minimum at 180 deg F.
      4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

4. Dielectric-Flange Insulating Kits:
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Advance Products & Systems, Inc.
      2) Calpico, Inc.
      3) Central Plastics Company.
      4) Pipeline Seal and Insulator, Inc.
      5) Or approved equal.

   b. Description:
      1) Nonconducting materials for field assembly of companion flanges.
      2) Pressure Rating: 150 psig
      3) Gasket: Neoprene or phenolic.
      4) Bolt Sleeves: Phenolic or polyethylene.
      5) Washers: Phenolic with steel backing washers.

5. Dielectric Nipples:
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Elster Perfection.
      2) Grinnell Mechanical Products.
      3) Matco-Norca, Inc.
      4) Precision Plumbing Products, Inc.
      5) Victaulic Company.
      6) Or approved equal.

   b. Description:
      1) Standard: IAPMO PS 66
2) Electroplated steel nipple.
3) Pressure Rating: 300 psig at 225 deg F.
4) End Connections: Male threaded or grooved.
5) Lining: Inert and noncorrosive, propylene.

PART 3 - Execution

3.1 Earth moving

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

3.2 Piping installation

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
E. Install piping to permit valve servicing.
F. Install piping at indicated slopes.
G. Install piping free of sags and bends.
H. Install fittings for changes in direction and branch connections.
I. Install piping to allow application of insulation.
J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
K. Make changes in direction for soil, storm 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 two 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.
L. 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.
M. Install soil, storm and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:

1. Sanitary Drainage Piping: 1/4" per foot downward in direction of flow for piping NPS 2 and smaller; 1/8" per foot downward in direction of flow for piping NPS 3 and larger.
2. Storm drainage piping: 1/4" per foot downward in direction of flow.
3. Vent Piping: 1/8" per 1’ down toward vertical fixture vent or toward vent stack.

N. 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."
O. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."
P. Install engineered soil and waste drainage and vent piping systems as follows:

Q. Plumbing Specialties:

1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."

2. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Section 221319 "Sanitary Waste Piping Specialties."

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

S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 Joint construction


C. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

D. Threaded Joints: Thread pipe with tapered pipe threads 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.

E. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

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

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

3.4 Specialty pipe fitting installation

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in OD's.


B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples or unions.

3. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges or flange kits or nipples.
3.5 Hanger and support installation

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

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

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install stainless-steel or fiberglass pipe hangers for horizontal piping in corrosive environments.
3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
5. Vertical Piping: MSS Type 8 or Type 42, clamps.
6. Install individual, straight, horizontal piping runs:
   a. 100 Feet 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.

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

C. Support horizontal piping and tubing within 12 inches of each fitting and coupling.

D. Support vertical piping and tubing at base and at each floor.

E. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

F. 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. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

G. Install supports for vertical cast-iron soil piping every 15 feet.

H. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/4: 72 inches with 3/8-inch rod.
   2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
   3. NPS 2-1/2: 108 inches with 1/2-inch rod.
   4. NPS 3: 10 feet with 1/2-inch rod.
   5. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
   6. NPS 6 and NPS 8: 48 inches with 3/4-inch rod.

I. Install supports for vertical copper tubing every 10 feet.

J. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 Connections

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

B. Connect soil, storm and waste piping to existing 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. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
5. Comply with requirements for cleanouts and drains specified in Section 221319 "Sanitary Waste Piping Specialties."
6. 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.

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

E. 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.

3.7 Identification

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.8 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.

3.9 Cleaning and protection

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.

3.10 Piping schedule

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
B. Aboveground, soil, storm and waste piping shall be any of the following:
   1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
   2. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
   3. Copper DWV tube, copper drainage fittings, and soldered joints.
C. Aboveground, vent piping shall be any of the following:
   1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
   2. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
   3. Copper DWV tube, copper drainage fittings, and soldered joints.
D. Underground, soil, waste, storm and vent piping shall be any of the following:
   1. Service class, cast-iron soil piping; gaskets; and gasketed joints.

END OF SECTION
PART 1 - General

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

1.2 Summary
   A. Section Includes:
      1. Cleanouts.
      2. Through-penetration firestop assemblies.
      4. Flashing materials.

1.3 Definitions
   B. FRP: Fiberglass-reinforced plastic.
   C. HDPE: High-density polyethylene plastic.
   D. PE: Polyethylene plastic.
   E. PP: Polypropylene plastic.
   F. PVC: Polyvinyl chloride plastic.

1.4 Informational submittals
   A. Field quality-control reports.

1.5 Closeout submittals
   A. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.6 Quality assurance
   A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.
   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.

PART 2 - Products

2.1 Cleanouts
   A. Exposed Metal Cleanouts:
      1. ASME A112.36.2M, Cast-Iron Cleanouts:
         a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1) Josam Company.
2) MIFAB, Inc.
4) Tyler Pipe.
5) Watts Drainage Products.
6) Zurn Plumbing Products Group.

2. Standard: ASME A112.36.2M for cast iron and ASME A112.3.1 for stainless steel for cleanout test tee.
3. Size: Same as connected drainage piping
4. Body Material: Hubless, cast-iron soil pipe test tee or Stainless-steel tee with side cleanout as required to match connected piping.
5. Closure: Countersunk, brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Metal Floor Cleanouts:

1. ASME A112.36.2M, Cast-Iron Cleanouts:
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Josam Company.
      3) Watts Drainage Products.
      4) Zurn Plumbing Products Group.

2. Standard: ASME A112.36.2M for adjustable housing, cast-iron soil pipe with cast-iron ferrule, or threaded, adjustable housing cleanout.
3. Size: Same as connected branch.
4. Type: Adjustable housing, Cast-iron soil pipe with cast-iron ferrule, or Threaded, adjustable housing.
5. Body or Ferrule: Cast iron or Stainless steel
7. Outlet Connection: Inside calk, Spigot, or Threaded.
8. Closure: Brass plug with straight threads and gasket, Brass plug with tapered threads, Cast-iron plug, or Plastic plug.
9. Adjustable Housing Material: Cast iron or Plastic with threads, set-screws or other device.
10. Frame and Cover Material and Finish: Coordinate finish with Architect
11. Frame and Cover Shape: Square in tile floor finishes; Round everywhere else.
13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.
15. Size: Same as connected branch.
17. Closure: Stainless steel with seal.
18. Riser: Stainless-steel drainage pipe fitting to cleanout.

C. Cast-Iron Wall Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. MIFAB, Inc.
d. Tyler Pipe; Wade Div.
e. Watts Drainage Products.
f. Zurn Plumbing Products Group.

2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk or raised-head, drilled-and-threaded, or brass or cast-iron plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
8. Finish: Coordinate shape and finish with architect.

2.2 Through-penetration firestop assemblies

A. Through-Penetration Firestop Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ProSet Systems Inc.
   b. Or approved equal

2. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
3. Size: Same as connected soil, waste, or vent stack.
4. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
6. Special Coating: Corrosion resistant on interior of fittings.

2.3 Miscellaneous sanitary drainage piping specialties

A. Open Drains:

1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.
2. Size: Same as connected waste piping with increaser fitting of size indicated.

B. Floor-Drain, Trap-Seal Primer Fittings:

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

C. Sleeve Flashing Device:

1. Description: Manufactured, cast-iron fitting, with clamping device, that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 2 inches above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

D. Stack Flashing Fittings:

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

E. Expansion Joints:
1. Standard: ASME A112.21.2M.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected soil, waste, or vent piping.

2.4 Flashing materials

A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:
1. General Use: 4.0-lb/sq. ft., 0.0625-inch thickness.
2. Vent Pipe Flashing: 3.0-lb/sq. ft., 0.0469-inch thickness.

B. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated:
1. General Applications: 12 oz./sq. ft.
2. Vent Pipe Flashing: 8 oz./sq. ft.

C. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.


E. Fasteners: Metal compatible with material and substrate being fastened.

F. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

G. Solder: ASTM B 32, lead-free alloy.

H. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 - Execution

3.1 Installation

A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
4. Locate at base of each vertical soil and waste stack.

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

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

D. Install through-penetration firestop assemblies in plastic conductors and stacks at floor penetrations.

E. Assemble open drain fittings and install with top of hub 2 inches above floor.

F. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
2. Size: Same as floor drain inlet.

G. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
H. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
I. Install wood-blocking reinforcement for wall-mounting-type specialties.
J. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 Connections
A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Install piping adjacent to equipment to allow service and maintenance.
C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 Flashing installation
A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
   1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.
   2. Copper Sheets: Solder joints of copper sheets.
B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
   1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
   2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
   3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
C. Set flashing on floors and roofs in solid coating of bituminous cement.
D. Secure flashing into sleeve and specialty clamping ring or device.
E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Section 076200 "Sheet Metal Flashing and Trim."
F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.
G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 Field quality control
A. Tests and Inspections:
   1. Leak Test: After installation, charge system 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.
3.5 Protection

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION
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. Commercial, electric, storage, domestic-water heaters.
   2. Domestic-water heater accessories.

1.3 Performance requirements

A. Seismic Performance: Commercial domestic-water heaters shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.4 Action submittals

A. Product Data: For each type and size of domestic-water heater indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings:

   1. Wiring Diagrams: For power, signal, and control wiring.

1.5 Informational submittals

A. Seismic Qualification Certificates: For commercial domestic-water heaters, accessories, and components, from manufacturer.

   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Product Certificates: For each type of commercial, electric, domestic-water heater, from manufacturer.

C. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.

D. Source quality-control reports.

E. Field quality-control reports.

F. Warranty: Sample of special warranty.
1.6 Closeout submittals
   A. Operation and Maintenance Data: For electric, domestic-water heaters to include in emergency, operation, and maintenance manuals.

1.7 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/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.
   C. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
   D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61, “Drinking Water System Components - Health Effects.”

1.8 Coordination
   A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.9 Warranty
   A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric, domestic-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 Periods: From date of Substantial Completion.
         a. Commercial, Electric, Storage, Domestic-Water Heaters:
            1) Storage Tank: Five years.
            2) Controls and Other Components: Three years.
         b. Compression Tanks: Five years.

PART 2 - Products

2.1 COMMERCIAL, ELECTRIC, domestic-WATER HEATERS
   A. Commercial, Electric, Storage, Domestic-Water Heaters:
      1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
         b. Cemline Corporation.
         c. Lochinvar Corporation.
         d. PVI Industries, LLC.
         e. Rheem Manufacturing Company.
         f. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.
         g. State Industries.
   a. Tappings: Factory fabricated of materials compatible with tank and piping connections. Attach tappings to tank before testing.
      1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
      2) NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.
   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.

4. 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: Steel with enameled finish.
   e. Heating Elements: Electric, screw-in or bolt-on immersion type arranged in multiples of three.
   f. Temperature Control: Adjustable thermostat.
   g. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
   h. Relief Valves: ASME rated and stamped for combination temperature-and-pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

5. Special Requirements: NSF 5 construction.

2.2 Domestic-water heater accessories
A. Domestic-Water Compression Tanks:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following
   a. AMTROL Inc.
   b. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.
   c. State Industries.
   d. Taco, Inc.

2. 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.
3. 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.
B. Drain Pans: Corrosion-resistant metal with raised edge. Comply with ANSI/CSA LC 3. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 with ASME B1.20.1 pipe threads or with ASME B1.20.7 garden-hose threads.

C. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1

D. Heat-Trap Fittings: ASHRAE 90.2.

E. Manifold Kits: Domestic-water heater manufacturer's factory-fabricated inlet and outlet piping for field installation, for multiple domestic-water heater installation. Include ball-, butterfly-, or gate-type shutoff valves to isolate each domestic-water heater and [calibrated] [memory-stop] balancing valves to provide balanced flow through each domestic-water heater.

1. Comply with requirements for ball-, butterfly-, or gate-type shutoff valves specified in Section 220523 "General-Duty Valves for Plumbing Piping."
2. Comply with requirements for balancing valves specified in Section 221119 "Domestic Water Piping Specialties."

F. Pressure-Reducing Valves: ASSE 1003 for water. Set at 25-psig- maximum outlet pressure unless otherwise indicated.

G. Combination Temperature-and-Pressure Relief Valves: ASME rated and stamped. Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.

H. Pressure Relief Valves: ASME rated and stamped. Include pressure setting less than domestic-water heater working-pressure rating.


J. Shock Absorbers: ASSE 1010 or PDI-WH 201, Size A water hammer arrester.

K. Domestic-Water Heater Stands: Manufacturer's factory-fabricated steel stand for floor mounting, capable of supporting domestic-water heater and water. Include dimension that will support bottom of domestic-water heater a minimum of 18 inches above the floor.

L. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

2.3 Source quality control

A. Factory Tests: Test and inspect domestic-water heaters specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test commercial domestic-water heaters to minimum of one and one-half times pressure rating before shipment.

C. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.

D. Prepare test and inspection reports.

PART 3 - Execution

3.1 Domestic-water heater installation

A. Commercial, Electric, Domestic-Water Heater Mounting: Install commercial, electric, domestic-water heaters on concrete base. Comply with requirements for concrete bases specified in Section 033000 "Cast-in-Place Concrete."

1. Exception: Omit concrete bases for commercial, electric, domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
2. Maintain manufacturer's recommended clearances.
3. Arrange units so controls and devices that require servicing are accessible.
4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.

5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

7. Install anchor bolts to elevations required for proper attachment to supported equipment.

8. Anchor domestic-water heaters to substrate.

9. Maintain manufacturer's recommended clearances.

10. Arrange units so controls and devices that require servicing are accessible.

11. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

12. Install anchor bolts to elevations required for proper attachment to supported equipment.

13. Anchor domestic-water heaters to substrate.

B. Install electric, domestic-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.

1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 220523 "General-Duty Valves for Plumbing Piping."

C. Install commercial, electric, domestic-water heaters with seismic-restraint devices. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

D. 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.

E. Install combination temperature-and-pressure relief valves in water piping for electric, domestic-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.

F. 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 electric, domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 221119 "Domestic Water Piping Specialties."

G. Install thermometers on outlet piping of electric, domestic-water heaters. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."

H. Install thermometers on inlet and outlet piping of domestic-water heaters. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."

I. Assemble and install inlet and outlet piping manifold kits for multiple electric, domestic-water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each electric, domestic-water heater. Include shutoff valve and thermometer in each domestic-water heater inlet and outlet, and throttling valve in each electric, domestic-water heater outlet. Comply with requirements for valves specified in Section 220523 "General-Duty Valves for Plumbing Piping," and comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."

J. Install pressure-reducing valve with integral bypass relief valve in electric, domestic-water booster-heater inlet piping and water hammer arrester in booster-heater outlet piping. Set pressure-reducing valve for outlet pressure of 25 psig. Comply with requirements for pressure-reducing valves and water hammer arresters specified in Section 221119 "Domestic Water Piping Specialties."
K. Install piping-type heat traps on inlet and outlet piping of electric, domestic-water heater storage tanks without integral or fitting-type heat traps.
L. Fill electric, domestic-water heaters with water.
M. Charge domestic-water compression tanks with air.

3.2 Connections

A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
B. Where installing piping adjacent to electric, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 Identification

A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 Field quality control

A. 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.
   2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
B. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 014000 "Quality Requirements" for retesting and re-inspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.
C. Prepare test and inspection reports.

3.5 Demonstration

A. Train Owner's maintenance personnel to adjust, operate, and maintain commercial, electric, domestic-water heaters.

END OF SECTION
Part 1 - General

1.1 Submittals
   A. Product Data: Provide catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.
   B. Manufacturer's Instructions: Indicate installation methods and procedures.
   C. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.2 Quality Assurance
   A. ANSI Standards: Comply with ANSI Standards pertaining to plumbing fixtures and systems.
   B. ANSI Standards: Comply with ANSI A117.1 standard pertaining to plumbing fixtures for handicapped.
   C. PDI Compliance: Comply with standards established by Plumbing and Drainage institute (PDI) pertaining to plumbing fixture supports.
   D. Federal Standards: Comply with applicable Federal Standard FS WW-P-541/Series sections pertaining to plumbing fixtures.

Part 2 - Products

2.1 Plumbing Fixtures
   A. General: Provide factory-fabricated fixtures of the type, style and material indicated. For each type of fixture, unless otherwise specified, provide fixture manufacturer's standard trim, carrier seats and valves as indicated by their published product information, either as designed and constructed, or as recommended by the manufacturer, and as required for a complete installation. Where more than one type or manufacturer is indicated, selection is Installer's option.

2.2 Materials
   A. General: Unless otherwise specified, comply with applicable Federal Specification WW-P-541/series sections pertaining to plumbing fixtures, fittings, trim, metals and finishes. Comply with requirements of WW-P-541/specification relative to quality of ware, glazing, enamel, composition and finish of metals, air gaps and vacuum breakers, even though some plumbing fixtures specified in this section are not described in WW-P-541.
   B. Provide materials that have been selected for their surface flatness and smoothness. Exposed surface which exhibit pitting, seam marks, roller marks, foundry sand holes, stains, discoloration or other surface imperfections on finished units are not acceptable.
   C. Where fittings, trim and accessories are exposed or semi-exposed, provide bright chrome-plated or polished stainless steel units.
   D. Comply with additional fixture requirements contained in the fixture schedule.

Part 3 - Execution

3.1 Installation
   A. Install plumbing fixtures of types indicated where shown and at indicated heights or where not shown in accordance with manufacturer's written instruction, roughing-in drawings and with recognized industry practices.
   B. Fasten plumbing fixtures securely to indicated supports or building structure, and ensure that fixtures are level and plumb and tight against mounting surface.
3.2 Field Quality Control

A. Upon completion of installation of plumbing fixtures and after units are water pressurized, test and adjust fixtures for proper operation.

END OF SECTION
PART 1 GENERAL

1.01 IMPOSED REGULATIONS
A. Applicable provisions of the State and Local Codes and of the following codes and standards in addition to those listed elsewhere in the specifications are hereby imposed on a general basis for mechanical work: codes and standards listed on the mechanical drawings.

1.02 SCOPE OF WORK
A. Provide all labor, materials, equipment and supervision to construct complete and operable mechanical systems as indicated on the drawings and specified herein. All materials and equipment used shall be new, undamaged and free from any defects.

1.03 RELATED DOCUMENTS AND OTHER INFORMATION
A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the portions of work specified in each and every Section of this Division, individually and collectively.

B. It is recognized that separate sub-contracts may be instituted by THIS CONTRACT'S GENERAL CONTRACTOR with others. It is the responsibility of THIS CONTRACT'S GENERAL CONTRACTOR to completely inform, coordinate and advise those sub-contractors as to all of the requirements, conditions and information associated with providing and installing their portion of the total job.

1.04 EXISTING SERVICES AND FACILITIES
A. Damage to Existing Services: Existing services and facilities damaged by the Contractor through negligence or through use of faulty materials or workmanship shall be promptly repaired, replaced, or otherwise restored to previous conditions by the Contractor without additional cost to the Owner.

B. Interruption of Services: Interruptions of services necessary for connection to or modification of existing systems or facilities shall occur only at prearranged times approved by the Owner. Interruptions shall only occur after the provision of all temporary work and the availability of adequate labor and materials will assure that the duration of the interruption will not exceed the time agreed upon.

C. Removed Materials: Existing materials made unnecessary by the new installation shall be stored on site. They shall remain the property of the Owner and shall be stored at a location and in a manner as directed by the Owner. If classified by the Owner's authorized representative as unsuitable for further use, the material shall become the property of the Contractor and shall be removed from the site at no additional cost to the owner.

1.05 PRODUCT WARRANTIES
A. Provide manufacturer's standard printed commitment in reference to a specific product and normal application, stating that certain acts of restitution will be performed for the Purchaser or Owner by the manufacturer, when and if the product fails within certain operational conditions and time limits. Where the warranty requirements of a specific specification section exceeds the manufacturer's standard warranty, the more stringent requirements will apply and modified manufacturer's warranty shall be provided. In no case shall the manufacturer's warranty be less than one (1) year.
1.06 PRODUCT SUBSTITUTIONS
A. General: Materials specified by manufacturer's name shall be used unless prior approval of an alternate is given by addenda. Requests for substitutions must be received in the office of the Architect at least 10 days prior to opening of bids. Refer to the general conditions for the substitution request form and required documentation.

PART 2 PRODUCTS
2.01 GENERAL MECHANICAL PRODUCT REQUIREMENTS
A. Standard Products: Provide not less (quality) than manufacturer's standard products, as specified by their published product data. In addition to the indication that a particular product/model number is acceptable, comply with the specified requirements. Do not assume that the available off-the-shelf condition of a product complies with the requirements; as an example, a specific finish or color may be required.

B. Uniformity: Where multiple units of a general product are required for the mechanical work, provide identical products by the same manufacturer, without variations except for sizes and similar variations as indicated.

C. Product Compatibility, Options: Where more than one product selection is specified, either generically or proprietarily, selection is Purchaser's or Installer's option. Provide mechanical adaptations as needed for interfacing of selected products in the work.

D. Equipment Nameplates: Provide a permanent operational data nameplate on each item of power operated mechanical equipment, indicating the manufacturer, product name, model number, serial number, speed, capacity, power characteristics, labels of tested compliance, and similar essential operating data.

E. Locate nameplates in easy-to-read locations. When product is visually exposed in an occupied area of the building, locate nameplate in a concealed position (where possible) which is accessible for reading by service personnel.

PART 3 EXECUTION
3.01 PRODUCT INSTALLATION, GENERAL
A. Except where more stringent requirements are indicated, comply with the product manufacturer's installation instructions and recommendations, including handling, anchorage, assembly, connections, cleaning and testing, charging, lubrication, startup, test operation and shut-down of operating equipment. Consult with manufacturer's technical experts, for specific instructions on unique product conditions and unforeseen problems.

B. Protection and Identification: Deliver products to project properly identified with names, models numbers, types, grades, compliance labels and similar information needed for distinct identifications; adequately packaged or protected to prevent deterioration during shipment, storage and handling. Store in a dry, well ventilated, indoor space, except where prepared and protected by the manufacturer specifically for exterior storage.

C. Permits and Tests: Provide labor, material and equipment to perform all tests required by the governing agencies and submit a record of all tests to the Owner or his representative. Notify the Architect five days in advance of any testing.

D. Where components such as duct, pipe, conduit, etc. pass through non-fire-rated, interior partitions, fill void between component and opening in wall with fiberglass insulation and sealant for acoustical separation.

END OF SECTION
SECTION 23 05 10
MECHANICAL COORDINATION

PART 1 GENERAL
1.01 QUALITY ASSURANCE
A. Mechanical Coordination Drawings: Prepare a set of coordination drawings showing the coordination of the major elements, components and systems of the mechanical work, and showing the coordination of mechanical work with other work. Prepare drawings at accurate scale and sufficiently large to show locations of every item, including clearances for installing, maintaining, insulating, breaking down equipment, replacing motors and similar requirements. Drawings shall indicate coordination with all other trades including, but not limited to, lighting, structural, plumbing and architectural items. Prepare drawings to include plans, elevations, sections and details as needed to conclusively show successful coordination and integration of the work. Submit drawings for review by the Architect/Engineer.

PART 2 PRODUCTS
2.01 MECHANICAL PRODUCT COORDINATION:
A. Power Characteristics: Refer to the electrical sections of the specifications and the electrical drawings for the power characteristics available for the operation of each power driven item of mechanical equipment. The electrical design was based on the power requirements of the mechanical equipment manufacturer scheduled or specified as "basis of design." Any modifications to the electrical system that are required due to the use of an approved equivalent manufacturer shall be made at no additional cost to the owner. All changes must be clearly documented and submitted for review by the Architect/Engineer prior to purchasing equipment. Coordinate purchases to ensure uniform interface with electrical work. Refer to specification Div 26 for additional coordination requirements.

B. Coordination of Options and Substitutions: When the contract documents permit the selection from several product options and it becomes necessary to authorize a substitution, do not proceed with purchase until coordination of interface to equipment has been checked and satisfactorily established.

PART 3 EXECUTION
3.01 INSPECTION AND PREPARATION:
A. Substrate Examination: The Installer of each element of the mechanical work must examine the condition of the substrate to receive the work, the conditions under which the work will be performed, and must notify the Contractor in writing of conditions detrimental to the proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

B. Do not proceed with the installation of sleeves, anchors, hangers, roof penetrations and similar work until mechanical coordination drawings have been processed and released for construction. Where work must be installed prior to that time in order to avoid a project delay, review proposed installation in a project coordination meeting including all parties involved with the interfacing of the work.

3.02 CUTTING AND PATCHING:
A. Structural Limitations: Do not cut structural framing, walls, floors, decks and other members intended to withstand stress, except with the Architect's or Engineer's written authorization. Authorization will be granted only where there is not other reasonable method for completing the mechanical work, and where the proposed cutting clearly does not materially weaken the structure.

B. Where authorized, cut opening through concrete (for pipe penetrations and similar services) by core drilling or sawing. Do not cut by hammer-driven chisel or drill.
C. Other work: Do not endanger or damage other work through the procedures and processes of cutting to accommodate mechanical work. Review the proposed cutting with the Installer of the work to be cut, and comply with his recommendations to minimize damage. Where necessary, engage the original Installer or other specialists to execute the cutting in the recommended manner.

D. Where patching is required to restore other work, because of either cutting or other damage inflicted during the installation of mechanical work, execute the patching in the manner recommended by the original Installer. Restore the other work in every respect, including the elimination of visual defects in exposed finishes, as judged by the Architect. Engage the original Installer to complete patching of the following categories of work:

1. Exposed concrete finishes.
2. Exposed masonry.
3. Waterproofing and vapor barriers.
4. Roofing, flashing and accessories.
5. Interior exposed finishes and casework, where judged by the Architect to be difficult to achieve an acceptable match by other means.

3.03 COORDINATION OF MECHANICAL INSTALLATION:
A. General: Sequence, coordinate and integrate the various elements of mechanical work so that the mechanical plant will perform as indicated and be in harmony with the other work of the building. The Architect/Engineer will not supervise the coordination, which is the exclusive responsibility of the Contractor. Comply with the following requirements:

B. Install piping, ductwork and similar services straight and true, aligned with other work and with overhead structures and allowing for insulation. Conceal where possible.

C. Arrange work to facilitate maintenance and repair or replacement of equipment. Locate services requiring maintenance on valves and similar units in front of services requiring less maintenance. Connect equipment for ease of disconnecting, with minimum of interference with other work.

D. Give the right-of-way to piping systems required to slope for drainage (over other service lines). Piping shall be located to avoid interference with ductwork and light fixtures.

E. Piping shall be located to avoid interference with ductwork and light fixtures.

F. Drawings: Conform with the arrangement indicated by the contract documents to the greatest extent possible, recognizing that portions of the work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, comply with the Architect's decision on resolution of the conflict.

G. Electrical Work: Coordinate the mechanical work with electrical work, and properly interface with the electrical service. In general, and except as otherwise indicated, install mechanical equipment ready for electrical connection. Refer to the electrical sections of the specifications for electrical connection of mechanical equipment.

H. Utility Connections: Coordinate the connection of mechanical systems with exterior underground utilities and services. Comply with the requirements of governing regulations, franchised service companies and controlling agencies. Provide a single connection for each service except where multiple connections are indicated.

3.04 COORDINATION OF MECHANICAL START-UP:
A. Seasonal Requirements: Adjust and coordinate the timing of mechanical system start-ups with seasonal variations, so that demonstration and testing of specified performance can be observed and recorded. Exercise proper care in off-season start-ups to ensure that systems and equipment will not be damaged.
B. Painting and Air Distribution: Coordinate the initial cleaning and start-up of the HVAC air distribution system, to occur prior to preparatory cleaning and general interior painting and decorating on the project.

END OF SECTION
SECTION 23 05 13
COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

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 general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.03 COORDINATION
A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
   1. Motor controllers.
   2. Torque, speed, and horsepower requirements of the load.
   3. Ratings and characteristics of supply circuit and required control sequence.
   4. Ambient and environmental conditions of installation location.

PART 2 PRODUCTS

2.01 GENERAL MOTOR REQUIREMENTS
A. Comply with NEMA MG 1 unless otherwise indicated.
B. Comply with IEEE 841 for severe-duty motors.

2.02 MOTOR CHARACTERISTICS
A. Duty: Continuous duty at ambient temperature of 104 deg F and at altitude of 3300 feet above sea level.
B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.03 POLYPHASE MOTORS
A. Description: NEMA MG 1, Design B, medium induction motor.
B. Efficiency: Energy efficient, as defined in NEMA MG 1.
C. Service Factor: 1.15.
D. Multispeed Motors: Variable torque.
   1. For motors with 2:1 speed ratio, consequent pole, single winding.
   2. For motors with other than 2:1 speed ratio, separate winding for each speed.
E. Multispeed Motors: Separate winding for each speed.
F. Rotor: Random-wound, squirrel cage.
G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
H. Temperature Rise: Match insulation rating.
I. Insulation: Class F.
J. Code Letter Designation:
   1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
   2. Motors Smaller than 15 HP: Manufacturer’s standard starting characteristic.

K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.04 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS
A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
   1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
   2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
   3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
   4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

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

2.05 SINGLE-PHASE MOTORS
A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
   1. Permanent-split capacitor.
   2. Split phase.
   3. Capacitor start, inductor run.
   4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 EXECUTION (Not Applicable)

END OF SECTION
SECTION 23 05 29
HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

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. Metal pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Metal framing systems.
   4. Thermal-hanger shield inserts.
   5. Fastener systems.
   6. Pipe stands.
   7. Equipment supports.
B. Related Sections:
   1. Section 230548 "Vibration and Seismic Controls for HVAC" for vibration isolation devices.
   2. Section 233113 "Metal Ducts" for duct hangers and supports.

1.03 DEFINITIONS
A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.04 PERFORMANCE REQUIREMENTS
A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
   1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
   2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
   3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.05 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.
B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:
   1. Trapeze pipe hangers.
   2. Metal framing systems.
   3. Pipe stands.
   4. Equipment supports.
C. Delegated-Design Submittal: For trapeze hangers 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. Detail fabrication and assembly of trapeze hangers.
   2. Design Calculations: Calculate requirements for designing trapeze hangers.
1.06 INFORMATIONAL SUBMITTALS
A. Welding certificates.

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

PART 2 PRODUCTS
2.1 METAL PIPE HANGERS AND SUPPORTS
A. Stainless-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
   2. Padded Hangers: Hanger with pipe insulation pad or cushion to support bearing surface of piping.
B. Copper Pipe Hangers:
   1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
   2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel or stainless steel.
C. Carbon-Steel Pipe Hangers and Supports:
   1. Description: MSS sp-58, Types 1 through 58, factory-fabricated components.
   2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
   3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
   4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

2.02 METAL FRAMING SYSTEMS
A. MFMA Manufacturer Metal Framing Systems:
   1. Description: Shop or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
   3. Channels: Continuous slotted steel channel with inturned lips.
   4. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
B. Non-MFMA Manufacturer Metal Framing Systems:
   1. Description: Shop or field-fabricated pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
   3. Channels: Continuous slotted steel channel with inturned lips.
   4. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.

2.03 TRAPEZE PIPE HANGERS
A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural stainless-steel shapes with MSS SP-58 stainless-steel hanger rods, nuts, saddles, and U-bolts.
2.04 THERMAL-HANGER SHIELD INSERTS
A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.
B. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C with 100-psig, or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.
C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.05 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.
B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated or stainless-steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.06 PIPE STANDS
A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support piping.
B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe.
C. Low-Type, Single-Pipe Stand: One-piece plastic or stainless-steel base unit with rubber base.
D. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.07 EQUIPMENT SUPPORTS
A. Description: Welded, shop- or field-fabricated equipment support made from structural stainless-steel shapes.

2.08 MISCELLANEOUS MATERIALS
A. Structural Steel: ASTM A 36/A 36M, stainless-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.
   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 EXECUTION
3.01 HANGER AND SUPPORT INSTALLATION
A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install
hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal 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 for individual pipe hangers.
   2. Field fabricate from ASTM A 36/A 36M, stainless-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Fastener System Installation:
   1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches 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.

F. Pipe Stand Installation:
   1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
   2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.

G. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.


I. 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.

J. Install lateral bracing with pipe hangers and supports to prevent swaying.

K. 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.

L. Load Distribution: Install hangers and supports so that 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 to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

N. Insulated Piping:
1. Attach clamps and spacers to piping.
   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
   c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:
   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
   b. NPS 4: 12 inches long and 0.06 inch thick.
   c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
   d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
   e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.

6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.02 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 bearing surface smooth.
   C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.03 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/D1.1M 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 so contours of welded surfaces match adjacent contours.

3.04 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.
3.05 **PAINTING**

A. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.06 **HANGER AND SUPPORT SCHEDULE**

A. Specific hanger and support requirements are 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 carbon-steel pipe hangers and supports, metal trapeze pipe hangers, and metal framing systems and attachments for general service applications.

F. Use stainless-steel pipe hangers and stainless steel or corrosion resistant attachments for hostile environment applications or outside the building.

G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

H. Use padded hangers for piping that is subject to scratching.

I. Use thermal-hanger shield inserts for insulated piping and tubing.

J. 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. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.

3. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron flange or stainless-steel plate.

4. 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 or stainless-steel plate, and with U-bolt to retain pipe.

5. 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.

6. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.

7. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.

8. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.

9. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.

10. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required.
K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Stainless-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

L. 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.

M. 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.
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.

N. 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.

O. 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.
   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 allow 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 allow 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 allow 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.

P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

R. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION
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. Elastomeric isolation pads.
   2. Elastomeric isolation mounts.
   3. Restrained elastomeric isolation mounts.
   4. Open-spring isolators.
   5. Housed-spring isolators.
   6. Restrained-spring isolators.
   8. Pipe-riser resilient supports.
   9. Resilient pipe guides.
  10. Elastomeric hangers.
  11. Spring hangers.
  12. Snubbers.
  13. Restraint channel bracings.
  15. Seismic-restraint accessories.
  16. Mechanical anchor bolts.
  17. Adhesive anchor bolts.

B. Related Requirements:
   1. Section 220548 "Vibration and Seismic Controls for Plumbing" for devices for plumbing equipment and systems.

1.03 DEFINITIONS


C. OSHPD: Office of Statewide Health Planning & Development (for the State of California).

1.04 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
   2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and seismic-restraint component required.
      a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service member of ICC-ES or OSHPD or an agency acceptable to authorities having jurisdiction.
      b. Annotate to indicate application of each product submitted and compliance with requirements.
   3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.
B. Shop Drawings:
1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated-Design Submittal: For each vibration isolation and seismic-restraint device.
1. Include design calculations and details for selecting vibration isolators, seismic restraints, and vibration isolation bases complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
2. Design Calculations: Calculate static and dynamic loading due to equipment weight, operation, and seismic and wind forces required to select vibration isolators and seismic and wind restraints and for designing vibration isolation bases.
   a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
3. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system was examined for excessive stress and that none exists.
4. Seismic- and Wind-Restraint Details:
   a. Design Analysis: To support selection and arrangement of seismic and wind restraints. Include calculations of combined tensile and shear loads.
   b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
   c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
   d. Preapproval and Evaluation Documentation: By an evaluation service member of ICC-ES or OSHPD or an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.05 INFORMATIONAL SUBMITTALS
A. Coordination Drawings: Show coordination of vibration isolation device installation and seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.

B. Qualification Data: For professional engineer and testing agency.

C. Welding certificates.

D. Field quality-control reports.

1.06 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data
1.07 QUALITY ASSURANCE

A. Testing Agency Qualifications: 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 and that is acceptable to authorities having jurisdiction.

B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are unavailable, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 - PRODUCTS

2.01 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Ace Mountings Co., Inc.
      b. California Dynamics Corporation.
      c. Isolation Technology, Inc.
      d. Kinetics Noise Control, Inc.
      e. Mason Industries, Inc.
      f. Vibration Eliminator Co., Inc.
      g. Vibration Isolation.
      h. Vibration Mountings & Controls, Inc.
   2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
   3. Size: Factory or field cut to match requirements of supported equipment.
   4. Pad Material: Oil and water resistant with elastomeric properties.
   5. Surface Pattern: Smooth or Ribbed or Waffle pattern.
   6. Infused nonwoven cotton or synthetic fibers.
   7. Load-bearing metal plates adhered to pads.
   8. Sandwich-Core Material: Resilient and elastomeric.
      a. Surface Pattern: Smooth or Ribbed or Waffle pattern.
      b. Infused nonwoven cotton or synthetic fibers.

2.02 ELASTOMERIC ISOLATION MOUNTS

A. Double-Deflection, Elastomeric Isolation Mounts:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Ace Mountings Co., Inc.
      b. California Dynamics Corporation.
      c. Isolation Technology, Inc.
      d. Kinetics Noise Control, Inc.
      e. Mason Industries, Inc.
      f. Vibration Eliminator Co., Inc.
      g. Vibration Isolation.
      h. Vibration Mountings & Controls, Inc.
2. Mounting Plates:
   a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
   b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.

3. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.03 RESTRAINED ELASTOMERIC ISOLATION MOUNTS
A. Restrained Elastomeric Isolation Mounts:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Ace Mountings Co., Inc.
      b. California Dynamics Corporation.
      c. Isolation Technology, Inc.
      d. Kinetics Noise Control, Inc.
      e. Mason Industries, Inc.
      f. Vibration Eliminator Co., Inc.
      g. Vibration Isolation.
      h. Vibration Mountings & Controls, Inc.

   2. Description: All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
      a. Housing: Cast-ductile iron or welded steel.
      b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.04 OPEN-SPRING ISOLATORS
A. Freestanding, Laterally Stable, Open-Spring Isolators:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Ace Mountings Co., Inc.
      b. California Dynamics Corporation.
      c. Isolation Technology, Inc.
      d. Kinetics Noise Control, Inc.
      e. Mason Industries, Inc.
      f. Vibration Eliminator Co., Inc.
      g. Vibration Isolation.
      h. Vibration Mountings & Controls, Inc.

   2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   7. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

2.05 HOUSED-SPRING ISOLATORS
A. Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
VIBRATION AND SEISMIC CONTROLS FOR HVAC

2.05 RESTRAINED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Ace Mountings Co., Inc.
      b. California Dynamics Corporation.
      c. Isolation Technology, Inc.
      d. Kinetics Noise Control, Inc.
      e. Mason Industries, Inc.
      f. Vibration Eliminator Co., Inc.
      g. Vibration Isolation.
      h. Vibration Mountings & Controls, Inc.

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators.
   a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
   b. Top housing with attachment and leveling bolt or threaded mounting holes and internal leveling device or elastomeric pad.

2.06 HOUSED-RESTRAINED-SPRING ISOLATORS

A. Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Ace Mountings Co., Inc.
      b. California Dynamics Corporation.
      c. Isolation Technology, Inc.

2. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.
   a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
   b. Top plate with threaded mounting holes or elastomeric pad.
   c. Internal leveling bolt that acts as blocking during installation.
3. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
d. Kinetics Noise Control, Inc.
e. Mason Industries, Inc.
f. Vibration Eliminator Co., Inc.
g. Vibration Isolation.
h. Vibration Mountings & Controls, Inc.

2. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with adjustable or non-adjustable snubbers to limit vertical movement.
   a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
   b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.

3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.08 PIPE-RISER RESILIENT SUPPORT
A. Description: All-directional, acoustical pipe anchor consisting of two steel tubes separated by a minimum 1/2-inch- thick neoprene.
   1. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
   2. Maximum Load Per Support: 500 psig on isolation material providing equal isolation in all directions.

2.09 RESILIENT PIPE GUIDES
A. Description: Telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum 1/2-inch- thick neoprene.
   1. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.10 ELASTOMERIC HANGERS
A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Ace Mountings Co., Inc.
      b. California Dynamics Corporation.
      c. Isolation Technology, Inc.
      d. Kinetics Noise Control, Inc.
      e. Mason Industries, Inc.
      f. Vibration Eliminator Co., Inc.
      g. Vibration Mountings & Controls, Inc.
   2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
   3. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.
2.11 SPRING HANGERS
A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Ace Mountings Co., Inc.
      b. California Dynamics Corporation.
      c. Kinetics Noise Control, Inc.
      d. Mason Industries, Inc.
      e. Vibration Eliminator Co., Inc.
      f. Vibration Isolation.
      g. Vibration Mountings & Controls, Inc.
   2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
   3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
   8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
   9. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

2.12 SNUBBERS
A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Kinetics Noise Control, Inc.
   2. Mason Industries, Inc.
   3. Vibration Mountings & Controls, Inc.

B. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
   1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
   2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
   3. Maximum 1/4-inch air gap, and minimum 1/4-inch- thick resilient cushion.

2.13 RESTRAINT CHANNEL BRACINGS
A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Cooper B-Line, Inc.
   2. Hilti, Inc.
   3. Mason Industries, Inc.
   4. Unistrut.

B. Description: MFMA-4, shop- or field-fabricated bracing assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.
2.14 RESTRAINT CABLES
A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Kinetics Noise Control, Inc.
   2. Loos & Co., Inc.
   3. Vibration Mountings & Controls, Inc.

B. Restraint Cables: ASTM A 603 galvanized or ASTM A 492 stainless-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with a minimum of two clamping bolts for cable engagement.

2.15 SEISMIC-RESTRAINT ACCESSORIES
A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Cooper B-Line, Inc.
   2. Kinetics Noise Control, Inc.
   3. Mason Industries, Inc.
   4. TOLCO.

B. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or Reinforcing steel angle clamped to hanger rod.

C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.

D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.16 MECHANICAL ANCHOR BOLTS
A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Cooper B-Line, Inc.
   2. Hilti, Inc.
   4. Mason Industries, Inc.

B. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.17 ADHESIVE ANCHOR BOLTS
A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Hilti, Inc.
   2. Kinetics Noise Control, Inc.
   3. Mason Industries, Inc.
B. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.18 VIBRATION ISOLATION EQUIPMENT BASES
A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   3. Mason Industries, Inc.
   4. Vibration Eliminator Co., Inc.
   5. Vibration Isolation.
   6. Vibration Mountings & Controls, Inc.

B. Steel Rails: Factory-fabricated, welded, structural-steel rails.
   1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide rails.
      a. Include supports for suction and discharge elbows for pumps.
   2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Rails shall have shape to accommodate supported equipment.
   3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

C. Steel Bases: Factory-fabricated, welded, structural-steel bases and rails.
   1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
      a. Include supports for suction and discharge elbows for pumps.
   2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
   3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

D. Concrete Inertia Base: Factory-fabricated or field-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.
   1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
      a. Include supports for suction and discharge elbows for pumps.
   2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
   3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
   4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

PART 3 - EXECUTION
3.01 EXAMINATION
A. Examine areas and equipment to receive vibration isolation and seismic- and wind-control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
3.02 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service member of ICC-ES or OSHPD or an agency acceptable to authorities having jurisdiction.

B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry present and future static and seismic loads within specified loading limits.

3.03 VIBRATION CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete." Section 033053 "Miscellaneous Cast-in-Place Concrete."

B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

C. Equipment Restraints:
   1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
   2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
   3. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES or OSHPD or an agency acceptable to authorities having jurisdiction that provides required submittals for component.

D. Piping Restraints:
   1. Comply with requirements in MSS SP-127.
   2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
   3. Brace a change of direction longer than 12 feet.

E. Install cables so they do not bend across edges of adjacent equipment or building structure.

F. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES or OSHPD or an agency acceptable to authorities having jurisdiction that provides required submittals for component.

G. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

H. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
I. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

J. Drilled-in Anchors:
   1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
   2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
   3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
   4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
   5. Set anchors to manufacturer's recommended torque, using a torque wrench.
   6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.04 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION
   A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Section 232113 "Hydronic Piping" for piping flexible connections.

3.05 FIELD QUALITY CONTROL
   A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
   B. Perform tests and inspections.
   C. Tests and Inspections:
      1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
      2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post connection testing has been approved), and with at least seven days' advance notice.
      4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
      5. Test to 90 percent of rated proof load of device.
      7. Measure isolator deflection.
      8. Verify snubber minimum clearances.
   D. Remove and replace malfunctioning units and retest as specified above.
   E. Prepare test and inspection reports.

3.06 ADJUSTING
   A. Adjust isolators after piping system is at operating weight.
B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

END OF SECTION
SECTION 23 05 53
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

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. Equipment labels.
   2. Warning signs and labels.
   3. Pipe labels.
   4. Stencils.
   5. Warning tags.

1.03 ACTION 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.

1.04 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
2.01 EQUIPMENT LABELS
A. Metal Labels for Equipment:
   1. Material and Thickness: Stainless steel, 0.025-inch, Aluminum, 0.032-inch 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.
   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, 1/16 inch thick and having predrilled holes for attachment hardware.
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.

B. 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.

C. 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.

2.02 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: White.
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 rivets or 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.

2.03 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.

2.04 DUCT LABELS
A. Self-Adhesive Duct Labels: Printed plastic with contact-type, permanent-adhesive backing.
B. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, equipment name (i.e. AHU-1, etc.), and an arrow indicating flow direction.
   1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.
   2. Lettering Size: At least 1-1/2 inches high.

2.05 STENCILS
A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4 inches for ducts; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.
   1. Stencil Material: Aluminum, Brass, Fiberboard, or metal.
   2. Stencil Paint: Exterior, gloss, alkyd enamel or acrylic enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
   3. Identification Paint: Exterior, alkyd enamel or acrylic enamel in colors according to ASME A13.1 unless otherwise indicated.

2.06 WARNING TAGS
A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
   1. Size: 3 by 5-1/4 inches minimum, 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.”

PART 3 EXECUTION
3.01 PREPARATION
A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

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

3.03 PIPE LABEL INSTALLATION
A. 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.  

B. Pipe Label Color Schedule:  
   1. Refrigerant Piping:  
      a. Background Color: Orange.  
      b. Letter Color: Black.  
   2. Condensate Piping:  
      a. Background Color: Green.  

3.04 DUCT LABEL INSTALLATION  
A. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:  
   1. Blue: For supply ducts.  
   2. Yellow: For return ducts.  
B. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.05 WARNING-TAG INSTALLATION  
A. Write required message on, and attach warning tags to, equipment and other items where required.  

END OF SECTION
SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING FOR HVAC

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. Balancing Air Systems:
      a. Constant-volume air systems.
      b. Variable-air-volume systems.

1.03 DEFINITIONS

C. TAB: Testing, adjusting, and balancing.
D. TABB: Testing, Adjusting, and Balancing Bureau.
E. TAB Specialist: An entity engaged to perform TAB Work.

1.04 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.


D. Certified TAB reports.

E. Sample report forms.

F. 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.

1.05 QUALITY ASSURANCE

A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC, NEBB, or TABB.
   1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC, NEBB, or TABB.
   2. TAB Technician: Employee of the TAB contractor and who is certified by AABC, NEBB, or TABB as a TAB technician.

B. Certify TAB field data reports and perform the following:
   1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

C. TAB Report Forms: Use standard TAB contractor's forms approved by Architect or Engineer.

D. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

E. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

F. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.06 PROJECT CONDITIONS

A. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.07 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

3.01 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, 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 ceiling plenums and underfloor air plenums used for supply, as specified in Section 233113 "Metal Ducts" and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan 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.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. 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.

J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls and connected and functioning.

K. Examine operating safety interlocks and controls on HVAC equipment.

L. 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.

3.02 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.

3.03 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", ASHRAE 111, NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems", SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.
   1. Comply with requirements in ASHRAE 62.1, 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.
   2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
   3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "HVAC Piping 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.
D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.04 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. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

D. 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.

E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

F. Verify that motor starters are equipped with properly sized thermal protection.

G. Check dampers for proper position to achieve desired airflow path.

H. Check for airflow blockages.

I. Check condensate drains for proper connections and functioning.

J. Check for proper sealing of air-handling-unit components.

K. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

3.05 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.
   6. Do not make fan-speed adjustments that result in motor overload. Consult
equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

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.

3.06 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.
   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.

3.07 PROCEDURES FOR CONDENSING UNITS
A. Verify proper rotation of fans.

B. Measure entering- and leaving-air temperatures.

C. Record compressor data.

3.08 PROCEDURES FOR HEAT-TRANSFER COILS
A. Measure, adjust, and record the following data for each electric heating coil:
   1. Nameplate data.
   2. Airflow.
   3. Entering- and leaving-air temperature at full load.
   4. Voltage and amperage input of each phase at full load and at each incremental
stage.
5. Calculated kilowatt at full load.
6. Fuse or circuit-breaker rating for overload protection.

B. Measure, adjust, and record the following data for each refrigerant coil:
1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Refrigerant suction pressure and temperature.

3.09 TOLERANCES
A. Set HVAC system's air flow rates within the following tolerances:
1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
2. Air Outlets and Inlets: Plus or minus 10 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.

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. Fan curves.
2. Manufacturers' test data.
3. Field test reports prepared by system and equipment installers.
4. 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.
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 fan 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. Face and bypass damper settings at coils.
   e. Fan drive settings including settings and percentage of maximum pitch diameter.
   f. Settings for supply-air, static-pressure controller.
   g. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air distribution systems. Present each system with single-line diagram and include the following:
   1. Quantities of outdoor, supply, return, and exhaust airflows.
   2. Duct, outlet, and inlet sizes.
   3. Terminal units.
   5. Position of balancing devices.

E. 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, and bore.
      i. Center-to-center dimensions of sheave, and amount of adjustments in inches.
      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, and bore.
      f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
   3. Test Data (Indicated and Actual Values):
      a. Total air flow rate in cfm.
      b. Total system static pressure in inches wg.
      c. Fan rpm.
      d. Discharge static pressure in inches wg.
      e. Filter static-pressure differential in inches wg.
      f. Preheat-coil static-pressure differential in inches wg.
      g. Cooling-coil static-pressure differential in inches wg.
      h. Heating-coil static-pressure differential in inches wg.
      i. Outdoor airflow in cfm.
      j. Return airflow in cfm.
      k. Outdoor-air damper position.
      l. Return-air damper position.
      m. Vortex damper position.
      n. Outdoor-air, wet and dry-bulb temperatures in deg F.
o. Return-air, wet and dry-bulb temperatures in deg F.
p. Entering-air, wet and dry-bulb temperatures in deg F.
q. Leaving-air, wet and dry-bulb temperatures in deg F.
r. Refrigerant expansion valve and refrigerant types.
s. Refrigerant suction pressure in psig.
t. Refrigerant suction temperature in deg F.
u. Average face velocity in fpm.

F. 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 o.c.
      f. Make and model number.
      g. Face area in sq. ft.
      h. Tube size in NPS.
      i. Tube and fin materials.
      j. Circuiting arrangement.
   2. Test Data (Indicated and Actual Values):
      a. Air flow rate in cfm.
      b. Average face velocity in fpm.
      c. Air pressure drop in inches wg.
      d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
      e. Return-air, wet- and dry-bulb temperatures in deg F.
      f. Entering-air, wet- and dry-bulb temperatures in deg F.
      g. Leaving-air, wet- and dry-bulb temperatures in deg F.
      h. Refrigerant expansion valve and refrigerant types.
      i. Refrigerant suction pressure in psig.
      j. Refrigerant suction temperature in deg F.
      k. Inlet steam pressure in psig.

G. 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.
      e. Number of stages.
      f. Connected volts, phase, and hertz.
      g. Rated amperage.
      h. Air flow rate in cfm.
      i. Face area in sq. ft.
      j. Minimum face velocity in fpm.
   2. Test Data (Indicated and Actual Values):
      a. Heat output in Btu/h.
      b. Air flow rate in cfm.
      c. Air velocity in fpm.
      d. Entering-air temperature in deg F.
      e. Leaving-air temperature in deg F.
      f. Voltage at each connection.
      g. Amperage for each phase.

H. 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, and bore.
h. Center-to-center dimensions of sheave, and amount of adjustments in inches.

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, and bore.
f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):
a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Suction static pressure in inches wg.

I. Round 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.
d. Duct static pressure in inches wg.
e. Duct size in inches.
f. Duct area in sq. ft.
g. Indicated air flow rate in cfm.
h. Indicated velocity in fpm.
i. Actual air flow rate in cfm.
j. Actual average velocity in fpm.
k. Barometric pressure in psig.

J. 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.

2. Test Data (Indicated and Actual Values):
a. Air flow rate in cfm.
b. Air velocity in fpm.
c. Preliminary air flow rate as needed in cfm.
d. Preliminary velocity as needed in fpm.
e. Final air flow rate in cfm.
f. Final velocity in fpm.
g. Space temperature in deg F.
K. System-Coil Reports: For reheat coils 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.
      e. Flowmeter type.
   2. Test Data (Indicated and Actual Values):
      a. Air flow rate in cfm.
      b. Entering-air temperature in deg F.
      c. Leaving-air temperature in deg F.

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 10 percent of air outlets.
      b. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
      c. Verify that balancing devices are marked with final balance position.
      d. 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 or Engineer.
   The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Architect or Engineer shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
   2. 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."
   3. 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
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 insulating the following duct services:
   1. Indoor, concealed exhaust and outdoor air.
   2. Indoor, exposed and outdoor air.
   5. Outdoor.
   6. Duct Liner.
B. Related Sections:
   1. Section 230719 "HVAC Piping Insulation."
   2. Section 233113 "Metal Ducts".

1.03 ACTION SUBMITTALS
A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

1.04 INFORMATIONAL SUBMITTALS
A. Qualification Data: For qualified Installer.
B. 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.
C. Field quality-control reports.

1.05 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. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing 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 agency.
   1. Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

1.06 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.

1.07 COORDINATION
A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance.
requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.08 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.

PART 2 PRODUCTS
2.01 INSULATION MATERIALS

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. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type II for sheet materials.
   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. Aeroflex USA, Inc.; Aerocel.
      b. Armacell LLC; AP Armalex.
      c. K-Flex USA; Insul-Sheet, K-Flex Gray Duct Liner, and KFLEX LS.

G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket or Type III with factory-applied FSP jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   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. CertainTeed Corp.; SoftTouch Duct Wrap.
      b. Johns Manville; Microlite.
      c. Knauf Insulation; Friendly Feel Duct Wrap.
      d. Manson Insulation Inc.; Alley Wrap.
      e. Owens Corning; SOFTR All-Service Duct Wrap.

H. 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. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   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. CertainTeed Corp.; Commercial Board.
      b. Fibrex Insulations Inc.; FBX.
      c. Johns Manville; 800 Series Spin-Glas.
      d. Knauf Insulation; Insulation Board.
      e. Manson Insulation Inc.; AK Board.
      f. Owens Corning; Fiberglas 700 Series.
2.02 FIRE RATED INSULATION SYSTEMS
A. Fire-Rated Board: Structural-grade, press-molded, xonolite calcium silicate, fireproofing board suitable for operating temperatures up to 1700 deg F. Comply with ASTM C 656, Type II, Grade 6. Tested and certified to provide a 2-hour fire rating by an NRTL acceptable to authorities having jurisdiction.
   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. Johns Manville; Super Firetemp M.
      b. Or Approved Equal.

B. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 2-hour fire rating by an NRTL acceptable to authorities having jurisdiction.
   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. CertainTeed Corp.; FlameChek.
      b. Johns Manville; Firetemp Wrap.
      c. Nelson Fire Stop Products; Nelson FSB Flameshield Blanket.
      d. Thermal Ceramics; FireMaster Duct Wrap.
      e. 3M; Fire Barrier Wrap Products.
      f. Unifrax Corporation; FyreWrap.

2.02 ADHESIVES
A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
   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. Aeroflex USA, Inc.; Aerocel.
      b. Armacell LLC; AP Armaflex.
      c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.K-Flex USA; R-373 Contact Adhesive.

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services’ “Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers.”

   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      b. Eagle Bridges - Marathon Industries; 225.
   2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less
when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services’ "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.03 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   b. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.

3. Service Temperature Range: Minus 20 to plus 180 deg F.

4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.


C. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   b. Eagle Bridges - Marathon Industries; 570.

2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.

3. Service Temperature Range: Minus 50 to plus 220 deg F.

4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.


D. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   b. Eagle Bridges - Marathon Industries; 550.
   e. Vimasco Corporation; WC-1/WC-5.

2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.

3. Service Temperature Range: Minus 20 to plus 180 deg F.

4. Solids Content: 60 percent by volume and 66 percent by weight.


2.04 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   c. Vimasco Corporation; 713 and 714.

3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.

4. Service Temperature Range: 0 to plus 180 deg F.


2.05 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
   c. Mon-Eco Industries, Inc.; 44-05.

2. Materials shall be compatible with insulation materials, jackets, and substrates.

3. Fire- and water-resistant, flexible, elastomeric sealant.

4. Service Temperature Range: Minus 40 to plus 250 deg F.

5. Color: Aluminum.

6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

7. Sealants shall comply with the testing and product requirements of the California Department of Health Services’ “Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers.”

2.06 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

   a. Factory cut and rolled to size.
   b. Finish and thickness are indicated in field-applied jacket schedules.
   c. Moisture Barrier for Outdoor Applications: 2.5-mil- thick polysurlyn.

2.07 TAPES

A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

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. ABI, Ideal Tape Division; 491 AWF FSK.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
   c. Compac Corporation; 110 and 111.
   d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.

2. Width: 3 inches.

3. Thickness: 6.5 mils.


5. Elongation: 2 percent.

6. Tensile Strength: 40 lbf/inch in width.

7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
A. Bands:
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. ITW Insulation Systems; Gerrard Strapping and Seals.
   b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.
2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal or closed seal.

B. Insulation Pins and Hangers:
1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- or 0.135-inch- diameter shank, length to suit depth of insulation indicated.
   a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      1) AGM Industries, Inc.; CWP-1.
      2) GEMCO; CD.
      3) Midwest Fasteners, Inc.; CD.
      4) Nelson Stud Welding; TPA, TPC, and TPS.

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- or 0.135-inch-diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
   a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      1) AGM Industries, Inc.; CHP-1.
      2) GEMCO; Cupped Head Weld Pin.
      3) Midwest Fasteners, Inc.; Cupped Head.
      4) Nelson Stud Welding; CHP.

3. 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.
   Comply with the following requirements:
   a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      1) AGM Industries, Inc.; Tactoo Perforated Base Insul-Hangers.
      2) GEMCO; Perforated Base.
      3) Midwest Fasteners, Inc.; Spindle.
   b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
   c. Spindle: Copper- or zinc-coated, low-carbon steel, Aluminum, Stainless steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
   d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.
   Comply with the following requirements:
   a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
1) GEMCO; Nylon Hangers.
2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.

b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.

c. Spindle: Nylon, 0.106-inch- diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.

d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

5. Self-Sticking-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. Comply with the following requirements:

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   1) AGM Industries, Inc.; Tactoo Self-Adhering Insul-Hangers.
   2) GEMCO; Peel & Press.
   3) Midwest Fasteners, Inc.; Self Stick.

b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.

c. Spindle: Copper- or zinc-coated, low-carbon steel, Aluminum, Stainless steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.

d. Adhesive-backed base with a peel-off protective cover.

6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel, aluminum, stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   1) AGM Industries, Inc.; RC-150.
   2) GEMCO; R-150.
   3) Midwest Fasteners, Inc.; WA-150.
   4) Nelson Stud Welding; Speed Clips.

b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1) GEMCO.
   2) Midwest Fasteners, Inc.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

D. Wire: 0.080-inch nickel-copper alloy, 0.062-inch soft-annealed, stainless steel, or 0.062-inch soft-annealed, galvanized steel.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2.09 DUCT LINER

A. Fibrous duct liner in the airstream shall not be acceptable.

B. Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C 534, Type II, Grade 1; and with NFPA 90A or NFPA 90B.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Aeroflex USA Inc.
      b. Armacell LLC.
      c. Rubatex International, LLC
   2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
   3. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
      a. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
      b. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."
   1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
   2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
   3. Butt transverse joints without gaps, and coat joint with adhesive.
   4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
   5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
   6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.
   7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
   8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
      a. Fan discharges.
      b. Intervals of lined duct preceding unlined duct.
      c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.
   9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.
      a. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.
   10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.
PART 3 EXECUTION

3.01 EXAMINATION
A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
   1. Verify that systems to be insulated have been tested and are free of defects.
   2. Verify that surfaces to be insulated are clean and dry.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION
A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.03 GENERAL INSTALLATION REQUIREMENTS
A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.
B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct 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. Keep insulation materials dry during application and finishing.
G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
H. Install insulation with least number of joints practical.
I. 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.
J. Apply adhesives, mastics, and sealants at manufacturer’s recommended coverage rate and wet and dry film thicknesses.
K. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.

5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

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 beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.04 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 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.

4. Seal jacket to wall flashing with flashing sealant.

C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: 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.

1. Comply with requirements in Section 078413 "Penetration Firestopping" and fire-resistive joint sealers.

3.05 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

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.

3.06 INSTALLATION OF MINERAL-FIBER INSULATION

A. 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 and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
   b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches 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 over compress 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 from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch 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 at 18-foot 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 two times the insulation thickness, but not less than 3 inches.
5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches 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-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

B. 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 and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
   b. On duct sides with dimensions larger than 18 inches, space pins 16
inches o.c. each way, and 3 inches maximum from 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 over compress 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 from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch 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 at 18-foot 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 two times the insulation thickness, but not less than 3 inches.

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-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.07 FIELD-APPLIED JACKET INSTALLATION

A. Where metal jackets are indicated, install with 2-inch 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 o.c. and at end joints.

3.08 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 Section 078413 "Penetration Firestopping."

3.09 FINISHES

A. Insulation with Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

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.


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 FIELD QUALITY CONTROL
A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
B. Perform tests and inspections.
C. Tests and Inspections:
1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the “Duct Insulation Schedule, General” Article.
D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.11 DUCT INSULATION SCHEDULE, GENERAL
A. Plenums and Ducts Requiring Insulation:
1. All supply, return, and outdoor air.
2. Where energy recovery wheel is present, environmental air exhaust to the wheel.
3. Exhaust between isolation damper and penetration of building exterior.
B. Items Not Insulated:
1. Fibrous-glass ducts.
2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
3. Factory-insulated flexible ducts.
5. Flexible connectors.
7. Factory-insulated access panels and doors.
8. Environmental air exhaust where energy recovery wheel is not present.
9. Where energy recovery wheel is present, environmental air exhaust after the wheel.

3.12 INDOOR DUCT AND PLENUM INSULATION SCHEDULE
A. Concealed exhaust and outdoor-air duct and plenum insulation shall be the following:
1. Mineral-Fiber Blanket: 2.2 inches thick and 0.75-lb/cu. ft. nominal density.
B. Exposed exhaust and outdoor-air duct in Utility and/or Spaces Below 8’ Above Finished Floor, insulation shall be the following:
1. Mineral-Fiber Board: 2 inches thick and 2-lb/cu. ft. nominal density.
D. Exposed supply, return, and outdoor-air duct where indicated on the drawings or Metal Duct Specification to have single wall duct, insulation shall be the following:
1. Mineral-Fiber Blanket: 2.2 inches thick and 0.75-lb/cu. ft. nominal density.
Surface of insulation shall be prepared for painting to match adjacent surfaces, coordinate with architectural plans.
E. Exposed supply, return, and outdoor-air duct where indicated on the drawings or Metal Duct Specifications to have double wall duct, liner shall be the following:
1. If perforated inner duct is used: Flexible Elastomeric: 1 inch thick.
2. If solid wall inner duct is used: Mineral-Fiber Blanket: 1 inches thick and 0.75-lb/cu. ft nominal density.

3.13 ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SCHEDULE
A. Exhaust and outdoor air duct:
   1. Phenolic Foam: 1.5 inch thick.

3.14 OUTDOOR, 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. Ducts and Plenums, Exposed:
   1. Aluminum: 0.040 inch thick.

3.15 DUCT LINER
A. Duct Liner:
   1. Exhaust Plenums: Flexible elastomeric, 1 inch thick.

END OF SECTION
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. Single-wall rectangular ducts and fittings.
2. Single-wall round ducts and fittings.
4. Sealants and gaskets.
5. Hangers and supports.

B. Related Sections:
1. Section 230593 “Testing, Adjusting, and Balancing for HVAC” for testing, adjusting, and balancing requirements for metal ducts.
2. Section 233300 “Air Duct Accessories” for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.03 PERFORMANCE REQUIREMENTS
A. Delegated 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 ASCE/SEI 7. And SMACNA's “Seismic Restraint Manual: Guidelines for Mechanical Systems.”
1. Seismic Hazard Level as stated on contract documents.

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.04 ACTION SUBMITTALS
A. Product Data: For each type of the following products:
1. Sealants and gaskets.
2. Seismic-restraint devices.

B. Shop Drawings:
1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access
doors and panels.

12. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.

1.05 INFORMATIONAL SUBMITTALS
A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
   2. Suspended ceiling components.
   3. Structural members to which duct will be attached.
   4. Size and location of initial access modules for acoustical tile.
   5. Penetrations of smoke barriers and fire-rated construction.
   6. Items penetrating finished ceiling including the following:
      a. Lighting fixtures.
      b. Air outlets and inlets.
      c. Speakers.
      d. Sprinklers.
      e. Access panels.
      f. Perimeter moldings.

B. Welding certificates.

C. Field quality-control reports.

1.06 QUALITY ASSURANCE
A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS
2.01 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 2-1, "Rectangular Duct/Transverse 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 2-2, "Rectangular Duct/Longitudinal Seams," 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 4, "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."
2.02 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.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Lindab Inc.
      b. McGill AirFlow LLC.
      c. SEMCO Incorporated.
      d. Sheet Metal Connectors, Inc.
      e. Spiral Manufacturing Co., Inc.
      f. Eastern Sheet Metal.
      g. Hamlin Sheet Metal.
      h. Turn Key Duct Systems.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal andFlexible."
   1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," 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."
   1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
   2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "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."

2.03 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.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   1. Galvanized Coating Designation: G60 or G90.
   2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.

D. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.

E. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.
F. Factory- or Shop-Applied Antimicrobial Coating:

1. Apply to the surface of sheet metal that will form the interior surface of the duct. An untreated clear coating shall be applied to the exterior surface.
2. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
3. Coating containing the antimicrobial compound shall have a hardness of 2H, minimum, when tested according to ASTM D 3363.
4. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
5. Shop-Applied Coating Color: Black or White.
6. Antimicrobial coating on sheet metal is not required for duct containing liner treated with antimicrobial coating.

G. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

H. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.04 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.

B. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: 3 inches.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
10. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Solvent-Based Joint and Seam Sealant:
1. **Application Method:** Brush on.
2. **Base:** Synthetic rubber resin.
3. **Solvent:** Toluene and heptane.
4. **Solids Content:** Minimum 60 percent.
5. **Shore A Hardness:** Minimum 60.
6. **Water resistant.**
7. **Mold and mildew resistant.**
8. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
9. **VOC:** Maximum 395 g/L.
10. **Maximum Static-Pressure Class:** 10-inch wg, positive or negative.
11. **Service:** Indoor or outdoor.
12. **Substrate:** Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

**E. Flanged Joint Sealant:** Comply with ASTM C 920.
1. **General:** Single-component, acid-curing, silicone, elastomeric.
2. **Type:** S.
3. **Grade:** NS.
4. **Class:** 25.
5. **Use:** O.
6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

**F. Flange Gaskets:** Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

**G. Round Duct Joint O-Ring Seals:**
1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

### 2.05 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 5-1, “Rectangular Duct Hangers Minimum Size,” and Table 5-2, “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:**
PART 3 EXECUTION

3.01 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. Install round and flat-oval ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. 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.

K. Where ducts pass through non-fire-rated, interior partitions, fill void between duct and opening in wall with fiberglass insulation and sealant for acoustical separation.

L. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers.

M. Protect duct interiors from moisture, construction debris and dust, and other foreign materials.

3.02 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.

3.03 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."

B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible": See Schedule

3.04 HANGER AND SUPPORT INSTALLATION
A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "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 thick.
   4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches 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 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches 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.

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.

3.05 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 requirements indicated in Seismic Specification.

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.
E. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.

F. Drilling for and Setting Anchors:
   1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
   2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
   3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
   4. Set anchors to manufacturer's recommended torque, using a torque wrench.
   5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

3.07 CONNECTIONS
A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.08 PAINTING
A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

3.09 FIELD QUALITY CONTROL
A. Perform tests and inspections.

B. Leakage Tests:
   2. Test the following systems:
      a. Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections totaling no less than 50 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 five days’ advance notice for testing.

C. Duct System Cleanliness Tests:
   1. Visually inspect duct system to ensure that no visible contaminants are present.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.
3.10 **START UP**

A. Air Balance: Comply with requirements in Section 230593 “Testing, Adjusting, and Balancing for HVAC.”

3.11 **DUCT SCHEDULE**

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated.

B. Ductwork

<table>
<thead>
<tr>
<th>Table 1: Recommended Ductwork Seal Levels by Duct Type (Current ASHRAE Handbook – Fundamentals)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Duct Location</strong></td>
</tr>
<tr>
<td>Outdoors</td>
</tr>
<tr>
<td>Unconditioned Spaces</td>
</tr>
<tr>
<td>Conditioned Spaces (concealed ductwork)</td>
</tr>
<tr>
<td>Conditioned Spaces (exposed ductwork)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 2: Duct Leakage Classification (Current ASHRAE Handbook – Fundamentals)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Duct Type</strong></td>
</tr>
<tr>
<td>Metal (flexible excluded) – Round and flat oval</td>
</tr>
<tr>
<td>Metal – Rectangular (less than or equal to 2 in-wg)</td>
</tr>
<tr>
<td>Metal – Rectangular (greater than 2 in-wg)</td>
</tr>
<tr>
<td>Flexible (metal, aluminum)</td>
</tr>
</tbody>
</table>

C. Intermediate Reinforcement:

2. Stainless-Steel Ducts:
   a. Exposed to Airstream: Match duct material.
   b. Not Exposed to Airstream: Match duct material.
3. Aluminum Ducts: Aluminum.

D. Elbow Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
   a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
   b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
   c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
   a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
      1) Radius-to-Diameter Ratio: 1.5.
   b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
   c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

H. Branch Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
   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 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
   a. Velocity (less than 2 in-wg) 1000 fpm or Lower: 90-degree tap.
   b. Velocity 1000 to 1500 fpm: Conical tap.
   c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION
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. Backdraft and pressure relief dampers.
2. Barometric relief dampers.
4. Control dampers.
5. Fire Dampers.
6. Smoke Dampers.
7. Combination fire and smoke dampers.
8. Flange connectors.
10. Remote damper operators.
11. Duct-mounted access doors.
12. Flexible connectors.
13. Flexible ducts.
14. Duct accessory hardware.

B. Related Requirements:
1. Section 283111 "Digital, Addressable Fire-Alarm System" for duct-mounted fire and smoke detectors.
2. Section 283112 "Zoned (DC-Loop) Fire-Alarm System" for duct-mounted fire and smoke detectors.

1.03 ACTION SUBMITTALS
A. Product Data: For each type of product.
1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
   a. Special fittings.
   c. Fire-damper, smoke-damper, combination fire- and smoke-damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
   d. Wiring Diagrams: For power, signal, and control wiring.

1.04 INFORMATIONAL SUBMITTALS
A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.

B. Source quality-control reports.

1.05 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.
PART 2 - PRODUCTS

2.01 ASSEMBLY DESCRIPTION


B. 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.

2.02 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   1. Galvanized Coating Designation: G60.
   2. Exposed-Surface Finish: Mill phosphatized.

B. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

C. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.03 BACKDRAFT AND PRESSURE RELIEF DAMPERS

A. Description: Gravity balanced.


C. Maximum System Pressure: 2-inch wg.

D. Frame: Hat-shaped, 0.05-inch thick, galvanized sheet steel with welded corners or mechanically attached and mounting flange.

E. Blades: Multiple single-piece blades, center pivoted, maximum 6-inch width, 0.025-inch-thick, roll-formed aluminum with sealed edges.

F. Blade Action: Parallel.

G. Blade Seals: Vinyl foam.

H. Blade Axles:
   1. Material: Galvanized steel.
   2. Diameter: 0.20 inch.

I. Tie Bars and Brackets: Aluminum or Galvanized steel

J. Return Spring: Adjustable tension.

K. Bearings: Steel ball or synthetic pivot bushings.

L. Accessories:
   1. Adjustment device to permit setting for varying differential static pressure.
   2. Counterweights and spring-assist kits for vertical airflow installations.
   3. Electric actuators.
   4. Chain pulls.
   5. Screen Mounting: Front mounted in sleeve.
      a. Sleeve Thickness: 20 gage minimum.
      b. Sleeve Length: 6 inches minimum.
6. Screen Mounting: Rear mounted.
7. Screen Material: Aluminum.
8. Screen Type: Insect.
9. 90-degree stops.

2.04 BAROMETRIC RELIEF DAMPERS
A. Suitable for horizontal or vertical mounting.
B. Maximum Air Velocity: 1250 fpm.
C. Maximum System Pressure: 2-inch wg.
D. Frame: Hat-shaped, [0.05-inch- thick, galvanized sheet steel, with welded corners or mechanically attached and mounting flange.
E. Blades:
   1. Multiple, 0.025-inch- thick, roll-formed aluminum.
   3. Action: Parallel.
F. Blade Seals: Vinyl
G. Blade Axles: Galvanized steel.
H. Tie Bars and Brackets:
   1. Material: Galvanized steel.
   2. Rattle free with 90-degree stop.
I. Return Spring: Adjustable tension.
J. Bearings: Synthetic.
K. Accessories:
   1. Flange on intake.
   2. Adjustment device to permit setting for varying differential static pressures.

2.05 MANUAL VOLUME DAMPERS
A. Standard, Aluminum, Manual Volume Dampers:
   1. Standard leakage rating, with linkage outside airstream.
   3. Suitable for horizontal or vertical applications.
   4. Frames:
      a. Hat-shaped, 0.094-inch- thick, galvanized sheet steel.
      b. Mitered and welded corners.
      c. Flanges for attaching to walls and flangeless frames for installing in ducts.
   5. Blades:
      a. Multiple or single blade.
      b. Parallel- or opposed-blade design.
      c. Stiffen damper blades for stability.
      d. Galvanized-steel, 0.064 inch thick.
   7. Bearings:
      a. Oil-impregnated bronze.
      b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
   8. Tie Bars and Brackets: Galvanized steel.
2.06 CONTROL DAMPERS

A. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.

B. Frames:
   1. Hat shaped.
   2. 0.094-inch- thick, galvanized sheet steel.
   3. Mitered and welded corners.

D. Blades:
   1. Multiple blade with maximum blade width of 6 inches.
   2. Parallel and/or Opposed-blade design.
   4. 0.064 inch thick single skin or 0.0747-inch- thick dual skin.

E. Blade Axles: 1/2-inch- diameter; galvanized steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.
   1. Operating Temperature Range: From minus 40 to plus 200 deg F.

F. Bearings:
   1. Oil-impregnated bronze.
   2. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
   3. Thrust bearings at each end of every blade.

2.07 FIRE DAMPERS

A. Type: Dynamic; rated and labeled according to UL 555 by an NRTL.

B. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.

C. Fire Rating: 1-1/2 and 3 hours.

D. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.

E. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
   1. Minimum Thickness: 0.138 inch thick, as indicated, and of length to suit application.
   2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.

F. Mounting Orientation: Vertical or horizontal as indicated.

G. Blades: Roll-formed, interlocking, 0.024-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.

H. Horizontal Dampers: Include blade lock and stainless-steel closure spring.


J. Heat-Responsive Device: Replaceable link and switch package, factory installed, 165 deg F rated.
2.08 SMOKE DAMPERS
A. General Requirements: Label according to UL 555S by an NRTL.
B. Smoke Detector: Integral, factory wired for single-point connection.
C. Frame: Hat-shaped, 0.094-inch thick, galvanized sheet steel, with welded interlocking, gusseted or mechanically attached corners.
D. Blades: Roll-formed, horizontal, interlocking or overlapping, 16 gauge, galvanized sheet steel.
E. Leakage: Class I
F. Rated pressure and velocity to exceed design airflow conditions.
G. Mounting Sleeve: Factory-installed, 20 gauge, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.
H. Damper Motors: Modulating or two-position action.
   1. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 “Common Motor Requirements for HVAC Equipment.”
   2. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   3. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Section 230900 “Instrumentation and Control for HVAC.”
   4. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
   5. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
   6. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
   7. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
J. Accessories:
   1. Auxiliary switches for signaling position indication.
   2. Test and reset switches, damper mounted.

2.10 COMBINATION FIRE AND SMOKE DAMPERS
A. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.
B. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.
C. Fire Rating: 1-1/2 and 3 hours.
D. Frame: Hat-shaped, 16 gauge, galvanized sheet steel, with welded, interlocking, gusseted or mechanically attached corners.
F. Smoke Detector: Integral, factory wired for single-point connection.
G. Blades: Roll-formed, horizontal, interlocking or overlapping, 16 gauge, galvanized sheet steel.

H. Leakage: Class I.

I. Rated pressure and velocity to exceed design airflow conditions.

J. Mounting Sleeve: Factory-installed, 20 gauge, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.

K. Master control panel for use in dynamic smoke-management systems.

L. Damper Motors: Modulating or two-position action.

M. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 “Common Motor Requirements for HVAC Equipment.”
   1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Section 230900 “Instrumentation and Control for HVAC.”
   3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
   4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
   5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
   6. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
   7. Electrical Connection: 115 V, single phase, 60 Hz.

N. Accessories:
   1. Auxiliary switches for signaling position indication.
   2. Test and reset switches, damper mounted.

2.11 FLANGE CONNECTORS
   A. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

   B. Material: Galvanized steel.

   C. Gage and Shape: Match connecting ductwork.

2.12 TURNING VANES
   A. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

   B. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."

D. Vane Construction: Single wall.

E. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.13 REMOTE DAMPER OPERATORS
A. Description: Cable system designed for remote manual damper adjustment.

B. Tubing: Brass, Copper or Aluminum.

C. Cable: Steel.

D. Cover: Surface.

2.14 DUCT-MOUNTED ACCESS DOORS

1. Door:
   a. Double wall, rectangular.
   b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
   c. Vision panel.
   d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
   e. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.

3. Number of Hinges and Locks:
   a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
   b. Access Doors up to 18 Inches Square: Continuous and two sash locks.
   c. Access Doors up to 24 by 48 Inches: Continuous and two compression latches with outside and inside handles.
   d. Access Doors Larger Than 24 by 48 Inches: Continuous and two compression latches with outside and inside handles.

2.12 FLEXIBLE CONNECTORS
A. Materials: Flame-retardant or noncombustible fabrics.

B. Coatings and Adhesives: Comply with UL 181, Class 1.

C. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch wide, 0.028-inch thick, galvanized sheet steel or 0.032-inch thick aluminum sheets. Provide metal compatible with connected ducts.


1. Minimum Weight: 26 oz./sq. yd.
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

1. Minimum Weight: 24 oz./sq. yd.
2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
3. Service Temperature: Minus 50 to plus 250 deg F.

   1. Minimum Weight: 14 oz./sq. yd.
   2. Tensile Strength: 450 lbf/inch in the warp and 340 lbf/inch in the filling.
   3. Service Temperature: Minus 67 to plus 500 deg F.

G. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
   1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
   2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
   7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.13 FLEXIBLE DUCTS
A. Insulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.
   1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
   3. Temperature Range: Minus 10 to plus 160 deg F.
   4. Insulation R-value: Comply with ASHRAE/IESNA 90.1.

B. Flexible Duct Connectors:
   1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action or Nylon strap in sizes 3 through 18 inches, to suit duct size.

2.17 DUCT ACCESSORY HARDWARE
A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 EXECUTION
3.01 INSTALLATION
A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
   1. Install steel volume dampers in steel ducts.
   2. Install aluminum volume dampers in aluminum ducts.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install test holes at fan inlets and outlets and elsewhere as indicated.

G. Install fire and smoke dampers according to UL listing.

H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
   1. On both sides of duct coils.
   2. Upstream and downstream from duct filters.
   3. At outdoor-air intakes and mixed-air plenums.
   4. At drain pans and seals.
   5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
   6. At each change in direction and at maximum 50-foot spacing.
   7. Control devices requiring inspection.
   8. Elsewhere as indicated.

I. Install access doors with swing against duct static pressure.

J. Access Door Sizes:
   1. One-Hand or Inspection Access: 8 by 5 inches.
   2. Two-Hand Access: 12 by 6 inches.

K. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

L. Install flexible connectors to connect ducts to equipment.

M. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

N. Connect terminal units to supply ducts directly or with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.

O. Connect diffusers to ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.

P. Connect flexible ducts to metal ducts with adhesive plus sheet metal screws.

Q. Install duct test holes where required for testing and balancing purposes.

R. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.
3.02 FIELD QUALITY CONTROL
A. Tests and Inspections:
   1. Operate dampers to verify full range of movement.
   2. Inspect locations of access doors and verify that purpose of access door can be performed.
   3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
   4. Inspect turning vanes for proper and secure installation.
   5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION
SECTION 23 37 13
DIFFUSERS, REGISTERS, AND GRILLES

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. Rectangular sidewall grilles
   2. Rectangular and square ceiling diffusers.
   3. Perforated diffusers.
   4. Louver face diffusers.
   5. Louvers.
B. Related Sections:
   1. Section 089116 "Operable Wall Louvers" and Section 089119 "Fixed Louvers" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
   2. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.03 ACTION SUBMITTALS
A. Product Data: For each type of product indicated, include the following:
   1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
   2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

1.04 INFORMATIONAL SUBMITTALS
A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
   1. Ceiling suspension assembly members.
   2. Method of attaching hangers to building structure.
   3. Size and location of initial access modules for acoustical tile.
   4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
   5. Duct access panels.
B. Source quality-control reports.

PART 2 - PRODUCTS
2.01 Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on drawings or equal.

2.02 Refer to drawings.

PART 3 - EXECUTION
3.01 EXAMINATION
A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
B. Proceed with installation only after unsatisfactory conditions have been corrected.
3.02 INSTALLATION
A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

D. Install louvers per manufacturer recommendations.

3.03 ADJUSTING
A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION
SECTION 23 74 33
DEDICATED OUTDOOR-AIR UNITS

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 factory-packaged units capable of supplying up to 100 percent outdoor air and providing cooling and heating.

1.03 ACTION SUBMITTALS
A. Product Data: For each type of product. Include rated capacities, operating characteristics, and furnished specialties and accessories.

B. Shop Drawings:
1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Prepare the following by or under the supervision of a qualified professional engineer:
   a. Mounting Details: For securing and flashing roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
   b. Include diagrams for power, signal, and control wiring.

C. Delegated-Design Submittal For design of vibration isolation, seismic restraints, and wind restraints, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Unit fabrication and assembly details.
   2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
   3. Design Calculations:
      a. Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
      b. Indicate compliance with "Performance Requirements" article.

1.04 INFORMATIONAL SUBMITTALS
A. Coordination Drawings: Roof-curb mounting details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Size and location of unit-mounted rails and anchor points and methods for anchoring units to roof curb.
   2. Required roof penetrations for ducts, pipes, and electrical raceways, including size and location of each penetration.

B. Seismic Qualification Certificates: For dedicated outdoor-air units, accessories, and components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Startup service reports.
D. Sample Warranty: For special warranty.

1.05 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For units to include in emergency, operation, and maintenance manuals.

1.06 WARRANTY
A. Special Warranty: Manufacturer agrees to replace components of units that fail in materials or workmanship within specified warranty period.
   1. Warranty Period for Compressors: Five years from date of Substantial Completion.
   2. Warranty Period for Heat Exchangers: Five years from date of Substantial Completion.

1.07 COORDINATION
A. Coordinate size and location of structural-steel support members.
B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 PRODUCTS
2.01 MANUFACTURERS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Munters Corporation, Dehumidification Division; Des Champs Products.
   2. Greenheck.
   3. Trane.
   4. AAON.

2.02 PERFORMANCE REQUIREMENTS
A. General Fabrication Requirements: Comply with requirements in ASHRAE 62.1, Section 5 - “Systems and Equipment,” and Section 7 - “Construction and System Start-up.”

B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design vibration isolation seismic restraints and wind restraints.

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

D. Wind-Restraint Performance:
   1. Basic Wind Speed: Refer to drawings.
   2. Building Classification Category: Refer to Architectural.
   3. Minimum 10 lb/sq. ft multiplied by the maximum area of unit projected on a vertical plane that is normal to the wind direction and 45 degrees either side of normal.

E. Cabinet Thermal Performance:
   1. Maximum Overall U-Value: Comply with requirements in ASHRAE/IESNA 90.1.
   2. Maximum Overall U-Value: 0.10 Btu/h x sq. ft. x deg F.
   3. Include effects of metal-to-metal contact and thermal bridges in the calculations.

F. Cabinet Surface Condensation:
1. Cabinet shall have additional insulation and vapor seals if required to prevent condensation on the interior and exterior of the cabinet.
2. Portions of cabinet located downstream from the cooling coil shall have a thermal break at each thermal bridge between the exterior and interior casing to prevent condensation from occurring on the interior and exterior surfaces. The thermal break shall not compromise the structural integrity of the cabinet.

G. Maximum Cabinet Leakage: 1 percent of the total supply-air flow at a pressure rating equal to the fan shut-off pressure.

H. Cabinet Deflection Performance:
1. Walls and roof deflection shall be within 1/200 of the span at the design working pressure equal to the fan shut-off pressure. Deflection limits shall be measured at any point on the surface.
2. Floor deflections shall be within 1/300 of the span considering the worst-case condition caused by the following:
   a. Service personnel.
   b. Internal components.
   c. Design working pressure defined for the walls and roof.

I. 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.

2.03 CABINET
A. Construction: double wall.

B. Exterior Casing Material: Galvanized steel with paint finish.

C. Interior Casing Material: Galvanized steel.


E. Base Rails: Galvanized-steel rails for mounting on roof curb or pad as indicated.

F. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
   1. Service Doors: Hinged access doors with gaskets. Material and construction of doors shall match material and construction of cabinet in which doors are installed.

G. Roof: Standing seam or membrane; sloped to drain water.

H. Floor: Reinforced, metal surface; reinforced to limit deflection when walked on by service personnel. Insulation shall be below metal walking surface.

I. Cabinet Insulation:
   1. Type: flexible elastomeric insulation complying with ASTM C 534, Type II, sheet materials.
   2. Thickness: 2 inches.
   3. Insulation Adhesive: Comply with ASTM C 916, Type I.
   4. Mechanical Fasteners: Suitable for adhesive, mechanical, or welding attachment to casing without damaging liner and without causing air leakage when applied as recommended by manufacturer.

J. Condensate Drain Pans:
   1. Shape: Rectangular, with 2 percent slope in at least two planes to direct water toward drain connection.
2. Size: Large enough to collect condensate from cooling coils including coil piping connections, coil headers, and return bends.
   a. Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
   b. Depth: A minimum of 2 inches deep.
4. Configuration: Double wall, with space between walls filled with foam insulation and moisture-tight seal.
7. Drain Connection:
   a. Located on both endsof pan, at lowest point of pan.
   b. Terminated with threaded nipple.
8. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

K. Surfaces in Contact with Airstream: Comply with requirements in ASHRAE 62.1 for resistance to mold and erosion.

L. Roof Curb: Full-perimeter curb of sheet metal, minimum 12 inches high, with wood nailer, neoprene sealing strip, and welded Z-bar flashing.

2.04 SUPPLY FAN
A. Forward-Curved Fan Type: Centrifugal; statically and dynamically balanced.
   1. Fan Wheel Material: Galvanized steel, mounted on solid-steel shaft.
B. Plenum Fan Type: Single width, non-overloading, with backward-inclined or airfoil blades.
   1. Fan Wheel Material: Aluminum; attached directly to motor shaft.
   5. Fan Balance: Precision balance fan below 0.08 inch/s at design speed with filter in.
C. Service Factor for Belt Drive Applications: V-belt drive with matching fan pulley and adjustable motor sheaves and belt assembly with minimum 2.0 service factor.
D. Mounting: Fan wheel, motor, and drives shall be mounted to fan casing with restrained, elastomeric, or spring isolators.

2.05 COOLING COILS
A. Capacity Ratings: Comply with ASHRAE 33 and ARI 410.
B. Coil Casing Material: Manufacturer's standard material.
C. Tube Material: Copper.
D. Tube Header Material: Manufacturer's standard material.
E. Fin Material: Aluminum or Copper.
F. Fin and Tube Joints: Mechanical bond.
G. Leak Test: Coils shall be leak tested with air underwater.

H. Refrigerant Coil Capacity Reduction: Circuit coils for control.

I. Refrigerant Coil Suction and Distributor Header Materials: Seamless copper tube with brazed joints.

J. Coating: Phenolic epoxy corrosion-protection coating after assembly.

2.06 REFRIGERATION SYSTEM


B. Refrigerant Charge: Factory charged with refrigerant and filled with oil.

C. Compressors: compressors with integral vibration isolators, internal overcurrent and overtemperature protection, internal pressure relief.

D. Refrigerant: R-410A.
   1. Classified as Safety Group A1 according to ASHRAE 34.
   2. Provide unit with operating charge of refrigerant.

E. Refrigeration System Specialties:
   1. Expansion valve with replaceable thermostatic element.
   2. Refrigerant dryer.
   3. High-pressure switch.
   4. Low-pressure switch.
   5. Thermostat for coil freeze-up protection during low ambient temperature operation or loss of air.
   6. Brass service valves installed in discharge and liquid lines.

F. Capacity Control:
   1. Hot-gas bypass refrigerant control for capacity control with continuous dehumidification on a single compressor.
   2. Patented, Rawal APR control with zero to 100 percent modulating capacity control using hot-gas bypass. Evaporator coil shall be continuously active for dehumidification.
   3. Single compressor with evaporator and condenser coil within the refrigerant section to provide initial pre-cooling and to reheat for humidity control.
   4. Heat-pipe heat exchanger wrapped around the evaporator coil to pre-cool the air entering the evaporator coil and reheat the air leaving the evaporator coil to control humidity.

G. Refrigerant coils:
   2. Tube Material: Copper.
   3. Fin Material: Aluminum or Copper.
   5. Leak Test: Coils shall be leak tested with air underwater.

H. Condenser Fan Assembly:
   1. Fans: Direct-drive propeller type with statically and dynamically balanced fan blades.
   2. Fan Motors:
      a. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
b. Motor Enclosure: Totally enclosed non-ventilating (TENV) or totally enclosed air over (TEAO) enclosure.

c. Enclosure Materials: Cast iron, Cast aluminum or Rolled steel.

d. Motor Bearings: Permanently lubricated bearings.

3. Fan Safety Guards: Steel with corrosion-resistant coating.

I. Safety Controls:
   1. Compressor motor and condenser coil fan motor low ambient lockout.
   2. Overcurrent protection for compressor motor.

2.07 INDIRECT-FIRED GAS FURNACE HEATING

A. Furnace Assembly:
   1. Factory assembled, piped, and wired.
   3. AGA Approval: Designed and certified by and bearing label of AGA.

B. Burners:
   3. Ignition: Electronically controlled electric spark with flame sensor.


D. Venting: Gravity vented.

E. Venting: Power vent with integral, motorized centrifugal fan interlocked with gas valve.

F. Safety Controls:
   1. Gas Control Valve: Electronic modulating.

2.08 OUTDOOR-AIR INTAKE HOOD

A. Type: Manufacturer's standard hood or louver.

B. Materials: Match cabinet.

C. Bird Screen: Comply with requirements in ASHRAE 62.1.

D. Configuration: Designed to inhibit wind-driven rain and snow from entering unit

2.09 FILTERS

A. Cleanable Filters: 2-inch-thick, cleanable metal mesh.

B. Disposable Panel Filters:
   1. Comply with NFPA 90A.
   2. Factory-fabricated, viscous-coated, flat-panel type.
   3. Thickness: 2 inches.
   4. Minimum Arrestance: 80, according to ASHRAE 52.1.
   5. Minimum Merv: 6, according to ASHRAE 52.2.

C. Mounting Frames:
1. Panel filters arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or from access plenum.
2. Extended surface filters arranged for flat orientation, removable from access plenum.
3. Galvanized or stainless steel with gaskets and fasteners, suitable for bolting together into built-up filter banks with space for prefilter.

2.10 ELECTRICAL POWER CONNECTIONS

A. General Electrical Power Connection Requirements: Factory-installed and -wired switches, motor controllers, transformers, and other necessary electrical devices shall provide a single-point field power connection to unit.

B. Enclosure: NEMA 250, Type 3R, mounted in unit with hinged access door in unit cabinet having a lock and key or padlock and key.

C. Wiring: Numbered and color-coded to match wiring diagram.

D. Wiring Location: Install factory wiring outside an enclosure in a raceway.

E. Power Interface: Field power interface shall be to NEMA KS 1, heavy-duty, non-fused disconnect switch.

F. Factory Wiring: Branch power circuit to each motor and to controls with one of the following disconnecting means:
   1. NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.
   2. NEMA KS 1, heavy-duty, nonfusible switch.
   3. UL 489, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

G. Factory-Mounted, Overcurrent-Protection Service: For each motor.

H. Transformer: Factory mounted with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.

I. Controls: Factory wire unit-mounted controls where indicated.

J. Lights: Factory wire unit-mounted lights.

K. Receptacle: Factory wire unit-mounted, ground fault interrupt (GFI) duplex receptacle.

L. Control Relays: Auxiliary and adjustable time-delay relays.

2.11 CONTROLS

A. Control equipment and sequence of operation are specified in Section 230900 “Instrumentation and Control for HVAC.”

B. Control Devices: Sensors, transmitters, relays, switches, detectors, operators, actuators, and valves shall be manufacturer's standard items to accomplish indicated control functions.

C. Remote-Mounted Status Panel:
   1. Cooling/Off/Heating Controls: Control operational mode.
   2. Damper Position: Indicate position of outdoor-air dampers in terms of percentage of outdoor air.
   3. Status Lights:
a. Filter dirty.
b. Fan operating.
c. Cooling operating.
d. Heating operating.
e. Smoke alarm.
f. General alarm.

4. Digital Numeric Display:
   a. Outdoor airflow.
   b. Supply airflow.
   c. Outdoor dry-bulb temperature.
   d. Outdoor dew point temperature.
   e. Space temperature.
   f. Supply temperature.
   g. Space relative humidity.
   h. Space carbon dioxide level.

D. Control Dampers:
   1. Damper Location: Factory installed inside unit for ease of blade axle and
      bushing service. Arrange dampers located in a mixing box to achieve
      convergent airflow to minimize stratification.
   2. Damper Leakage: Comply with requirements in AMCA 500-D. Leakage shall not
      exceed 6.5 cfm per sq. ft. at a static-pressure differential of 4.0 inches water
      column when a torque of 5 inch pounds per sq. ft. is applied to the damper
      jackshaft.
   3. Damper Rating: Rated for close-off pressure equal to the fan shutoff pressure.
   4. Damper Label: Bear the AMCA seal for both air leakage and performance.
   5. Blade Configuration: Unless otherwise indicated, use parallel blade configuration
      for two-position control and equipment isolation service and use modulating
      control when mixing two airstreams. For other applications, use an opposed-
      blade configuration.
   7. Blade Type: Single-thickness metal reinforced with multiple V-grooves or hollow-
      shaped airfoil.
   8. Blade Material: Extruded aluminum, galvanized steel, or stainless steel.
   11. Blade Seals: Replaceable, continuous perimeter vinyl seals and jambs with
      stainless-steel compression-type seals.
   13. Airflow Measurement:
       a. Monitoring System: Complete and functioning system of airflow
          monitoring as an integral part of the damper assembly where indicated.
       b. Remote Monitoring Signal: 0-10 volt or 4-20 mA scaled signal.
       c. Accuracy of flow measurement: Within 5 percent of the actual flow rate
          between the range of the scheduled minimum and maximum airflow. For
          units with a large range between minimum and maximum airflow,
          configure the damper sections and flow measurement assembly as
          necessary to comply with accuracy.
       d. Straightening Device: Integral to the flow measurement assembly if
          required to achieve the specified accuracy as installed.
       e. Flow measuring device: Suitable for operation in untreated and unfiltered
          outdoor air. If necessary, include temperature and altitude compensation
          and correction to maintain the accuracy.

E. Damper Operators:
   1. Factory-installed electric operator for each damper assembly with one operator
      for each damper assembly mounted to the damper frame.
   2. Operator capable of shutoff against fan pressure and able to operate the damper
with sufficient reserve power to achieve smooth modulating action and proper speed of response at the velocity and pressure conditions to which the damper is subjected.

3. Maximum Operating Time: Open or close damper 90 degrees in 90 seconds.
4. Adjustable Stops: For both maximum and minimum positions.
5. Position Indicator and Graduated Scale: Factory installed on each actuator with words "OPEN" and "CLOSED," or similar identification, at travel limits.
6. Spring-return operator to fail-safe; either closed or open as required by application.
7. Operator Type: Direct coupled, designed for minimum 60,000 full-stroke cycles at rated torque.

F. Refrigeration System Controls:
1. Unit-mounted enthalpy controller shall lock out refrigerant system when outdoor-air enthalpy is less than 28 Btu/lb of dry air or outdoor-air temperature is less than 60 deg F.
2. Outdoor-air sensor de-energizes dehumidifier operation when outdoor-air temperature is less than 60 deg F.
3. Relative-humidity sensor energizes dehumidifier operation when relative humidity is more than 50 percent.

G. Damper Controls: Space pressure sensor modulates outdoor- and return-air dampers to maintain a positive pressure in space at a minimum of 0.05 inch wg with respect to outdoor reference.

H. DDC Temperature Control: Standalone control module for link between unit controls and DDC temperature-control system. Control module shall be compatible with control system specified in Section 230900 "Instrumentation and Control for HVAC." Links shall include the following:
1. Start/stop interface relay, and relay to notify DDC temperature-control system alarm condition.
2. Hardware interface or additional sensors for the following:
   a. Room temperature.
   b. Discharge-air temperature.
   c. Refrigeration system operating.
   d. Furnace operating.
   e. Constant and variable motor loads.
   f. Variable-frequency-controller operation.
   g. Cooling load.
   h. Economizer cycles.
   i. Air-distribution static pressure and ventilation-air volumes.

I. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display unit status and alarms.

2.12 ACCESSORIES
A. Service Lights and Switch: Factory installed in each accessible section with weatherproof cover. Factory wire lights to a single-point field connection.

B. Duplex Receptacle: Factory mounted in unit supply-fan section, with 20 amp 120 V GFI duplex receptacle and weatherproof cover

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 piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.

C. Examine roof curbs and equipment supports for suitable conditions where units will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Comply with manufacturer's rigging and installation instructions for unloading units and moving to final locations.

B. Curb Support: Install roof curb on roof structure according to "The NRCA Roofing Manual."
   1. Install and secure units on curbs and coordinate roof penetrations and flashing with roof construction.
   2. Coordinate size, installation, and structural capacity of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."
   3. Coordinate size, location, and installation of unit manufacturer's roof curbs and equipment supports with roof Installer.

C. Restrained Curb Support: Install restrained vibration isolation roof-curb rails on roof structure according to "The NRCA Roofing Manual."

D. Equipment Mounting:
   1. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
   2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

E. Install wall- and duct-mounted sensors furnished by manufacturer for field installation. Install control wiring and make final connections to control devices and unit control panel.

F. Install 3000-psi, compressive-strength (28-day) concrete base inside roof curb, 4 inches thick. Concrete and reinforcement are specified with concrete.


H. Install separate devices furnished by manufacturer and not factory installed.

I. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.

J. Install drain pipes from unit drain pans to sanitary drain.
   1. Drain Piping: Drawn-temper copper water tubing complying with ASTM B 88, Type L, with soldered joints.
   2. Drain Piping: Schedule 40 PVC pipe complying with ASTM D 1785, with solvent-welded fittings.
      a. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
      b. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
      c. Solvent cement and adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
   3. Pipe Size: Same size as condensate drain pan connection.
3.03 CONNECTIONS
A. Where installing piping adjacent to units, allow space for service and maintenance.

B. Gas Piping Connections:
1. Comply with requirements in Section 231123 “Facility Natural-Gas Piping.”
2. Connect gas piping to furnace, full size of gas train inlet, and connect with union, pressure regulator, and shutoff valve with sufficient clearance for burner removal and service.
3. Install AGA-approved flexible connectors.

C. Duct Connections:
1. Comply with requirements in Section 233113 “Metal Ducts.”
2. Drawings indicate the general arrangement of ducts.
3. Connect ducts to units with flexible duct connectors. Comply with requirements for flexible duct connectors in Section 233300 "Air Duct Accessories."

D. Electrical Connections: Comply with requirements for power wiring, switches, and motor controls in electrical Sections.
1. Install electrical devices furnished by unit manufacturer but not factory mounted.

3.04 STARTUP SERVICE
A. Engage a factory-authorized service representative to perform startup service.
1. Complete installation and startup checks according to manufacturer’s written instructions.
2. Inspect units for visible damage to refrigerant compressor, condenser and evaporator coils, and fans.
3. Start refrigeration system when outdoor-air temperature is within normal operating limits and measure and record the following:
   a. Cooling coil leaving-air, dry- and wet-bulb temperatures.
   b. Cooling coil entering-air, dry- and wet-bulb temperatures.
   c. Condenser coil entering-air dry-bulb temperature.
   d. Condenser coil leaving-air dry-bulb temperature.
4. Simulate maximum cooling demand and inspect the following:
   a. Compressor refrigerant suction and hot-gas pressures.
   b. Short-circuiting of air through outside coil or from outside coil to outdoor-air intake.
5. Inspect casing insulation for integrity, moisture content, and adhesion.
6. Verify that clearances have been provided for servicing.
7. Verify that controls are connected and operable.
8. Verify that filters are installed.
9. Clean coils and inspect for construction debris.
10. Clean furnace flue and inspect for construction debris.
11. Inspect operation of power vents.
12. Purge gas line.
13. Inspect and adjust vibration isolators and seismic restraints.
15. Clean fans and inspect fan-wheel rotation for movement in correct direction without vibration and binding.
16. Adjust fan belts to proper alignment and tension.
17. Start unit.
18. Inspect and record performance of interlocks and protective devices including response to smoke detectors by fan controls and fire alarm.
19. Operate unit for run-in period.
20. Calibrate controls.
22. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
23. Verify operational sequence of controls.
24. Measure and record the following airflows. Plot fan volumes on fan curve.
   a. Supply-air volume.
   b. Return-air flow.
   c. Outdoor-air flow.

B. After startup, change filters, verify bearing lubrication, and adjust belt tension.
C. Remove and replace components that do not properly operate and repeat startup procedures as specified above.
D. Prepare written report of the results of startup services.

3.05 ADJUSTING
A. Adjust initial temperature and humidity set points.
B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
C. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.05 DEMONSTRATION
A. Engage a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate, and maintain fans.

END OF SECTION
PART 1 - GENERAL

1.1 IMPOSED REGULATIONS

A. Applicable provisions of the State and Local Codes and of the following codes and standards in addition to those listed elsewhere in the specifications are hereby imposed on a general basis for electrical work: codes and standards listed on the electrical drawings.

1.2 SCOPE OF WORK

A. Provide all labor, materials, equipment and supervision to construct complete and operable electrical systems as indicated on the drawings and specified herein. All materials and equipment used shall be new, undamaged and free from any defects.

1.3 RELATED DOCUMENTS AND OTHER INFORMATION

A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the portions of work specified in each and every Section of this Division, individually and collectively.

1.4 EXISTING SERVICES AND FACILITIES

A. Damage to Existing Services: Existing services and facilities damaged by the Contractor through negligence or through use of faulty materials or workmanship shall be promptly repaired, replaced, or otherwise restored to previous conditions by the Contractor without additional cost to the Owner.

B. Interruption of Services: Interruptions of services necessary for connection to or modification of existing systems or facilities shall occur only at prearranged times approved by the Owner. Interruptions shall only occur after the provision of all temporary work and the availability of adequate labor and materials will assure that the duration of the interruption will not exceed the time agreed upon.

C. Removed Materials: Existing materials made unnecessary by the new installation shall be stored on site. They shall remain the property of the Owner and shall be stored at a location and in a manner as directed by the Owner. If classified by the Owner's authorized representative as unsuitable for further use, the material shall become the property of the Contractor and shall be removed from the site at no additional cost to the owner.

1.5 PRODUCT WARRANTIES

A. Provide manufacturer's standard printed commitment in reference to a specific product and normal application, stating that certain acts of restitution will be performed for the Purchaser or Owner by the manufacturer, when and if the product fails within certain operational conditions and time limits. Where the warranty requirements of a specific specification section exceed the manufacturer's standard warranty, the more stringent requirements will apply and modified manufacturer's warranty shall be provided. In no case shall the manufacturer's warranty be less than one (1) year.

1.6 PRODUCT SUBSTITUTIONS

A. General: Materials specified by manufacturer's name shall be used unless prior approval of an alternate is given by addenda. Requests for substitutions must be received in the office of
the Architect at least 10 days prior to opening of bids.

1.7 ELECTRICAL DRAWINGS

A. Electrical contract drawings are diagrammatic and indicate the general arrangement of electrical equipment. Do not scale electrical plans. Obtain all dimensions from the Architect's dimensioned drawings and field measurements. The Contractor shall review Architectural plans for door swings and built-in equipment; conditions indicated on those plans shall govern for this work.

B. Coordinate installation of electrical equipment with the structural and mechanical equipment and access thereto. Coordinate exterior electrical work with civil and landscaping work.

C. Discrepancies shown on different drawings, between drawings and specifications or between documents and field conditions shall be installed to provide the better quality or greater quantity of work; or, comply with the more stringent requirement; either or both in accordance with the A/E’s interpretation.

1.8 SYSTEMS REQUIRING ROUGH-IN

A. Rough-in shall consist of all outlet boxes/raceway systems/supports and sleeves required for the installation of cables/devices by other Divisions and by the Owner. It shall be the responsibility of this Contractor to determine the requirements by reviewing the contract documents and meeting with the Superintendent of the trade involved and Owner’s representative to review submittal data, shop drawings, etc.

B. Sealing of all sleeves, to meet the fire rating of the assembly, whether active or not, is work of this Division.

1.9 SUBMITTALS

A. Refer to section 260510

PART 2 - PRODUCTS

2.1 FIRESTOPPING:

A. Refer to Division 07 sections for additional requirements.

B. A firestop system shall be used to seal penetrations of electrical conduits and cables through fire-rated partitions per the NEC. The firestop system shall be qualified by formal performance testing in accordance with ASTM E-814, or UL 1479.

C. The firestop system shall consist of a fire-rated caulk type substance and a high temperature fiber insulation. It shall be permanently flexible, waterproof, non-toxic, smoke and gas tight and have a high adhesion to all solids so damming is not required. Only metal conduit shall be used in conjunction with this system to penetrate fire rated partitions. Install in strict compliance with manufacturer's recommendations. 3M, Hilti, STI or equal

D. Comply with TIA/EIA-569-A, Annex A, "Firestopping."

E. Comply with BICSI TDMM, "Firestopping Systems" Article.
A. Except where more stringent requirements are indicated, comply with the product manufacturer's installation instructions and recommendations, including handling, anchorage, assembly, connections, cleaning and testing, charging, lubrication, startup, test operation and shut-down of operating equipment. Consult with manufacturer's technical experts, for specific instructions on unique product conditions and unforeseen problems.

B. Protection and Identification: Deliver products to project properly identified with names, models numbers, types, grades, compliance labels and similar information needed for distinct identifications; adequately packaged or protected to prevent deterioration during shipment, storage and handling. Store in a dry, well ventilated, indoor space, except where prepared and protected by the manufacturer specifically for exterior storage.

C. Permits and Tests: Provide labor, material and equipment to perform all tests required by the governing agencies and submit a record of all tests to the Owner or his representative. Notify the Architect five days in advance of any testing.

D. Install temporary protective covers over equipment enclosures, outlet boxes and similar items after interiors, conductors, devices, etc. are installed, to prevent the entry of construction debris and to protect the installation during finish work performed by others. Do not install device plates, equipment covers or trims until finish work is complete.

E. Clean all equipment, inside and out, upon completion of the work. Scratched or marred surfaces shall be touched-up with touch-up paint furnished by the equipment manufacturer.

F. Replace all equipment and materials that become damaged.

G. No more than three phase conductors, each of opposite phases for a three phase WYE system, shall be combined in a single raceway unless written approval is granted by the engineer or noted otherwise on the construction documents. (For 120 volt and 277 volt receptacle and lighting circuits are no more than 3 circuits unless written approval is granted by the engineer or noted otherwise on the construction documents.)

3.2 LOW VOLTAGE CABLING SEPARATION FROM EMI SOURCES

A. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.

B. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
   1. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches
   2. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches
   3. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches

C. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
   1. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches
   2. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches
   3. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches

D. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
2. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches
3. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches

E. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches

F. Separation between Cables and light fixtures: A minimum of 5 inches

3.3 EQUIPMENT PROTECTION

A. Equipment and materials shall be protected during shipment and storage against physical damage, vermin, dirt, corrosive substances, fumes, moisture, cold and rain.

B. Store equipment indoors in clean dry space with uniform temperature to prevent condensation. Equipment shall include but not be limited to switchgear, switchboards, panelboards, transformers, motor control centers, motor controllers, uninterruptible power systems, enclosures, controllers, circuit protective devices, cables, wire, light fixtures, electronic equipment, and accessories.

C. During installation, equipment shall be protected against entry of foreign matter; and be vacuum-cleaned both inside and outside before testing and operating. Compressed air shall not be used to clean equipment. Remove loose packing and flammable materials from inside equipment.

D. Damaged equipment shall be, as determined by the Engineer, placed in first class operating condition or be returned to the source of supply for repair or replacement.

E. Painted surfaces shall be protected with factory installed removable heavy kraft paper, sheet vinyl or equal.

F. Damaged paint on equipment and materials shall be refinished with the same quality of paint and workmanship as used by the manufacturer so repaired areas are not obvious.

3.4 UTILITY CONNECTIONS:

A. Coordinate the connection of the electrical system with the local power company. Comply with the requirements of governing regulations, franchised service companies and controlling agencies. Pay all utility fees and charges.

3.5 ELECTRICAL WORK:

A. Electrical work shall be accomplished with all affected circuits or equipment de-energized. When an electrical outage cannot be accomplished in this manner for the required work, the following requirements are mandatory:

1. Electricians must use full protective equipment (i.e., certified and tested insulating material to cover exposed energized electrical components, certified and tested insulated tools, etc.) while working on energized systems in accordance with NFPA 70E.

2. Electricians must wear personal protective equipment while working on energized systems in accordance with NFPA 70E.

3. Before initiating any work, a job specific work plan must be developed by the contractor with a peer review conducted and documented by the Contractor. The work plan must include procedures to be used on and near the live electrical
equipment, barriers to be installed, safety equipment to be used and exit pathways. This plan is subject to review and comment by the owner.

B. Nothing in the above shall impose any duty on the Architects and Architect’s consultants, nor relieve the General Contractor and its subcontractors of its obligations, duties and responsibilities including but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending and coordinating the Electrical Work in accordance with the Contract Documents and any health or safety precautions required by any regulatory agencies.

END OF SECTION 26 05 00
PART 1 - GENERAL

1.1 SUBMITTALS
   A. Refer to section 26 05 10.

1.2 References

1.3 SCOPE OF WORK
   A. Acceptance tests shall be performed in accordance with the current version of ANSI/NETA ATS
   B. Tests shall be performed in accordance with applicable codes, standards, and equipment manufacturers’ instruction.
   C. The Contractor shall provide all test equipment, materials and labor necessary to perform the tests, and shall coordinate with the other trades for necessary services, such as scaffolding and the uncoupling of motors.
   D. Tests shall consist of visual inspections, manual operations, and electrical testing under all normal and expected abnormal operating conditions.
   E. The Owner shall be notified at least 2 weeks in advance of all tests.
   F. Tests shall be witnessed by the Engineer unless such witnessing is waived in writing.
   G. The Engineer shall be provided with a written test report, signed and dated, for all tests.
   H. Acceptance testing shall be provided and reviewed by the Engineer prior to energizing of electrical equipment. Phasing may require multiple trips/tests/reports and after hours work.

1.4 TESTING CRITERIA
   A. High potential tests shall be performed at the AC or DC voltage listed in ANSI/NETA ATS unless specified otherwise herein. Do not perform more than one high potential test on any item without authorization from the Owner.
   B. Dielectric absorption tests shall be performed with a 2,500 volt DC megger.
   C. Megger tests shall be performed at a DC voltage of 1,000 volts for 600 volt rated equipment, and at a DC voltage of 500 volts for 120-300 volt rated equipment.
   D. Continuity checks shall be performed with a low voltage DC meter, light or bell.
   E. The resistance to ground shall be measured using either the three point method or the fall of potential method.
   F. Test instruments shall be calibrated to national standards to ensure the accuracy of tests. These calibration reports shall be made available to the Owner when requested. Depending upon frequency of use, the instruments shall be calibrated at least every 12 months.
PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 VISUAL INSPECTIONS

A. Prior to manual operation and electrical testing, verify the following:
   1. The equipment is free from damage and defects.
   2. The equipment has been lubricated.
   3. The ventilation louvers are open and unobstructed.
   4. Electrical connections have been tightened.
   5. Voltages, phases, and rotation have been identified.
   6. Terminations have been identified.
   7. Equipment labels have been installed.
   8. The equipment has been calibrated.
   9. The equipment is ready to be electrically tested

3.2 MANUAL OPERATIONS

A. Prior to electrical testing, verify the following:
   1. Mechanical components operate smoothly and freely.
   2. Mechanical stops, limit switches, etc., are properly adjusted.

3.3 ELECTRICAL ACCEPTANCE TESTS

A. Duct Banks
   1. A stiff bristled brush shall be pulled through each duct to clean out dirt and debris.
   2. A solid mandrel rated for the inside diameter of the ducts and at least 5 inches long shall be pulled through each duct to verify the absence of kinks, flat spots, and other obstructions.

B. 600 Volt Power Cables
   1. A continuity check and a 1,000 volt DC megger test shall be performed on 600 volt power cables No. 4 AWG and larger. The megger test shall be performed between each pair of conductors and from each conductor to ground. Each test shall be performed for 15 seconds or until the insulation resistance value stabilizes.
   2. The insulation resistance between conductors, and from each conductor to ground, shall be 100 megohms minimum in one minute or less. In addition, the lowest insulation resistance value shall not differ from the highest value by more than 20 percent. If all megger readings for a given circuit are above 1000-megohms, the 20 percent balance requirement may be waived.
   3. Proper rotation shall be verified.

C. Control Cable
   1. A continuity check shall be performed on control and instrumentation wiring.

D. Transformers, Reactors, Switchboards, Panelboards, and Motor Control Equipment
   1. A continuity check and a 1,000 volt DC megger test shall be performed on distribution and isolation transformers, and on line reactors.
   2. A 1,000 volt DC megger test shall be performed on buses, motor starters, circuit breakers, and disconnect switches. This test may be combined with the power cable megger test by testing the devices and terminated cables together.
3. A continuity check shall be performed on motor control circuits and control panel internal wiring.
4. An operational test shall be performed on the motor controls.
5. Motor heater sizes shall be checked for proper size.
6. Test all shunt trip and under voltage circuit breakers.
7. Measure the resistance of each winding at each tap connection.
8. Overpotential test on all high- and low-voltage windings-to-ground.

E. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panel, and enclosed Bus. Remove all access panels so joints and connections are accessible to portable scanner.
1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
2. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

F. Grounding
1. Upon completion of installation of electrical grounding system, test resistance of each ground rod installation using the "Fall of Potential" method. Ground resistances shall be measured in normally dry conditions not less than 48 hours after rainfall and at low tide. Where tests show resistance to ground is over the specified value, take appropriate action to reduce resistance by driving additional sections of ground rods and then retest to demonstrate compliance. Tests shall be conducted in the presence of the Project Electrical Engineer. Provide forms to record the data as the tests are conducted. Forms shall be signed by the person conducting the test and included with project closeout documents.

END OF SECTION 26 05 02
PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with the applicable requirements of the Division 1 specifications (01 33 00) and the requirements of this Division of the specifications.

1.2 SUBMITTALS

A. Submit for review by the Engineer Architect a schedule with engineering data of materials and equipment to be incorporated in the work. Submittals shall be supported by descriptive materials, i.e., catalog sheets, product data sheets, diagrams, performance curves and charts published by the manufacturer, warranties, etc., to show conformance to Specifications and Plan requirements; model numbers alone shall not be acceptable. Data submitted for review shall contain all information to indicate compliance with Contract Documents. Complete electrical characteristics shall be provided for all equipment. Submittals for lighting fixtures shall include Photometric Data. The Engineer reserves the right to require samples of any equipment to be submitted for review.

B. The purpose of shop drawing review is to demonstrate to the Architect that the Contractor understands the design concept. The Architect's review of such drawings, schedules, or cuts shall not relieve the Contractor from responsibility for deviations from the drawings or specifications unless he has, in writing, called the Architect's attention to such deviation at the time of submission, and received written permission from the Architect for such deviations.

C. Where cut sheets include an entire product family, mark all specific items to be utilized for this project on equipment cut sheets. Generic cut sheets with no indication of which items on the cut sheet shall be used will be rejected.

D. Response to Submittals: Shop drawings shall be returned by the Electrical Engineer with the following classifications:

1. "No Exceptions Taken": No corrections, no marks. Contractor shall submit copies for distribution

2. "Make Corrections Noted": A few minor corrections. Items may be ordered as marked up without further resubmission. Submit copies for distribution.

3. "Amend and Resubmit": Minor corrections. Item may be ordered at the Contractor's risk. Contractor shall resubmit drawings with corrections noted.

4. "Rejected - Resubmit": Major corrections or not in accordance with the contract documents. No items shall be ordered. Contractor shall correct and resubmit drawings.

E. Prior Approvals and Shop Drawings must be hand delivered, received by mail, or email.

F. Equipment and materials requiring submittals:

1. Section 26 05 00 – Common Work Results for Electrical
   a. Product Warranties
   b. Firestopping Materials
   c. Firestopping Installation Drawings for each conduit penetration, cable in metal sleeve penetration and blank metal sleeve penetration for each type of wall/floor penetration.
construction encountered.

2. Section 26 05 02 – Electrical Acceptance Tests
   a. Test Reports
   b. Testing Company Qualifications.

3. Section 26 05 11 – Electrical Work Closeout
   a. Record Drawings
   b. Record Manuals
   c. Close out submittals
   d. Training verification

4. Section 26 05 12 – Electrical Coordination
   a. Coordination Affidavit
   b. Electrical Coordination Drawings
   c. Electrical schedule Gantt Chart

5. Section 26 05 19 – Low-Voltage Electrical Conductors and Cables
   a. Splice Kits
   b. Waterproof Wire Connectors
   c. Wire
   d. Field Quality Control Test Reports

6. Section 26 05 23 – Control Voltage Electrical Power Cables
   a. Cables and wire

7. Section 26 05 26 – Grounding and Bonding for Electrical Systems
   a. Ground Rods
   b. Grounding Connections
   c. Ground Wire
   d. Field Quality Control Test Reports
   e. Bonding Bushings
   f. Bonding Jumper Braid
   g. "Water Valve" Enclosures
   h. Ground buss bars

8. Section 26 05 29 – Hangers and Supports for Electrical Systems
   a. Product Data

9. Section 26 05 33 – Raceway and Boxes for Electrical Systems
   a. Raceway
   b. Boxes
   c. Enclosure ratings
   d. Dimension data
   e. Corrosion Protection
   f. Hazardous Location Conduit Bodies, Fittings, Outlet Boxes, and Covers
   g. Surface Metallic/Nonmetallic Raceway
   h. Cast Outlet/Device Boxes

10. Section 26 05 43 – Underground Ducts and Raceways for Electrical Systems
    a. Raceway
    b. Handholes
    c. Warning Tape
11. Section 26 05 48 – Vibration and Seismic Controls for Electrical Systems
   a. Submit seismic force level (Fp) calculations from applicable building code.
   b. Submit pre-approved restraint selections and installation details
   c. Restraint selection and installation details shall be sealed by a professionally licensed engineer experienced in seismic restraint design.
   d. Submit manufacturer’s product data on strut channels including, but not limited to, types, materials, finishes, gauge thickness, and hole patterns. For each different strut cross-section, submit cross sectional properties including Section Modulus (Sx) and Moment of Inertia (Ix).
   e. Electrical equipment seismic certification (These certificates can be submitted with the product data in the equipment specification)
   f. Field reports

12. Section 26 05 53 – Identification for Electrical Systems
   a. Product data for all labeling products
   b. Samples of device name plates

13. Section 26 05 74 – Short Circuit, Overcurrent Protection, Arc Flash Hazard Analysis
   a. Provide study per specification.

14. Section 26 08 00 – Electrical Commissioning

15. Section 26 09 23 – Lighting Control Devices
   a. Lighting Contactors
   b. Lighting Control Panels
   c. Photo Cells.
   d. Enclosures
   e. Dimensional Data
   f. Wiring Diagrams
   g. Time Clock
   h. Short Circuit Current Rating

16. Section 26 24 00 – Switchboards and Panelboards
   a. Product data
   b. Enclosures
   c. Dimensional Data
   d. Circuit Directory
   e. Circuit Breaker trip curves
   f. Locks
   g. Shunt-Trip Breakers
   h. Busing Diagrams
   i. Ground-Fault Protection
   j. Schematic Wiring Diagram
   k. Layout Drawings and elevations
   l. Short Circuit Current Rating
   m. Device nameplate data.
   n. Electrical equipment seismic certification

17. Section 26 27 26 – Wiring Devices
   a. Product data
   b. Device Plates
   c. Weatherproof Covers
   d. Special Purpose Receptacles
   e. Dimmer Switches
   f. Occupancy Sensors
   g. Occupancy Sensor Wiring Diagrams
h. Occupancy Sensor Layout Drawings showing location and orientation of each sensor.
   i. Device and device plate colors

18. Section 26 28 16 – Enclosed Switches and Circuit Breakers
   a. Product data
   b. Enclosures
   c. Dimensional Data
   d. Control Wiring Diagrams
   e. Accessories
   f. Short Circuit Current Rating
   g. Test reports
   h. Indicate on the submittal the name of the load served by each device submitted.
   i. Electrical equipment seismic certification

19. Section 26 43 00 – Surge Protective Devices
   a. Unit dimensions
   b. Installation instructions
   c. Product data
   d. Warranty statement
   e. Current Ratings
   f. Clamping Voltages
   g. Response Time
   h. Enclosure

20. Section 26 51 00 – Interior Lighting
   a. Lighting Fixtures
   b. Ballasts
   c. Lamps
   d. Emergency Ballasts
   e. Emergency transfer units
   f. Color Samples

21. Section 26 56 00 – Exterior Lighting
   a. Lighting Fixtures
   b. Ballasts
   c. Lamps
   d. Emergency Ballasts
   e. Poles and Accessories
   f. Color Samples

22. Section 27 11 01 – Equipment Racks
   a. Product Data
   b. Seismic Compliance Information

23. Section 27 13 00 – Communication Backbone Cabling
   a. Cable

24. Section 27 15 00 – Communications Horizontal Cabling
   a. Cabling administration drawings and printouts including labeling information.
   b. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
   c. Field quality-control reports.
   d. Cables
   e. Jacks
   f. Outlets
g. Faceplates
h. Faceplates colors
i. Termination blocks
j. Patch panels
k. Equipment enclosures
l. Racks
m. UPS units
n. TVSS and plug strip units
o. Cable supports
p. Cable management devices
q. Cable - Nominal OD, Minimum bending radius, Maximum pulling tension.
r. Shop Drawings:
s. Qualification Data: For Installer
t. Field quality-control reports.
u. Communications Backboard and Rack Layout Diagrams
w. Lightning Arrestors
w. Patch cords

25. Section 28 31 00 – Fire Detection and Alarm
a. Surge Protection
b. HVAC/Kitchen Hood/Egress Door/Elevator Recall Control Wiring Diagrams
c. Battery calculations.
d. Voltage drop calculations
e. Installer’s qualifications.
f. Conduit fill calculations.
g. Manufacturer's detailed data sheet for each control unit, initiating device, and notification appliance.
h. Device layout drawings with proposed conduit routing. Drawings must be prepared using AutoCAD Release 2017 or newer.
i. System riser diagram.
 j. List of all devices on each signaling line circuit, with spare capacity indicated.
k. Clear and concise description of operation, with input/output matrix similar to that shown in NFPA 72
l. Warranty
m. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
n. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
o. Submission to Authority Having Jurisdiction: In addition to routine submission of the above material, make an identical submission to the authority having jurisdiction. Include copies of shop drawings as required to depict component locations to facilitate review. Upon receipt of comments from the Authority, make resubmissions if required to make clarifications or revisions to obtain approval.
p. Inspection and Test Reports:
   1) Submit inspection and test plan prior to closeout demonstration
   2) Submit documentation of satisfactory inspections and tests.
   3) Submit NFPA 72 "Inspection and Test Form," filled out.

PART 2 - PRODUCTS

2.1 Not Used.

PART 3 - EXECUTION
3.1 MANUFACTURER’S DATA

A. Include the manufacturer’s comprehensive product data sheet and installation instructions. Where operating ranges are shown, mark data to show portion of range required for project application. Where pre-printed data sheet covers more than one distinct product-size, type, material, trim, accessory group or other variations, delete or mark-out portions of the pre-printed data which are not applicable.

3.2 EQUIPMENT LIST

A. Where more than one type of a product is being used (i.e. starters, disconnects, breakers, etc.) provide a list with each submittal correlating the type and size of product to the load served.

3.3 TEST REPORTS

A. Submit test reports which have been signed and dated by the firm performing the tests, and prepare in the manner specified in the standard or regulation governing the tests procedure as indicated.

END OF SECTION 26 05 10
SECTION 26 05 11
ELECTRICAL WORK CLOSEOUT

PART 1 - GENERAL

1.1 SUBMITTALS
   A. Refer to section 26 05 10.

1.2 RELATED SECTIONS
   A. Refer to section 01 78 39 for additional requirements.

PART 2 - PRODUCTS

2.1 RECORD DRAWINGS
   A. Except where otherwise indicated, electrical drawings prepared by Engineer are diagrammatic in nature and may not show locations accurately for various components of electrical system. Shop drawings, including coordination drawings, prepared by the Contractor show portions of work more accurately to scale and location, and in greater detail. It is recognized that actual layout of installed work may vary substantially from both Contractor drawings and shop drawings.
   
   B. The electrical superintendent shall maintain a white set of contract documents and shop drawings in clean, undamaged condition, for mark-up of actual installations which vary substantially from the work as shown. PDF or digital mark-ups is acceptable alternates Mark-up whatever drawings are most capable of showing installed conditions accurately. However, where shop drawings are marked, record a reference note on appropriate contract drawings. Mark with erasable pencil, and use multiple colors to aid in the distinction between work of separate electrical systems. These documents shall be used for no other purpose. In general, record every substantive installation of electrical work which previously is either not shown or shown inaccurately, but in any case record the following:
      1. Post all addenda prior to beginning work.
      2. Underground feeder conduits, both interior and exterior, drawn to scale and fully dimensioned.
      3. Work concealed behind or within other work, in a non-accessible arrangement.
      4. Mains and branches of wiring systems, with panelboards and control devices located and numbered, with concealed splices located, and with devices requiring maintenance located.
      5. Scope of each change order (C.O.), noting C.O. number.
   
   C. Upon each visit by the Architect/Engineer, the Contractor shall demonstrate that the record documents are being kept current, as specified hereinbefore.

2.2 RECORD MANUALS
   A. Record manuals shall include the following:
      1. Manufacturer’s operation and maintenance manuals for:
         a. Light Fixtures
         b. Loadcenters, Panelboards and Circuit Breakers
         c. Surge Protection Devices
         d. Fire Alarm System
         e. Switchboards
         f. Electrical Meters
g. Lighting Control Systems

2. Shop drawings, revised to reflect all review comments, supplemented with the installation instructions shipped with equipment.
3. One copy of all panelboard directories.
4. All field test Reports
5. Electrical Contractor's Warranty
6. Fire alarm set of floor plans showing actual installed locations of components, conduit, and zones.
7. Fire Alarm "As programmed" operating sequences, including control events by device, updated input/output chart, and voice messages by event.

B. Submit record manuals in quantities and in the format prescribed in the Division 1 specifications.

C. Submit copies of all Maintenance contracts including:
    1. Fire Alarm Systems.

2.3 CLOSEOUT SUBMITTALS

A. Software and Firmware Operational Documentation:
    1. Software operating and upgrade manuals.
    2. Program Software Backup: On USB drive, complete with data files.
    3. Device address list.
    4. Printout of software application and graphic screens.

PART 3 - EXECUTION

3.1 SITE VISITS

A. At all construction observations by the Architect/Engineer, the Contractor shall demonstrate to the Architect/Engineer that all work is complete in accordance with the contract documents and that all systems have been tested and are fully operational. The Contractor shall furnish the personnel, tools and equipment required to inspect and test all systems.

3.2 TRAINING

A. Train Owner's personnel on the operation and maintenance of the following systems:
    1. Fire Alarm System - 2 hours
    2. Lighting Control Systems – 2 hours

B. Training shall not be conducted until system has been tested by the Contractor and is 100% operational. Refer to the individual specification sections for additional requirements.

END OF SECTION 26 05 11
PART 1 - GENERAL

1.1 SUBMITTALS
   A. Refer to section 260510.

PART 2 - PRODUCTS

2.1 ELECTRICAL WORK SCHEDULE
   A. After the award of contract, the Contractor shall prepare a detailed schedule (aka milestone chart) using "Microsoft Project" software or equivalent. The Contractor Project Schedule (CPS) shall indicate detailed activities for the projected life of the project. The CPS shall consist of detailed activities and their restraining relationships. It will also detail manpower usage throughout the project.

   B. Electrical Work Schedule: Provide a Gantt chart for review by the Engineer and Owner at least 10-days prior to beginning work. The chart shall have color-coding to distinguish between demolition and renovation tasks as well as any other specific tasks. The Gantt chart shall include the following items:
      1. Date of on-site arrival of electrical equipment and accessories required for system installation.
      2. Estimated dates and duration of all service outage times.
      3. Estimated start date and completion date for the demolition.
      4. Estimated dates and duration of required work access to areas that are not in the current phase of work.

2.2 ELECTRICAL COORDINATION DRAWINGS
   A. Electrical Rooms: Provide layouts of all electrical rooms using the dimensions of equipment actually furnished. Locate all ducts and piping entering or crossing these spaces.

   B. Feeders over 100 Amps: The routing of main feeders is not shown on the drawings. Actual routing shall be determined by the contractor in accordance with the specifications and shall be coordinated with work by other trades. For underground lines, show all utility crossings.

   C. Drawing Format: Drawings shall be prepared at a scale of no less than 1/16"=1'-0" for feeder routes and 1/4"=1'-0" for electrical rooms/equipment yards. Drawing shall be titled to define Project Name, Drawing subject and date prepared. Drawings are to be prepared in AutoCAD 2007 or compatible software.

2.3 EQUIPMENT REQUIRING ELECTRICAL SERVICE
   A. Provide electrical connections for all electrically driven equipment. Final connections are electrical work, except as otherwise noted. Obtain a copy of the shop drawings of equipment. Review shop drawings to verify electrical characteristics and to determine rough-in requirements, final connection requirements, location of disconnect switch, etc. Notify the General Contractor if the information received is ambiguous or incomplete. Keep a copy of these shop drawings at the project site throughout the course of construction.

   B. Equipment to be connected includes, but is not limited to the following:
      1. HVAC Equipment
2. Fire Protection Equipment
3. Telephone/Computer Systems
4. Fire Alarm System
5. Control Systems

C. The design of circuits for electrically driven equipment is based on the product of one manufacturer and may not be representative of all acceptable manufacturers. If equipment furnished has differing characteristics, make necessary adjustments to circuit components at no additional cost to the Owner, subject to the approval of the Engineer.

D. Provide motor starters and disconnects for all mechanical equipment unless provided by the mechanical contractor.

PART 3 - EXECUTION

3.1 COORDINATION OF MECHANICAL INSTALLATION:

A. Attachment Number 1 shall be filled out and returned with shop drawing submittals. The intent of Attachment Number 1 is to ensure that the electrical requirements for equipment have been reviewed and coordinated by the Contractor. No electrical equipment shall be ordered, nor shall rough-in begin, before this coordination has taken place. This document shall be returned appropriately marked whether or not any changes are deemed to be necessary by the contractor.
ATTACHMENT NO. 1

SHOP DRAWING COORDINATION AFFIDAVIT

I, the undersigned, certify that I have reviewed the equipment shop drawings for electrically driven equipment and that the accompanying electrical shop drawings reflect the requirements of the actual equipment to be furnished for use on this project. The following deviations from design drawings were required to serve the furnished equipment:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>CKT. DESIG.</th>
<th>BKR. SIZE</th>
<th>CONDUIT/WIRE</th>
<th>DISC. SIZE</th>
<th>STARTER</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>New</td>
<td>Old</td>
<td>New</td>
<td>Old</td>
<td>New</td>
</tr>
</tbody>
</table>

NOTE: If no deviations are required please indicate by circling the appropriate answer above your signature.

PROJECT: ___________________________  DEVIATIONS: Yes / No

COMPANY: ________________________________________________________________

TITLE: ___________________  SIGNATURE: ________________________

TELEPHONE: __________________ DATE: ________________________________

IT IS THE RESPONSIBILITY OF THE DIVISION 26 CONTRACTOR TO OBTAIN SHOP DRAWING INFORMATION FROM OTHER TRADES. FAILURE TO PERFORM THE WORK REQUIRED BY THIS AFFIDAVIT, PRIOR TO ORDERING MATERIALS OR ROUGHING-IN, MAY RESULT IN IMPROPER CONNECTIONS BEING PROVIDED. THE EXPENSE OF CORRECTIVE MEASURES, IF REQUIRED, SHALL BE BORNE BY THE CONTRACTOR.

NOTE:
PANELBOARD SHOP DRAWINGS WILL NOT BE REVIEWED UNTIL THE ELECTRICAL CONTRACTOR COMPLETES AND SUBMITS THIS AFFIDAVIT TO THE ELECTRICAL ENGINEER.

END OF SECTION 260512
LOW-VOLTAGE ELECTRICAL CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY
   A. This section includes the requirements for the following:
      1. Wire and cable for 600 volts and less.
      2. Wiring connectors and connections.

1.2 SUBMITTALS
   A. Refer to section 26 05 10.

1.3 QUALITY ASSURANCE
   A. Conform to requirements of NFPA 70.
   B. Furnish products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.4 REFERENCE STANDARDS

PART 2 - PRODUCTS

2.1 WIRING REQUIREMENTS
   A. Concealed Dry Interior Locations: Use only THHN-2, THWN-2 or XHHW-2 wire in raceway.
   B. Exposed Dry Interior Locations: Use only THHN-2, THWN-2, or XHHW-2 in raceway.
   C. Above Accessible Ceilings: Use only THHN-2, THWN-2, or XHHW-2 in raceway.
   D. Wet or Damp Interior Locations: Use only THWN-2 or XHHW-2 in raceway.
   E. Exterior locations (above or below grade) THWN-2, XHHW-2 or USE in raceway.
   F. Use conductors not smaller than 12 AWG for power and lighting circuits.
   G. Use conductors not smaller than 14 AWG for control circuits.
   H. Metal Clad (MC) cable shall not be used unless prior approval has been granted by the architect and engineer.

2.2 BUILDING WIRE
A. Conductor: Copper.

B. Insulation Voltage Rating: 600 volts.

C. Temperature Rating: 90°C.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Pull all conductors into raceway at same time.

B. Use suitable wire pulling lubricant for building wire 4 AWG and larger. Do not exceed manufacturers recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.

D. Neatly train and lace wiring inside boxes, equipment, and panelboards.

E. Clean conductor surfaces before installing lugs and connectors.

F. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.

G. Use split bolt connectors or compression fittings for splices and taps on conductors 6 AWG and larger. Tape uninsulated conductors and connector with electrical tape to 150 percent of insulation rating of conductor.

H. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.

I. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.

J. Tighten electrical connectors and terminals according to manufacturer’s published torque-tightening values or UL 486A and UL 486B.

K. Identify and color code wire and cable under provisions of Section 26 05 53. Identify each conductor with its circuit number or other designation indicated.

L. For each electrical connection/termination, provide a complete assembly of materials, including but not necessarily limited to, pressure connectors, terminals (lugs), electrical insulating tape, heat-shrinkable insulating tubing, cable ties, solderless wire nuts, and other materials necessary to complete splices and terminations. Torque all connections according to installation instructions.

M. Motor connections shall be made with compression connectors forming a bolted in-line or stub-type connection.

N. Splicing of feeder conductors shall not be acceptable, unless specifically indicated on the drawing. Where splicing of feeder conductors is indicated, splices shall be made using compression type butt splice.

O. All splices made underground or in the pipe basements shall be rated suitable for water immersion.
P. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for 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.

3.2 LABELING

A. Color Coding
   1. Color shall be green for grounding conductors and green with yellow stripe for isolated grounding conductors.
   2. The color of the circuit conductors shall be as follows:
      120/208 volt, 3-phase:  Phase A - Black  
                                Phase B - Red  
                                Phase C - Blue  
                                Neutral - White  
      277/480 volt, 3-phase:  Phase A - Brown  
                                Phase B - Orange  
                                Phase C - Yellow  
                                Neutral - Gray  

3.3 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA STD ATS, except Section 4.
B. Perform inspections and tests listed in NETA STD ATS, Section 7.3.2.

END OF SECTION 260519
SECTION 26 05 23
CONTROL-VOLTAGE ELECTRICAL CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Low-voltage control cabling.
   2. Control-circuit conductors.
   3. Identification products.

1.2 DEFINITIONS

A. EMI: Electromagnetic interference.
B. IDC: Insulation displacement connector.
C. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.
D. Open Cabling: Passing telecommunications cabling through open space (e.g., between the studs of a wall cavity).
E. UTP: Unshielded twisted pair.

1.3 SUBMITTALS
1. Refer to section 26 05 10

1.4 QUALITY ASSURANCE

A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Flame-Spread Index: 25 or less.
   2. Smoke-Developed Index: 50 or less

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

1.5 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install UTP and optical fiber cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

PART 2 - PRODUCTS

2.1 PATHWAYS

A. Support of Open Cabling: NRTL labeled for support of cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.
   1. Support brackets with cable tie slots for fastening cable ties to brackets.
   2. Lacing bars, spools, J-hooks, and D-rings.
   3. Straps and other devices.
B. Install all control voltage electrical cables in conduit. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems.

2.2 BACKBOARDS

A. Description: Plywood, fire-retardant treated, and painted.

2.3 UTP CABLE

A. Description: 100-ohm, four-pair UTP
   1. Comply with ICEA S-90-661 for mechanical properties.
   2. Comply with TIA/EIA-568-B.1 for performance specifications.
   3. Comply with TIA/EIA-568-B.2, Category 6
   4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
      a. Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.

2.4 UTP CABLE HARDWARE

A. UTP Cable Connecting Hardware: IDC type, using modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of the same category or higher.

B. Connecting Blocks: 110 style for Category 6 Provide blocks for the number of cables terminated on the block, plus 25 percent spare; integral with connector bodies, including plugs and jacks where indicated.

2.5 LOW-VOLTAGE CONTROL CABLE

A. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
   1. One pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
   2. PVC insulation.
   3. Unshielded.
   4. PVC jacket.
   5. Flame Resistance: Comply with NFPA 262.

B. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
   1. One pair, twisted, No. 18 AWG, stranded (19x30) tinned-copper conductors.
   2. Fluorinated ethylene propylene insulation.
   3. Unshielded.

2.6 CONTROL-CIRCUIT CONDUCTORS

A. Class 1 Control Circuits: Stranded copper, Type THHN-THWN, in raceway, complying with UL 83.

B. Class 2 Control Circuits: Stranded copper, Type THHN-THWN, in raceway or power-limited cable, concealed in building finishes complying with UL 83 and or UL 44.

C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type TW or Type TF, in raceway, complying with UL 83.
2.7 IDENTIFICATION PRODUCTS

A. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3 - EXECUTION

3.1 INSTALLATION OF PATHWAYS

A. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-A-7.

B. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.

C. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.

D. Install manufactured conduit sweeps and long-radius elbows if possible.

E. Pathway Installation in Equipment Rooms:
   1. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed or in the corner of room if multiple sheets of plywood are installed around perimeter walls of room.
   2. Install cable trays to route cables if conduits cannot be located in these positions.
   3. Secure conduits to backboard if entering room from overhead.
   4. Extend conduits 3 inches above finished floor.
   5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

3.2 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:
   2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
   3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
   4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
   5. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
   6. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
   7. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
   8. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:
2. Install 110-style IDC termination hardware unless otherwise indicated.
3. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.

D. Installation of Control-Circuit Conductors:
   1. Install wiring in raceways. Comply with requirements specified in Division 26 Section "Raceway and Boxes for Electrical Systems."

E. Open-Cable Installation:
   1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
   2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
   3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

3.3 REMOVAL OF CONDUCTORS AND CABLES
   A. Remove abandoned conductors and cables in construction area.

3.4 CONTROL-CIRCUIT CONDUCTORS
   A. Minimum Conductor Sizes:
      1. Class 1 remote-control and signal circuits, No 14 AWG.
      2. Class 2 low-energy, remote-control, and signal circuits, No. 16 AWG.
      3. Class 3 low-energy, remote-control, alarm, and signal circuits, No 12 AWG.

3.5 GROUNDING
   A. For data communication wiring, comply with ANSI-J-STD-607-A and with BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
   B. For low-voltage wiring and cabling, comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems."

3.6 IDENTIFICATION
   A. Identify system components, wiring, and cabling according to TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.7 FIELD QUALITY CONTROL
   A. Perform tests and inspections.
   B. Tests and Inspections:
      1. Visually inspect UTP jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA/EIA-568-B.1.
      2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
      3. Test UTP cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not after cross connection.
a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

END OF SECTION 260523
PART 1 - GENERAL

1.1 SUMMARY
A. Grounding and bonding components.
B. Provide all components necessary to complete the grounding system(s) consisting of:
   1. Existing and new metal underground water pipe.
   2. Metal frame of the building.
   3. Steel water storage tank and supports.
   4. Concrete-encased electrode.

1.2 SUBMITTALS
A. Refer to section 26 05 10.

1.3 QUALITY ASSURANCE
A. Conform to requirements of NFPA 70.

1.4 REFERENCES

1.5 PERFORMANCE REQUIREMENTS
A. Maximum grounding system resistance: 15 ohms.
B. Services at power company interface points shall comply with the power company ground resistance requirements.

PART 2 - PRODUCTS

2.1 ELECTRODES
A. Sectionalized steel with copper-welded exterior, 3/4" dia. x 10'. One 10-foot section shall be required at each ground rod location, unless as otherwise directed in this specification.

2.2 CONDUCTORS
A. Bonding Jumper Braid: Copper braided tape, sized for application.
B. Electrical Grounding conductors: Unless otherwise indicated, provide bare or green insulated
stranded copper electrical grounding conductors sized according to NEC or as shown or specified. Provide green insulated for conductors sized No. 10 AWG and smaller.

2.3 GROUND CONNECTIONS

A. Below Grade: Exothermic-welded type connectors.

B. Above Grade:
   1. Bonding Jumpers: compression type connectors, using zinc-plated fasteners and external tooth lock washers.
   2. Ground Busbars: Two-hole compression type lugs using tin-plated copper or copper alloy bolts and nuts.
   3. Rack and Cabinet Ground Bars: one-hole compression-type lugs using zinc-plated or copper alloy fasteners.

C. Install exothermic connectors and terminals as recommended by the connector and terminal manufacturer for intended applications.

D. Bolted clamp will not be accepted between grounding rods and ground conductors.

2.4 EQUIPMENT RACK AND CABINET GROUND BARS

A. Provide solid copper ground bars designed for mounting on the framework of open or cabinet-enclosed equipment racks with minimum dimensions of 3/8 inch x ¾ inch unless noted otherwise.

B. Busbar Connectors: Cast silicon bronze, solderless, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch (15.8- or 25.4-mm) centers for a two-bolt connection to the busbar.

C. Telecommunications Enclosures and Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install top-mounted rack grounding busbar unless the enclosure and rack are manufactured with the busbar. Bond the equipment grounding busbar to the TGB No. 2 AWG bonding conductors.

D. Shielded Cable: Bond the shield of shielded cable to the TGB in communications rooms and spaces. Comply with TIA/EIA-568-B.1 and TIA/EIA-568-B.2 when grounding screened, balanced, twisted-pair cables.

E. Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.

2.5 GROUND TERMINAL BLOCKS

A. At any equipment mounting location (e.g. backboards and hinged cover enclosures) where rack-type ground bars cannot be mounted, provide screw lug-type terminal blocks.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify existing conditions prior to beginning work.

B. Verify that final backfill and compaction has been completed before driving rod electrodes.
3.2 ELECTRICAL AND COMMUNICATION ROOM GROUNDING

A. Building Earth Ground Busbars: Provide ground busbar hardware at each electrical and communication room and connect to pigtail extensions of the building grounding ring.

3.3 CONDUCTIVE PIPING

A. Bond all conductive piping systems (excluding fuel gas piping), interior and exterior, to the building to the grounding electrode system. Bonding connections shall be made as close as practical to the equipment ground bus.

B. Install braided type bonding jumpers with ground clamps on water meter piping to electrically bypass meter where the main is metallic on both sides of the meter. Install clamp-on connectors only on thoroughly cleaned metal contact surfaces, to ensure electrical conductivity and circuit integrity.

3.4 CORROSION INHIBITORS

A. When making ground and ground bonding connections, apply a corrosion inhibitor to all contact surfaces. Use corrosion inhibitor appropriate for protecting a connection between the metals used.

B. Where concrete penetration is necessary, non-metallic conduit shall be cast flush with the points of concrete entrance and exit so as to provide an opening for the ground wire and the opening shall be sealed with a suitable compound after installation of the ground wire.

3.5 SECONDARY EQUIPMENT AND CIRCUITS

A. Switchgear, Panelboards, Disconnects, Switchboards, Unit Substations, and Motor Control Centers; Connect metallic conduits, which terminate without mechanical connection to the housing, by grounding bushings and grounding conductor to the equipment ground bus.

B. Feeders and Branch Circuits: Install equipment grounding conductors with all feeders and power and lighting branch circuits, sized in accordance with Article 250 of NFPA 70.

C. Boxes, Cabinets, Enclosures, and Panelboards:
   1. Bond the equipment grounding conductor to each pullbox, junction box, outlet box, device box, cabinets, and other enclosures through which the conductor passes (except for special grounding systems for intensive care units and other critical units shown).
   2. Provide lugs in each box and enclosure for equipment grounding conductor termination.
   3. Provide ground bars in panelboards, bolted to the housing, with sufficient lugs to terminate the equipment grounding conductors.

D. Motors and Starters: Provide lugs in motor terminal box and starter housing or motor control center compartment to terminate equipment grounding conductors.

E. Receptacles shall not be grounded through their mounting screws. Ground with a jumper from the receptacle green ground terminal to the device box ground screw and the branch circuit equipment grounding conductor.
F. Fixed electrical appliances and equipment shall be provided with a ground lug for termination of the equipment grounding conductor.

G. Metallic Conduit: Metallic conduits which terminate without mechanical connection to an electrical equipment housing by means of locknut and bushings or adapters, shall be provided with grounding bushings. Connect bushings with a bare grounding conductor to the equipment ground bus.

3.6 INSTALLATION

A. Install ground electrodes at locations indicated. Provide additional electrodes as required to achieve specified resistance to ground.

B. Install nominal 10" diameter x 18" long fiberglass "water valve" type enclosure, with cover, over each ground rod. The top of ground rods shall be 12" below finished grade. The rod and exothermic connection to the grounding electrode conductor shall be accessible from within enclosure. Fill the lower 3" of enclosure with crushed rocks. Top of enclosure shall be flush with finished grade.

C. Make rebar in concrete footing around the perimeter of the building electrically continuous such that the resulting installation consists of a concrete encased electrode per Article 250 of the NEC. Extend No. 1/0 THWN grounding electrode conductors from convenient points along the "ground ring" to the equipment ground system.

D. If it is determined that the rebar cannot be made electrically continuous, install a No 1/0 bare copper conductor in the footing around the perimeter of the building.

E. Provide grounding electrode conductor and connect to reinforcing steel in foundation footing.

F. Bond together metal siding not attached to grounded structure; bond to ground.

G. Bond together reinforcing steel and metal accessories in pool and fountain structures.

3.7 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA STD ATS except Section 4.

B. Perform inspections and tests listed in NETA STD ATS, Section 7.13.

C. Upon completion of installation of electrical grounding system, test resistance of each ground rod installation using the "Fall of Potential" method. Ground resistances shall be measured in normally dry conditions not less than 48 hours after rainfall and at low tide. Where tests show resistance to ground is over the specified value, take appropriate action to reduce resistance by driving additional sections of ground rods and then retest to demonstrate compliance. Tests shall be conducted in the presence of the Project Electrical Engineer. Provide forms to record the data as the tests are conducted. Forms shall be signed by the person conducting the test and included with project closeout documents.

D. Test the effectiveness of the grounding system in patient care areas as required by NFPA 99.

END OF SECTION 260526
PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the requirements for the following:
1. Conduit and equipment supports.
2. Anchors and fasteners.

1.2 SUBMITTALS

A. Refer to section 26 05 10.

1.3 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.
B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.4 REFERENCE STANDARDS


PART 2 - PRODUCTS

2.1 MATERIALS

A. Hangers, Supports, Anchors, and Fasteners - General: Corrosion-resistant materials of size and type adequate to carry the loads of equipment and conduit, including weight of wire in conduit.

B. Supports: Fabricated of structural steel or formed steel members; galvanized.

C. Anchors and Fasteners:
1. Do not use powder-actuated anchors.
2. Concrete Structural Elements: Use precast inserts, expansion anchors, or preset inserts.
3. Steel Structural Elements: Use beam clamps, steel spring clips, steel ramset fasteners, or welded fasteners.
4. Concrete Surfaces: Use self-drilling anchors or expansion anchors.
5. Hollow Masonry, Plaster, and Gypsum Board Partitions: Use toggle bolts or hollow wall fasteners.
7. Sheet Metal: Use sheet metal screws.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install hangers and supports as required to adequately and securely support electrical system components, in a neat and workmanlike manner, as specified in NECA 1.
1. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.

B. Cutting or Holes:
   1. Locate holes in advance where they are proposed in the structural sections such as ribs or beams. Obtain the approval of the Owner prior to drilling through structural sections.
   2. Cut holes through concrete and masonry in new and existing structures with a diamond core drill or concrete saw. Pneumatic hammer, impact electric, hand or manual hammer type drills are not allowed, except where permitted by the Owner as required by limited working space.

C. Rigidly weld support members or use hexagon-head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.

D. Install surface-mounted cabinets and panelboards with minimum of four anchors.

E. In wet and damp locations use steel channel supports to stand cabinets, disconnects and panelboards 1 inch (25 mm) off wall.

F. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.

G. Use stamped steel bridges to fasten flush mounting outlet box between studs.

H. Use adjustable steel channel fasteners for hung ceiling outlet box.

I. Do not fasten boxes to ceiling support wires.

J. Support boxes independently of conduit, except cast box that is connected to two rigid metal conduits both supported within 12 inches of box.

K. Support conduit using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.

L. Group related conduits; support using conduit rack. Construct rack using steel channel; provide space on each for 25 percent additional conduits

M. Do not support conduit with wire, wire ties, or perforated pipe straps. Remove wire used for temporary supports.

N. Do not attach conduit to ceiling support wires.

END OF SECTION 260529
SECTION 26 05 33
RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUBMITTALS
A. Refer to section 26 05 10

1.2 QUALITY ASSURANCE
A. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for purpose specified and shown.

1.3 REFERENCE STANDARDS
A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); current edition
B. ANSI C80.3 - American National Standard for Steel Electrical Metallic Tubing (EMT); current edition
C. ANSI C80.5 - American National Standard for Electrical Rigid Aluminum Conduit (ERAC); current edition
E. NECA 101 - Standard for Installing Steel Conduit (Rigid, IMC, EMT); National Electrical Contractors Association; current edition
F. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; National Electrical Manufacturers Association; current edition

1.4 DELIVERY, STORAGE, AND HANDLING
A. Accept conduit on site. Inspect for damage
B. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

PART 2 - PRODUCTS

2.1 CONDUIT REQUIREMENTS
A. Conduit Size: Comply with NFPA 70.
   1. Minimum Size: 3/4 inch

B. Wet and Damp Locations:
   1. Exterior above ground and in pipe basements: RMC, IMC, or LFMC (LFMC shall be only used with restrictions, see conduit installation)
   2. Exterior below ground: RNC schedule 80
   3. Interior: RMC, IMC, or LFMC (LFMC shall be only used with restrictions, see conduit installation)
   4. Interior below grade: RNC schedule 80
   5. Where RNC Schedule 40 is installed below grade or under floor slabs, the elbows
required to turn the raceway up through the slab shall be RMC.

C. Dry Locations:
1. Concealed: Use EMT or FMC (FMC shall be only used with restrictions, see conduit installation)
2. Exposed: Use EMT or FMC (FMC shall be only used with restrictions, see conduit installation)
3. Interior below grade: RNC schedule 80

D. Area subject to physical damage: RMC, IMC, or LFMC (LFMC shall be only used with restrictions, see conduit installation)
1. “Areas subject to physical damage” shall be defined as the most stringent of the following:
   a. Exposed conduit below eight feet above finished floor.
   b. As interpreted by the authority having jurisdiction (AHJ).

2.2 METAL CONDUIT

A. Rigid Steel Galvanized Conduit (RMC): ANSI C80.1.


C. Fittings and Conduit Bodies: NEMA FB 1; material to match conduit.
   1. Fittings shall meet the requirements of UL 514B and ANSI/ NEMA FB1.
   2. Standard threaded couplings, locknuts, bushings, and elbows: Only steel or malleable iron materials are acceptable. Integral retractable type IMC couplings are also acceptable.
   3. Die-cast or pressure-cast zinc-alloy fittings or fittings made of "pot metal" are prohibited.
   4. Locknuts: Bonding type with sharp edges for digging into the metal wall of an enclosure.
   5. Bushings: Metallic insulating type, consisting of an insulating insert molded or locked into the metallic body of the fitting. Bushings made entirely of metal or nonmetallic material are not permitted.
   6. Sealing fittings: Threaded cast iron type. Use continuous drain type sealing fittings to prevent passage of water vapor. In concealed work, install fittings in flush steel boxes with blank cover plates having the same finishes as that of other electrical plates in the room.

2.3 FLEXIBLE METAL CONDUIT

A. FLEXIBLE METAL CONDUIT (FMC) Description: Interlocked steel construction. Flexible metal conduit shall conform to UL 1.

B. Fittings: NEMA FB 1.
   1. Conform to UL 514B. Only steel or malleable iron materials are acceptable.
   2. Die-cast or pressure-cast zinc-alloy fittings or fittings made of "pot metal" are prohibited.
   3. Clamp type, with insulated throat.

2.4 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

A. LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC) Description: Interlocked steel construction with PVC jacket. Liquid-tight flexible metal conduit: Shall Conform to UL 360.

1. Only steel or malleable iron materials are acceptable.
2. Die-cast or pressure-cast zinc-alloy fittings or fittings made of "pot metal" are prohibited.
3. Fittings must incorporate a threaded grounding cone, a steel or plastic compression ring, and a gland for tightening. Connectors shall have insulated throats.
4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch, with overlapping sleeves protecting threaded joints.

2.5 ELECTRICAL METALLIC TUBING

A. ELECTRICAL METALLIC TUBING (EMT) Description: ANSI C80.3

B. Fittings and Conduit Bodies: NEMA FB 1; steel compression type.
   1. Fittings shall meet the requirements of UL 514B and ANSI/ NEMA FB1.
   2. Only steel or malleable iron materials are acceptable.
   3. Die-cast or pressure-cast zinc-alloy fittings or fittings made of "pot metal" are prohibited.
   4. Couplings and connectors: Concrete tight and rain tight, with connectors having insulated throats. Use gland and ring compression type couplings and connectors for conduit sizes 50mm (2 inches) and smaller.
   5. Indent type connectors or couplings are prohibited.

2.6 NONMETALLIC CONDUIT

A. RIGID NONMETALLIC CONDUIT (RNC): Direct burial plastic conduit: Shall conform to UL 651 and UL 651A, heavy wall PVC or high density polyethylene (PE).

B. RNC: NEMA TC 2, schedule 40 PVC

C. Fittings shall meet the requirements of UL 514C and NEMA TC3

D. Fittings for RNC: NEMA TC 3; match to conduit or tubing type and material.

2.7 EXPANSION AND DEFLECTION COUPLINGS

A. Conform to UL 467 and UL 514B.

B. Accommodate, 0.75 inch deflection, expansion, or contraction in any direction, and allow 30 degree angular deflections.

C. Include internal flexible metal braid sized to guarantee conduit ground continuity and fault currents in accordance with UL 467, and the NEC code tables for ground conductors.

D. Jacket: Flexible, corrosion resistant, watertight, moisture and heat resistant molded rubber material with stainless steel jacket clamps.

2.8 CORROSION PROTECTION

A. Corrosion protection for conduits passing through concrete slabs shall be by one of the following means: field-wrapped with 3M Scotchrap No. 50, 2-inch wide (minimum), with a 50 percent overlay, or shall have a factory-applied polyvinyl chloride, plastic resin, or epoxy coating.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify routing and termination locations of conduit prior to rough-in.

B. Conduit routing is shown on drawings in approximate locations unless dimensioned. Route as required to provide a complete wiring system.

3.2 CONDUIT INSTALLATION

A. All fire alarm cable shall be installed in metallic conduit. Coordinate with fire alarm system manufacturer for cable routing and quantities.

B. Install conduit securely, in a neat and workmanlike manner, as specified in NECA 101.

C. Waterproofing: At floor, exterior wall, and roof conduit penetrations, completely seal clearances around the conduit and make watertight.

D. Arrange supports to prevent misalignment during wiring installation.

E. Arrange conduit to maintain headroom and present neat appearance.

F. Route exposed conduit parallel and perpendicular to walls.

G. Route conduit installed above accessible ceilings parallel and perpendicular to walls.

H. Route conduit in and under slab from point-to-point.

I. Maintain adequate clearance between conduit and piping.

J. Maintain 12 inch (300 mm) clearance between conduit and surfaces with temperatures exceeding 104 degrees F (40 degrees C).

K. Cut conduit square using saw or pipe cutter; de-burr cut ends.

L. Bring conduit to shoulder of fittings; fasten securely.

M. For power conduits install no more than equivalent of three 90 degree bends between boxes. Use conduit bodies to make sharp changes in direction, as around beams. Use hydraulic one shot bender to fabricate bends in metal conduit larger than 2 inch (50 mm) size.

N. For communication conduits install no more than the equivalent of two 90 degree bends between pull points. Use conduit bodies to make sharp changes in direction, as around beams. Use hydraulic one shot bender to fabricate bends in metal conduit larger than 2 inch (50 mm) size.

O. Avoid moisture traps; provide junction box with drain fitting at low points in conduit system.

P. Provide suitable fittings to accommodate expansion and deflection where conduit crosses seismic, control, and expansion joints.

Q. Seal the inside of all conduits where conduit passes below floor or outside of the building.

R. Provide suitable pull string in each empty conduit except sleeves and nipples.
S. Use suitable caps to protect installed conduit against entrance of dirt and moisture.

T. Do not install FMC or LFMC in lengths over 6'.

U. Use LFMC or FMC only to connect to equipment subject to vibration or to suspended light fixtures.

V. Wherever possible, install horizontal raceway runs above water and drain piping. Give the right-of-way in confined spaces to piping that must slope for drainage and to larger HVAC ductwork and similar services that are less conformable than electrical services.

W. Complete the installation of electrical raceways before starting installation of cables within raceways.

X. Raceways shall not be installed exposed in finished spaces. Install concealed in walls, ceilings, below slab-on-grade or embedded in slabs above grade.

3.3 BOX INSTALLATION

A. Boxes for Concealed Conduits:
   1. Flush mounted.
   2. Provide raised covers for boxes to suit the wall or ceiling, construction and finish.

B. In addition to boxes shown, install additional boxes where needed to prevent damage to cables and wires during pulling in operations.

C. Remove only knockouts as required and plug unused openings. Use threaded plugs for cast metal boxes and snap-in metal covers for sheet metal boxes.

D. Outlet boxes in the same wall mounted back-to-back are prohibited. A minimum 24 inch, center-to-center lateral spacing shall be maintained between boxes.

E. Minimum size of outlet boxes for ground fault interrupter (GFI) receptacles is 4 inches square by 2-1/8 inches deep, with device covers for the wall material and thickness involved.

F. Clean all debris out of floor boxes.

3.4 IDENTIFICATION

A. Stencil or install phenolic nameplates on covers of the boxes identified on riser diagrams; for example "SIG-FA JB No. 1"

B. On all concealed junction box covers, identify the circuits with black marker. For exposed junction boxes use printed labels.

END OF SECTION 260533
SECTION 26 05 43
UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUBMITTALS:

A. Refer to section 260510.

PART 2 - PRODUCTS

2.1 DUCTBANKS

A. Any grouping of conduits underground shall be considered a duct bank.

B. Ducts shall be 4" diameter minimum, type EB40 for encased burial.

C. Raceways shall be provided in accordance with specification 260533 Raceway and Boxes for Electrical Systems.

D. Fittings for raceways shall be designed specifically for use with the type of raceway installed. All couplings or other connections shall be made tight and sealed to exclude water and concrete.

E. Top, intermediate and bottom spacers of plastic, or other approved non-organic material, shall be provided to maintain a separation between raceways of not less than that shown on drawings. Spacers shall be of the type specifically intended for encased installations.

2.2 HANDHOLES

A. Handholes shall be constructed of steel reinforced 3,000 pound, 28-day strength concrete, or reinforced polymer concrete manufactured in molded structural shapes, on undisturbed or thoroughly compacted earth and shall conform with details and dimensions indicated on the drawings. Neoprene or other suitable water-stops shall be provided at all concrete construction joints.

B. Locations of handholes shall be as dimensioned. Where no locating dimensions are given, handholes shall be approximately where shown, with possible interferences with other utilities, etc.

C. Frames and covers for handholes shall be heavy duty, top quality, close grained gray cast iron or reinforced polymer concrete, both being milled to provide a true fit. Covers shall be equipped with drop lift handles and with the word "ELECTRIC" cast thereon. Type and style of frames and covers shall be as indicated on the drawings.

D. Hardware shall be of gray cast iron or hot-dip galvanized steel.

E. Water, mud, and trash shall be periodically pumped or otherwise removed from handholes by the Contractor until final acceptance of the work.

F. Metal Frames and Covers: Shall be made of cast iron. Cast iron frames and covers shall meet Fed Spec. RR-F-621. Covers shall be rated AASHTO H20. The words "electric" shall be cast in the top face of the covers.

2.3 WARNING TAPE
A. Provide a plastic warning tape in the backfill above all underground cables, conduits and duct banks. The tape shall be 3 inches wide, shall be bright, fade-resistant, red in color for power, yellow/orange in color for low voltage, and shall include an imprinted legend, "WARNING - BURIED HIGH VOLTAGE LINE", "WARNING - BURIED FIBER OPTIC LINE" or "WARNING - BURIED TELEPHONE LINE", as applicable., repeated continuously throughout the entire length. Tape shall be buried 12 inches below top of trench.

PART 3 - EXECUTION

3.1 GENERAL

A. Layout of duct banks is the responsibility of the Contractor. Coordinate layout with existing site conditions, the elevation of manhole openings and work by other trades. Duct lines shall be sloped to drain towards manholes and pull boxes, with a pitch of not less than 3 inches in 100 feet. For lines run between adjacent manholes or pull boxes, high point may occur in the middle of run.

B. Excavation, Trenching and Backfilling: Provide as required to install duct banks in the manner indicated on the drawings and in accordance with the applicable sections of Division 31 through 33 of the specifications.

C. Provide barricades with warning lights, around all trenches. Barricades shall be orange mesh type supported by rods driven into the earth. Barricades shall remain in place at all times, not just at night. Maintain the integrity and appearance of the barricades until the trenches have been backfilled and compacted.

D. Clearance from Other Utilities: Do not install lines installed under this contract in the same trenches with other utilities. Maintain horizontal and vertical separation as required by ANSI C2.

3.2 INSTALLATION

A. During construction, partially completed duct lines shall be protected from the entrance of debris such as mud, sand and dirt, by means of suitable conduit plugs. As each section of a duct line is completed from manhole to manhole, a testing mandrel not less than 12 inches long with a diameter 1/4-inch less than the size of the conduit, shall be drawn through each conduit, after which a brush having the diameter of the conduit, and having stiff bristles, shall be drawn through until the conduit is clear of all particles of earth, sand, and/or gravel; conduit plugs shall then be immediately installed.

B. Install spacers every 5' along the duct run and at the midpoint and points of tangency of all bends. Anchor spacers to trench to ensure that the duct banks are held securely in place during concrete pours.

C. Ducts shall be encased in concrete as shown on the drawings. Care shall be taken that no voids are left between ducts.

D. Ducts crossing roadways and parking lots shall be reinforced as indicated on the drawings. Cutting and patching shall conform to the details shown on the Civil drawings. Engage the services of the paving and grading contractor to perform all cutting and patching.

E. Install warning tape 12" below grade along the entire length of, and centered on duct banks.

F. Bends: Except at conduit risers, changes in direction of runs exceeding a total of 10 degrees,
either vertical or horizontal, shall be accomplished by long sweep bends having a minimum radius of curvature of 25 feet. Sweep bends may be made up of one or more curved or straight sections or combinations thereof. Manufactured bends shall have a minimum radius of 48”.

G. Connections to Handholes: Connections shall be constructed to have a flared section adjacent to the manhole to provide shear strength. Underground structures shall be constructed to provide for keying the concrete envelope of the duct line into the wall of the structure. Vibrators shall be used when this portion of the envelope is poured to assure a seal between the envelope and the wall of the structure. Conduits shall terminate in end-bells where duct lines enter manholes.

H. Connections at Pad Mounted transformers: Terminate encasement at underside of concrete pad.

3.3 RECONDITIONING OF SURFACES

A. Ground covering and vegetation disturbed during installation, shall be restored to original elevation and condition.

B. Sod or topsoil shall be preserved carefully and replaced after the backfilling is completed. Sod that is damaged shall be replaced by sod of quality equal to that removed. When the surface is disturbed in a newly seeded area, the restored surface shall be re-seeded with the same quantity and formula of seed as that use in the original seeding.

3.4 CABLE PULLING

A. Pull cables down grade with the feed-in point at the handhole or buildings of the highest elevation. Use flexible cable feeds to convey cables through the handhole opening and into the conduit. Cable slack shall be accumulated at each handhole where space permits. Minimum allowable bending radii shall be maintained.

B. Lubricants: For assisting in the pulling of cables shall be those specifically recommended by the cable manufacturer. The lubricant shall not be deleterious to the cable sheath, jacket, or outer coverings.

C. Cable Pulling Tensions: Shall not exceed the maximum pulling tension recommended by the cable manufacturer.

D. Grounding Conductor: Secondary cable runs, 600 volts and less, in non-metallic conduit shall, although not indicated, include an insulated copper equipment grounding conductor sized as required by the rating of the overcurrent device supplying the phase conductors.

END OF SECTION 260543
SECTION 26 05 48
VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUBMITTALS
A. Refer to section 260510.

1.2 QUALITY ASSURANCE
A. Submittals must be signed and sealed shop drawings from a professional engineer licensed in the state that the project is located in. Shop drawings to include project specific details, sketches, product data cut sheets.
B. The contractor shall provide pre-engineered seismic restraint systems to meet total design lateral force requirements for support and restraint of piping, conduit, cable trays and other similar systems and equipment where required by the applicable building code.
C. System Supports/Restraints Manufacturers shall be firms regularly engaged in the manufacture of products of the types specified in this section, whose products have been in satisfactory use in similar service for not less than 5 years.

PART 2 - PRODUCT

2.1 SEISMIC BRACING
A. General:
1. Seismic restraint designer shall coordinate all attachments with the structural engineer of record.
2. Design analysis shall include calculated dead loads, static seismic loads, and capacity of materials utilized for the connection of the equipment or system to the structure.
3. Analysis shall detail anchoring methods, bolt diameter, and embedment depth.
4. All seismic restraint devices shall be designed to accept without failure the forces calculated per the details and notes on the construction documents
B. Friction from gravity loads shall not be considered resistance to seismic forces.

PART 3 - EXECUTION

3.1 INSTALLATION
A. All seismic restraint systems shall be installed in strict accordance with the manufacturer’s seismic restraint guidelines manual and all certified submittal data
B. Installation of seismic restraints shall not cause any change in position of equipment or piping, resulting in stresses or misalignment.
C. No rigid connections between equipment and the building structure shall be made that degrade the noise and vibration-isolation system specified.
D. Do not install any equipment, piping, duct, or conduit that makes rigid connections with the building.
E. Prior to installation, bring to the architect’s/engineer’s attention any discrepancies between the specifications and the field conditions, or changes required due to specific equipment selection.

F. Bracing may occur from flanges of structural beams, upper truss cords of bar joists, cast in place inserts, or wedge-type concrete anchors. Consult structural engineer of record.

G. Overstressing of the building structure shall not occur from overhead support of equipment. Bracing attached to structural members may present additional stresses. The contractor shall submit loads to the structural engineer of record for approval in this event.

H. Brace support rods when necessary to accept compressive loads. Welding of compressive braces to the vertical support rods is not acceptable.

I. Provide reinforced clevis bolts where required.

J. Seismic restraints shall be mechanically attached to the system. Looping restraints around the system is not acceptable.

K. Do not brace a system to two independent structures such as a ceiling and wall.

L. Provide appropriately sized openings in walls, floors, and ceilings for anticipated seismic movement.

3.2 FIELD QUALITY CONTROL

A. Inspect all seismic supports after installation and submit a report from a professional engineer licensed in the state that the project is located in.

END OF SECTION 260548
SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUBMITTALS

A. Refer to section 26 05 10.

PART 2 - PRODUCTS

2.1 NAMEPLATES AND LABELS

A. Nameplates: Engraved three-layer laminated plastic, black letters on white background unless noted otherwise.

B. Locations:
   1. Each electrical distribution and control equipment enclosure.

C. Letter Size:
   1. Use 1/4 inch (6 mm) letters for identifying grouped equipment and loads.

D. Labels: Embossed adhesive tape, with 3/16 inch (5 mm) white letters on black background. Use only for identification of individual wall switches, receptacles, and control device stations. Labels shall identify the panel and circuit number (Ex: PANEL: CIRCUIT).

E. 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).

PART 3 - EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive nameplates and labels.

3.2 INSTALLATION

A. Install nameplates and labels parallel to equipment lines.

B. Secure nameplates to equipment front using corrosion resistant screws.

C. Secure nameplates to inside surface of door on panelboard that is recessed in finished locations.

D. Provide name plates on all disconnects, panelboards, switchboards, switchgear, transformers, and motor starters.

E. Provide labels on all receptacles, light switches, and wall mounted occupancy sensors.

END OF SECTION 260553
SECTION 26 05 74

SHORT CIRCUIT, OVERCURRENT PROTECTION, ARC FLASH HAZARD ANALYSIS

PART 1 - GENERAL

1.1 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. Coordination of series-rated devices is permitted where indicated on Drawings.

1.2 SUBMITTALS

A. Refer to section 260510.

1.3 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. Registered 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.

1.4 REFERENCES

A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems
2. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
3. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis
5. IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems

B. American National Standards Institute (ANSI):

1. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
2. ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures
3. ANSI C37.010 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis
5. ANSI C37.5 – Methods for Determining the RMS Value of a Sinusoidal Current Wave and Normal-Frequency Recovery Voltage, and for Simplified Calculation of Fault Currents

C. The National Fire Protection Association (NFPA)
   1. NFPA 70 - National Electrical Code, latest edition
      a. NFPA 70E – Standard for Electrical Safety in the Workplace

PART 2 - PRODUCTS

2.1 STUDIES

A. Contractor to furnish short-circuit and protective device coordination studies as prepared by equipment manufacturer. By using the equipment manufacturer the study allows coordination of proper breakers, fuses, and current transformers. The coordination study shall begin with the utility company's feeder protective device and include all of the electrical protective devices down to and include the largest feeder circuit breaker and motor starter in the 480 Volt motor control centers and power distribution panelboards. The study shall also include variable frequency drives, harmonic filters, power factor correction equipment, transformers and protective devices associated with variable frequency drives, emergency and standby generators associated paralleling equipment and distribution switchgear.

B. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E - Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D.

2.2 DATA COLLECTION

A. Contractor shall furnish all field data as required by the power system studies. The Engineer performing the short-circuit, protective device coordination and arc flash hazard analysis studies shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to eliminate unnecessary delays and assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.

B. Source combination may include present and future utility supplies, motors, and generators.

C. Load data utilized may include existing and proposed loads obtained from Contract Documents provided by Owner or Contractor.

D. Include fault contribution of existing motors in the study, with motors < 50 hp grouped together. The Contractor shall obtain required existing equipment data, if necessary, to satisfy the study requirements.

2.3 SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY

A. Use actual conductor impedances if known. If unknown, use typical conductor impedances based on IEEE Standards 141, latest edition.

B. Transformer design impedances and standard X/R ratios shall be used when test values are not available.

C. Provide the following:
   1. Calculation methods and assumptions
   2. Selected base per unit quantities
   3. One-line diagram of the system being evaluated with available fault at each bus, and interrupting rating of devices noted
4. Source impedance data, including electric utility system and motor fault contribution characteristics
5. Typical calculations
6. Tabulations of calculated quantities
7. Results, conclusions, and recommendations

D. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each:
1. Electric utility’s supply termination point
2. Incoming switchgear
3. Unit substation primary and secondary terminals
4. Low voltage switchgear
5. Motor control centers
6. Standby generators and automatic transfer switches
7. Branch circuit panelboards
8. Other significant locations throughout the system

E. For grounded systems, provide a bolted line-to-ground fault current study for areas as defined for the three-phase bolted fault short-circuit study.

F. Protective Device Evaluation:
1. Evaluate equipment and protective devices and compare to short circuit ratings
2. Adequacy of switchgear, motor control centers, and panelboard bus bracing to withstand short-circuit stresses
3. Adequacy of transformer windings to withstand short-circuit stresses
4. Cable and busway sizes for ability to withstand short-circuit heating
5. Notify Owner in writing, of existing, circuit protective devices improperly rated for the calculated available fault current

2.4 PROTECTIVE DEVICE COORDINATION STUDY

A. Proposed protective device coordination time-current curves shall be graphically displayed on log-log scale paper.

B. Include on each curve sheet a complete title and one-line diagram with legend identifying the specific portion of the system covered.

C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.

D. Identify device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

E. Plot the following characteristics on the curve sheets, where applicable:
1. Electric utility’s protective device
2. Medium voltage equipment relays
3. Medium and low voltage fuses including manufacturer’s minimum melt, total clearing, tolerance, and damage bands
4. Low voltage equipment circuit breaker trip devices, including manufacturer’s tolerance bands
5. Transformer full-load current, magnetizing inrush current, and ANSI transformer withstand parameters
6. Conductor damage curves
7. Ground fault protective devices, as applicable
8. Pertinent motor starting characteristics and motor damage points
9. Pertinent generator short-circuit decrement curve and generator damage point
10. Other system load protective devices for the largest branch circuit and the largest feeder circuit breaker in each motor control center

F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

2.5 ARC FLASH HAZARD ANALYSIS

A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2004, Annex D.

B. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Alternative methods shall be presented in the proposal.

C. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.

D. The Arc-Flash Hazard Analysis shall include all MV, 575v, & 480v locations and significant locations in 240 volt and 208 volt systems fed from transformers equal to or greater than 125 kVA.

E. Safe working distances shall be specified for calculated fault locations based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm2.

F. The Arc Flash Hazard analysis shall include calculations for maximum and minimum contributions of fault current magnitude. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume a minimum motor load. Conversely, the maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.

G. Arc flash computation shall include both line and load side of main breaker calculations, where necessary.

H. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B.1.2.

2.6 REPORT SECTIONS

A. Input Data:
   1. Utility three-phase and line-to-ground available contribution with associated X/R ratios
   2. Short-circuit reactance of rotating machines with associated X/R ratios
   3. Cable type, construction, size, # per phase, length, impedance and conduit type
   4. Bus duct type, size, length, and impedance
   5. Transformer primary & secondary voltages, winding configurations, kVA rating, impedance, and X/R ratio
   6. Reactor inductance and continuous ampere rating
   7. Aerial line type, construction, conductor spacing, size, # per phase, and length

B. Short-Circuit Data:
   1. Source fault impedance and generator contributions
   2. X to R ratios
   3. Asymmetry factors
4. Motor contributions  
5. Short circuit Kva  
6. Symmetrical and asymmetrical fault currents

C. Recommended Protective Device Settings:
   1. Phase and Ground Relays:
      b. Current setting.
      c. Time setting.
      d. Instantaneous setting.
      e. Specialty non-overcurrent device settings.
      f. Recommendations on improved relaying systems, if applicable.
   2. Circuit Breakers:
      a. Adjustable pickups and time delays (long time, short time, ground).
      b. Adjustable time-current characteristic.
      c. Adjustable instantaneous pickup.
      d. Recommendations on improved trip systems, if applicable.

D. Incident energy and flash protection boundary calculations:
   1. Arcing fault magnitude
   2. Device clearing time
   3. Duration of arc
   4. Arc flash boundary
   5. Working distance
   6. Incident energy
   7. Hazard Risk Category
   8. Recommendations for arc flash energy reduction

PART 3 - EXECUTION

3.1 FIELD ADJUSTMENT

A. Adjust relay and protective device settings according to the recommended settings table provided by the coordination study. Field adjustments to be completed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.

B. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.

C. Notify Architect / Engineer in writing of any required major equipment modifications.

D. Following completion of all studies, acceptance testing and startup by the field engineering service division of the equipment manufacturer, a 2-year warranty shall be provided on all components manufactured by the engineering service parent manufacturing company.

3.2 ARC FLASH WARNING LABELS

A. The vendor shall provide a 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each work location analyzed.

B. The label shall have an orange header with the wording, “WARNING, ARC FLASH HAZARD”, and shall include the following information:
   1. Location designation
   2. Nominal voltage
3. Flash protection boundary
4. Hazard risk category
5. Incident energy
6. Working distance
7. Engineering report number, revision number and issue date

C. Labels shall be machine printed, with no field markings

D. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.
   1. For each 600, 480 and applicable 208 volt panelboards and disconnects, one arc flash label shall be provided
   2. For each motor control center, one arc flash label shall be provided
   3. For each low voltage switchboard, one arc flash label shall be provided
   4. For each switchgear, one flash label shall be provided
   5. For medium voltage switches one arc flash label shall be provided

E. Labels shall be field installed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.

3.3 ARC FLASH TRAINING

A. The equipment vendor shall train personnel of the potential arc flash hazards associated with working on energized equipment (minimum of 4 hours). Maintenance procedures in accordance with the requirements of NFPA 70E, Standard For Electrical Safety Requirements For Employee Workplaces, shall be provided in the equipment manuals. The training shall be certified for continuing education units (CEUs) by the International Association for Continuing Education Training (IACET).

END OF SECTION 260574
SECTION 26 08 00
COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED SECTIONS

A. The following (but not limited to) related sections apply to this specification section:
   1. 01 91 13 General Commissioning Requirements.
   2. 22 08 00 Commissioning of Plumbing Systems.
   3. 23 08 00 Commissioning of HVAC Systems.
   4. 26 05 10 Electrical Submittals
   5. 25 05 11 Electrical Closeout
   6. 26 05 12 Electrical Coordination

1.2 COMMISSIONING PROGRAM CRITERIA.

A. Electrical Trade Representative:
   1. The Mechanical Contractor shall assign a qualified individual to function as the Trade
      Representative to coordinate the Commissioning Program. The Trade
      Representative reports to the Commissioning Authority.

B. Commissioning Cost:
   1. Each Trade and supplier of equipment shall include in his quoted price the cost of
      furnishing the material requested and manpower necessary for the operation and
      maintenance manuals, training and system verification as specified under this
      section.

PART 2 - PRODUCTS

2.1 NOT APPLICABLE.

PART 3 - EXECUTION

3.1 RESPONSIBILITIES

A. Electrical Trade Representative:
   1. Include requirements for submittal data. O & M data and training in each purchase
      order or sub-contract written.
   2. Ensure cooperation and participation of specialty sub-Trade Representatives.
   3. Ensure participation of major equipment manufacturers and their representatives.
   4. Attend initial pre-commissioning coordination meeting scheduled by the
      Commissioning Authority. Prepare necessary preliminary schedule for Maintenance
      orientation and inspections, O & M manual submission, training sessions, pipe and
      duct system testing, flushing and cleaning, equipment start-up, test, adjust and
      balance start and job completion for use by the Commissioning authority. Update
      schedule as appropriate throughout the construction period.
   5. Attend initial training session and conduct Maintenance orientation and inspection at
      the equipment placement completion stage. Update drawings to the record condition,
      to date, and review with the Commissioning Authority prior to the Maintenance
      orientation and inspection meeting.
   6. Obtain O & M data on all equipment and assemble in binders using tabs as required.
      Submit to Engineer of Record for approval prior to the Distribution completion stage.
7. Conduct the second Maintenance orientation and inspection at the Distribution completion stage. Update drawings to the record condition, to date, and review with the Commissioning Authority prior to the-inspection.
8. Notify the Commissioning Authority of the time for the electrical system pressure testing and piping system flushing.
9. Notify the Commissioning Authority of the time for all equipment start up activities.
10. Attend the initial TAB meeting for the review of the TAB procedures.
11. Participate in and schedule vendors and other Trade Representatives to participate in the training sessions set up by the Commissioning Authority.
12. Conduct a Maintenance orientation and inspection with hands on training. Update drawings to the record condition to date and review with the Commissioning Authority prior to the orientation.
13. Attend all regularly scheduled commissioning coordination meetings.
14. Provide written certification and completed Field Installation Verification forms and checklists documenting that the following work has been completed in accordance with the plans and specifications and that they are functioning as designed. Where the Work has been sub-contracted, the sub-Trade Representative shall be responsible for the initial certification with the Mechanical Trade Representative recertifying that he has inspected the Work and that it has been completed and functioning as designed. This certification must be submitted to the Commissioning Authority prior to the final verification.
   a. Electrical Panels and switch gear
   b. Electrical meters
   c. Lighting control systems
15. Demonstrate the performance of each piece of equipment to the Commissioning Authority.
16. Provide set of record mark-ups to the Engineer of Record for inclusion into record documents.

3.2 OPERATION AND MAINTENANCE MANUALS
   A. Refer to section 019113 General Commissioning Requirements

3.3 TRAINING:
   A. Refer to section 019113 General Commissioning Requirements

3.4 VERIFICATION OF PERFORMANCE
   A. Refer to section 019113 General Commissioning Requirements

END OF SECTION 260800
PART 1 - GENERAL

1.1 SUBMITTALS
A. Refer to section 260510.

1.2 QUALITY ASSURANCE
A. Conform to requirements of NFPA 70.
B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
C. Products: Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
D. UL Approvals: UL listed under UL 916 Energy Management Equipment.

1.3 REFERENCE STANDARDS

PART 2 - PRODUCTS

2.1 MANUFACTURERS
B. Lutron Electronics Inc: www.lutron.com
C. Wattstopper Inc: www.wattstopper.com

2.2 CONTACTORS
A. Contactors shall be rated 30A/600V and shall be installed in a NEMA 1 enclosure. Coil voltage shall be 120V, unless noted otherwise. Contactors shall be electically operated, mechanically held type with coil clearing contacts. Contactors shall be field-convertible for use with maintained-contact (two-wire) or momentary-contact (three-wire) control devices. Provide three-wire control unless noted otherwise.
B. Contactors shall be of the number of poles required to control the circuits indicated, plus a minimum of two spare poles. Where number of circuits controlled exceeds the maximum number of poles available, provide multiple contactors connected in parallel.
C. Provide H-O-A switch in cover of enclosure for contactors serving exterior lighting. Connect switch to operate as indicated on the drawings.
D. Contactors shall have silver alloy double-break contacts and coil clearing contacts for mechanically held contactor and shall require no arcing contacts.

2.3 PHOTOCELLS

A. Photocells shall have the following features:
   1. Quick-response, cadmium-sulfide type.
   2. A 15 to 30 second, built-in time delay to prevent response to momentary lightning flashes, car headlights or cloud movements.
   3. Energizes the system when the north sky light decreases to approximately 1.5 footcandles, and maintains the system energized until the north sky light increases to approximately 3 to 5 footcandles.

2.4 CONTROLS

A. Switches
B. Wiring

PART 3 - EXECUTION

3.1 INSTALLATION

A. Photocell Switch Aiming: Aim switch according to manufacturer’s recommendations. Set adjustable window slide for proper footcandles photocell turn-on.

B. Locate contactors controlling lighting circuits above panels in which circuits originate; locate contactors controlling receptacles above accessible ceiling of room near location of door to room.

C. Neutral and grounding conductors shall be routed through contactor enclosure with associated phase conductor(s) being switched. Group each branch circuit within enclosure using nylon tie straps.

D. Do not splice conductors within contactor enclosure.

E. Provide wiring troughs with terminal strips adjacent to contactors, so that unswitched portions of circuits (i.e. exit lights, etc.) can bypass the contactors. The use of wirenuts within enclosures is not acceptable. Connect contactor enclosure to panelboard and troughs with conduit nipples sized for the total number of branch circuits conductors encountered.

3.2 LABELING

A. All wiring shall be labeled clearly indicating which lighting control panel or device it connects to.

B. Use only properly color-coded, stranded wire as indicated on the drawings.

3.3 DEMONSTRATION

A. Demonstrate proper operation of system.

3.4 FIELD QUALITY CONTROL

A. Perform field inspection, testing, and adjusting in accordance with Section 01 40 00.
B. Inspect each device for defects.
C. Operate each switch and verify proper operation.

3.5 ADJUSTING

A. Adjust devices and wall plates to be flush and level.
B. It shall be the contractor's responsibility to make all proper adjustments to assure owner's satisfaction with the lighting control system.

END OF SECTION 260923
PART 1 - GENERAL

1.1 SUBMITTALS
   A. See section 260510.

1.2 QUALITY ASSURANCE
   A. Where switchboards or panelboards are used as service entrance equipment, they shall comply with all NEC and UL requirements for service entrance and a UL service entrance label shall be provided.
   B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.3 REFERENCE STANDARDS
   B. NEMA PB 1 - Panelboards; National Electrical Manufacturers Association; current edition.
   C. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less; National Electrical Manufacturers Association; current edition.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
   A. Eaton Electrical/Cutler-Hammer
   B. GE Industrial
   C. Square D
   D. Siemens

2.2 PANELBOARDS
   A. Description: NEMA PB1, circuit breaker type, lighting and appliance branch circuit panelboard.
   B. Panelboard Bus: Copper (98% conductivity).
   C. Provide copper ground bus in each panelboard
   D. Enclosure: Interior - NEMA 1, Exterior locations – gasketed NEMA 4X, Kitchen - Stainless NEMA 1
   E. Cabinet Front: Flush cabinet front with concealed trim clamps, concealed hinge, metal
directory frame, and flush lock all keyed alike. Finish in manufacturer's standard gray enamel. Paint all hallway panels to match wall finish.

F. All panelboards shall be hinged “door in door” type with:
   1. Interior hinged door with hand operated latch or latches as required to provide access to circuit breaker operating handles only, not to energized ports.
   2. Outer hinged door shall be securely mounted to the panelboard box with factory bolts, screws, clips or other fasteners requiring a tool for entry, hand operated latches are not acceptable.
   3. Push inner and outer doors shall open left to right.

G. All panelboard shall have bolt-on style breakers.

H. Provisions for future breakers shall be fully bussed complete with all necessary mounting hardware.

2.3 CIRCUIT BREAKERS

A. For circuit breakers over 200 amps provide -Adjustable Trip molded case, solid state adjustable trip type circuit breakers.
   2. Ground-Fault Protection: Integrially mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator. (where indicated)
   3. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay. (where indicated)
   4. Trip units shall have field adjustable tripping characteristics as follows:
      a. Ampere setting (continuous).
      b. Long time band.
      c. Short time trip point.
      d. Short time delay.
      e. Instantaneous trip point.

B. For all circuit breakers 200 amps and smaller provide - Molded Case Circuit Breakers: Thermal magnetic trip circuit breakers.
   1. Type SWD for lighting circuits.
   2. Type HACR for air conditioning equipment circuits.
   3. Class A ground fault interrupter circuit breakers where scheduled.
   4. Do not use tandem circuit breakers.
   5. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration for all residential applications.
   6. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip). (where indicated)

C. Circuit breakers serving fire alarm devices shall be provided with a red fire alarm circuit breaker lockout kit that permanently identifies circuit as “FIRE ALARM”.

2.4 CONTROL WIRING:

A. Control wiring shall be 600 volt class B stranded SIS. Install all control wiring complete at the factory adequately bundled and protected. Wiring across hinges and between shipping units
shall be Class C stranded. Size in accordance with NEC. Provide control circuit fuses. Provide integral power supply in switchgear for control power.

2.5 SHORT CIRCUIT CURRENT RATING:

A. Devices which achieve the level of fault protection indicated by means of "series" or "integrated" rating shall not be acceptable unless specifically indicated on the drawings. All panelboards shall be fully rated.

B. Minimum SSCR
   1. 208 Volt Panelboards: Minimum 10,000 amperes rms symmetrical unless noted otherwise on plans.
   2. 480 Volt Panelboards: Minimum 22,000 amperes rms symmetrical unless noted otherwise on plans.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards in accordance with NEMA PB 1.1 and NECA 1.

B. Install panelboards plumb. Install recessed panelboards flush with wall finishes.

C. Height: 6 feet (1800 mm) to top of panelboard; install panelboards taller than 6 feet (1800 mm) with bottom no more than 4 inches (100 mm) above floor.

D. Provide filler plates for unused spaces in panelboards.

E. Provide typed circuit directory for each branch circuit panelboard. Revise directory to reflect circuiting changes required to balance phase loads.

F. Provide engraved plastic nameplates on all switchboard and panelboards.

G. Provide spare conduits out of each recessed panelboard to an accessible location above ceiling. Identify each as SPARE.
   1. Minimum spare conduits: 6 empty 1 inch conduits.

H. Ground and bond panelboard and switchboard enclosure according to Section 26 05 26.

I. Do not splice conductors in panelboard or switchboard enclosure.

J. Install switchboard on 4" high concrete pad with 3" minimum overlap on all sides. Bolt switchboard to pad in all four corners, minimum.

K. Each section of two section panels shall contain only those conductors which originate in that section. Do not use panel as a wireway.

L. Piggy-back or tandem type breakers shall not be used.

M. Multi-pole breakers shall be common trip, with a single handle.

3.2 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA STD ATS, except Section 4.
B. Perform inspections and tests listed in NETA STD ATS, Section 7.5 for switches, Section 7.6 for circuit breakers.

3.3 ADJUSTING

A. Adjust the breaker trip set points per the values provided by the engineer, per an Overcurrent protective device study provided by the contractor.

B. Touch-up scratched or marred surfaces to match original finish.

C. Clean all debris from panel interiors.

3.4 LABELING

A. Provide nameplates on all electrical panels that new circuits are modified or installed. Indicate the following information:
   1. Panel name
   2. Panel fed from
   3. Normal (Black with white letters), Emergency Critical (Orange with black letters), Emergency Equipment (Green with black letters), or Emergency Life safety (Yellow with black letters)
   4. Voltage, phase, wire
   5. Available fault circuit (main only)
   6. Date installed

B. Provide a typed legend for all modified or new electrical panels. Update the panel board schedules after load balancing.

C. Identify load served and location by room names assigned by user, not by room numbers on floor plans. Note spares and spaces as such.

D. \

E. Provide a laminated 11x17 one line in the main electrical room mounted to the wall or main electrical panel.

F. Provide ARC flash identification per NFPA 70E. ARC Flash levels will be provided by the engineer.

3.5 CLEARANCE AND WORKSPACE

A. Maintain workspace and clearances as required by the NEC for the voltage encountered. No pipes or ducts shall pass above the outline of the panelboard. It shall be the responsibility of this Contractor to make sure that other trades do not encroach on this space.

END OF SECTION 262400
PART 1 - GENERAL

1.1 SCOPE OF WORK:
   A. Equipment shall comply with the latest applicable standards of NEMA and UL. Where meter centers are used as service entrance equipment, they shall comply with all NEC and UL requirements for service entrance and a UL service entrance label shall be provided.

1.2 QUALITY ASSURANCE:
   A. Manufacturers: Provide products by one of the following:
      1. General Electric Company
      2. Square D Co.
      3. Cutler Hammer
      4. Siemens
   B. Compliance / Labels:
      1. Equipment shall comply with the latest applicable standards of NEMA PB-1 and UL 67.
      2. Where meter centers are used as service entrance equipment, they shall comply with all NEC and UL requirements for service entrance and a UL service entrance label shall be provided.
   C. Submittals: Refer to Section 260510 for requirements.

1.3 COORDINATION:
   A. Utility Requirements: Meter centers shall comply with the requirements of the local utility company. Submit shop drawings for utility company approval prior to submitting to Architect. Utility approval must accompany submittal to Architect.

PART 2 - PRODUCTS

2.1 ENCLOSURES:
   A. Enclosure shall be constructed of code gauge steel constructed without knock-outs. Provide manufacturer's standard light gray finish. The complete assembly shall be rated for outdoor use.

2.2 CONSTRUCTION:
   A. Meter centers shall be dead front construction and shall be modular, consisting of a termination section, and metering sections. Metering sections shall consist of not more than 5 vertically stacked meters. Each meter position shall include meter socket and circuit breaker. Circuit breakers shall have gasketed, hinged cover with a heavy-duty, corrosion-resistant hasp, suitable for a padlock. Padlocks will be provided by the Owner. All current-carrying parts shall be plated to resist corrosion. All lugs shall be suitable for use with copper or aluminum wire.
   B. Meter centers shall be rated for use on a 120/208V, 3ph, 4w system. Circuit breakers shall have a minimum interrupting rating of 10,000 amps, rms symmetrical.
   C. Provide, at each meter position, a laminated plastic nameplate engraved with street address
North Charleston Wannamaker County Park

26 27 13

Park Center Replacement

ELECTRICAL METERING

served by specific meter, voltage, ampere rating/type fault current rating, and date. Nameplate shall be screwed and glued to the enclosure.

Ex: 123 Main Street
120/208V, 3 phase, 4W
225A Main Lugs
14,000 AIC
2/96

D. Meter center shall be suitable for overhead or underground service entrance as applicable.

E. Meter sockets and sealing rings shall be of the type required by the local utility.

2.3 BUSSING:

A. Meter centers shall be equipped with tin-plated copper bus bars, full-sized neutral bar and an equipment ground bus.

B. The bus system shall be an integral part of each meter socket module. Separate busways are not acceptable. The main bus shall be connected by a single-bolt joint assembly or other approved method. The single-bolt joints shall be accessible for tightening without removal of barriers whether the bus is energized or de-energized.

C. Vertical bus shall be welded to the main horizontal bus and tied to the meter socket jaws by means of bus connection straps. Bolts joining the straps to the bus shall be accessible through the socket base with the meter removed. Bus connections shall be provided between socket load jaws and individual branch breakers.

D. The unmetered bus in each meter module shall be completely barriered to prevent unauthorized access to current. Covers over meter module wireways shall be removable with the watt-hour meters sealed in place.

2.4 CIRCUIT BREAKERS:

A. Provide bolt-in type, heavy duty, quick-make, quick-break molded case circuit breakers.
   1. Provisions for future breakers shall be fully bussed complete with all necessary mounting hardware.

B. Anti-turn solderless, pressure type connectors shall be provided suitable for aluminum/copper wire.

C. Circuit breakers shall be able to be replaced without disturbing adjacent units.

D. Devices which achieve the level of fault protection indicated by means of "series" or "integrated" rating shall not be acceptable unless specifically indicated on the drawings.

PART 3 - EXECUTION

3.1 GENERAL:

A. Meter Center shall be supported by 1-1/2" x 1-1/2", 12 ga. steel channels attached horizontally to the exterior wall. Provide a minimum of two channel supports.

B. Meter center mounting height shall comply with standards of the local utility, except that no breaker shall be higher than 6'-6" above finished grade.
   1. Do not splice conductors in meter center enclosure.
C. Each section of the meter assembly shall contain only those conductors which originate in that section. Do not use meter center as a wireway.

D. Feeders shall exit the bottom of meter center and be run beneath the 1st floor slab. Support conduits in the same manner as specified for meter centers. Turn feeders up in wall at panel locations. Actual route shall be determined by the Contractor subject to the approval of the Architect.

3.2 ADJUST AND CLEAN

A. Touch-up scratched or marred surfaces to match original finish.

B. Clean all debris from meter center interiors.

C. Protect meter center from damage while the building exterior is cleaned. Replace any portions of the system showing signs of rust at the time of final inspection.

D. Clearance and Workspace: Maintain workspace and clearances as required by the NEC for the voltage encountered.

END OF SECTION 262713
SECTION 26 27 26
WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the requirements for the following:
   1. Receptacles.
   2. Device plates.
   3. Wall switches.

1.2 SUBMITTALS

A. Refer to section 260510.

1.3 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

C. Products: Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.4 OCCUPANCY SENSOR DRAWING

A. Drawing Format: Drawings shall be prepared at a scale of no less than 1/16"=1'-0". Drawing shall be titled to define Project Name, Drawing subject and date prepared. Drawings are to be prepared in AutoCAD 2017 or compatible software.

1.5 REFERENCE STANDARDS


B. NEMA WD 1 - General Color Requirements for Wiring Devices; National Electrical Manufacturers Association; current edition.

C. NEMA WD 6 - Wiring Device -- Dimensional Requirements; National Electrical Manufacturers Association; current edition.

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Acceptable manufacturers, contingent upon compliance with the contract documents, are as listed below. Bidders shall carefully review the requirements listed in the technical specifications and only submit products that are equal or better. Equal products by other manufacturers are acceptable providing substitutions are submitted in accordance with requirements listed in the front end specifications and approved by the A/E. Bidders shall carefully review the front end documents and submit all information required to allow the A/E the ability to make a fully informed decision.
   1. Cooper Wiring Devices
   2. GE Industrial
3. Leviton Manufacturing, Inc
4. Hubbell, Inc
5. Lutron Electronics Inc
6. Wattstopper Inc
7. Schneider Electric
8. Legrand – Pass & Seymour
9. C.W. Cole & Company
10. Acuity Brands Lighting, Inc

2.2 RECEPCTACLES

A. GFCI Receptacles: Convenience receptacle with integral ground fault circuit interrupter to meet regulatory requirements. Feed through GFCI devices shall not be used. GFCI devices shall contain self-testing feature with power lockout if self-test fails.

B. Special Purpose Receptacles: Provide heavy-duty type as indicated on the drawings.

C. Wet Location: A receptacle installed in a wet location shall be GFCI listed weather-resistant type.

2.3 WALL PLATES

A. Cover Plates: Provide one piece wall plates for wiring devices, with ganging and cutouts as required. Provide blank wall plates for all un-used outlet boxes. Provide with metal screws for securing plates to devices, screw heads colored to match finish of plate. All plates shall be standard size, smooth stainless steel.

B. Weatherproof Cover Plates: All devices installed outdoors and indoor devices specifically indicated, shall be provided with weatherproof covers. Covers shall be of the type that maintains weatherproof integrity when in-use and not in-use. Covers shall be listed and identified as “extra duty” type.

C. Flush Device Plates shall be Concealite/DisCover Series FDP (Flush Device Plate) and shall conform to UL Standards UL514 and be installed in accordance with all National Electrical Code requirements. The unit shall have a flush access door that rotates and allows access to the device. The unit shall be constructed of a stainless steel flush mounting plate system that rotates and allows access to the device.

2.4 WALL SWITCHES

A. Wall Switches: Heavy Duty, AC only general-use snap switch, complying with NEMA WD 6 and WD 1.
   1. Body and Handle: color by architect plastic with toggle handle, or red for emergency power devices.
   2. Locator Light: Lighted handle type switch; red color handle.
   3. Ratings: Match branch circuit and load characteristics.
   4. Switch shall be rated for the horse power of the motor served.

B. Switch Types: Single pole, double pole, 3-way, and 4-way.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Verify that outlet boxes are installed at proper height.
B. Verify that wall openings are neatly cut and will be completely covered by wall plates.
C. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.2 PREPARATION
A. Provide extension rings to bring outlet boxes flush with finished surface.
B. Clean debris from outlet boxes.

3.3 INSTALLATION
A. Install securely, in a neat and workmanlike manner, as specified in NECA 1.
B. Install devices plumb and level.
C. Do NOT utilize back wiring on any wiring device.
D. Install receptacles with grounding pole on top.
E. Do not install receptacles within 6" of the edge of sinks.
F. Connect wiring device ground terminal to outlet box with bonding jumper.
G. All receptacles installed as listed below shall be GFCI type.
   1. Receptacles installed outdoors.
   2. Receptacles installed within six feet of sinks.
   3. Receptacles designated for electric drinking fountains.
   4. Receptacles designated for vending machines.
   5. Any other receptacles specifically indicated on the drawings.
   6. Receptacles installed in residential mechanical rooms.
H. Install decorative plates in finished areas.
I. Connect wiring devices by wrapping conductor around screw terminal.
J. Provide engraved stainless steel wall plates that indicate the branch circuit to which the associated device is connected. Use 1/8" high black letters.

3.4 FIELD QUALITY CONTROL
A. Perform all field inspection, testing, and adjusting specified in NETA STD ATS.
B. Inspect each wiring device for defects.
C. Verify that each receptacle device is energized.
D. Test each receptacle device for proper polarity.
E. Test each GFCI receptacle device for proper operation.

3.5 ADJUSTING
A. Adjust devices and wall plates to be flush and level.

3.6 CLEANING

A. It is anticipated that painting and other finish work may occur after device installation. Device plates shall not be installed until these activities are completed. Protect device and conductors by installing molded plastic cover.

B. Clean exposed surfaces to remove splatters and restore finish.

END OF SECTION 262726
PART 1 - GENERAL

1.1 SUBMITTALS

A. Refer to section 260510.

1.2 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

C. Products: Furnish products listed and classified by Underwriters Laboratories Inc.; or testing firm acceptable to authority having jurisdiction as suitable for purpose specified and indicated.

1.3 REFERENCES

A. NEMA FU 1 - Low Voltage Cartridge Fuses; National Electrical Manufacturers Association; current edition.

B. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum); National Electrical Manufacturers Association; current edition.


PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable manufacturers
   1. Eaton Electrical/Cutler-Hammer
   2. GE Industrial
   3. Square D
   4. Siemens

2.2 NON-FUSIBLE SWITCH

A. Non-fusible Switch Assemblies: NEMA KS 1, Type HD enclosed load interrupter knife switch.
   1. Externally operable handle interlocked to prevent opening front cover with switch in ON position.
   2. Handle lockable in OFF position.

2.3 FUSIBLE SWITCH

A. Fusible Switch Assemblies: NEMA KS 1, Type HD enclosed load interrupter knife switch.
   1. Externally operable handle interlocked to prevent opening front cover with switch in ON position.
   2. Handle lockable in OFF position.
   3. Fuse clips: Designed to accommodate NEMA FU1, Class R or J fuse
2.4 MOLDED CASE CIRCUIT BREAKERS

A. Molded Case Circuit Breakers for circuit breakers smaller than 200 amps: UL listed for the following service conditions: Temperature: 40 degrees C. Provide HACR rated breakers where they serve HVAC equipment.

B. Field-Adjustable Trip Circuit Breakers: Provide circuit breakers with frame sizes 200 amperes and larger with mechanism for adjusting long time and short time current

2.5 ENCLOSURES

A. Enclosures: NEMA KS 1.
   1. Interior Dry Locations: Type 1.

2.6 ACCESSORIES

A. Shunt Trip Device: 120; volts, AC; provide where indicated.
   24; volts, DC; provide where indicated.

B. Undervoltage Trip Device: 120; volts, AC; provide where indicated

C. Auxiliary NO and NC contact: 120; volts, AC; provide where indicated

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with Manufacturer’s instructions.

B. Apply adhesive tag on inside door of each fused switch indicating NEMA fuse class and size installed.

C. All switches associated with outdoor equipment shall be located as close to the equipment as possible (when equipment is in a service yard, switches shall also be in the service yard) and mounted such that the top of the switch is no more than 6'-6" above grade. All switches associated with equipment mounted above a lay-in ceiling shall also be located above the lay-in ceiling.

D. Coordinate safety and disconnect switch installation with surrounding equipment to provide unobstructed access to the switch (4 foot clearance) and to insure that the switch is within sight of the controller or driven equipment.

3.2 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA STD ATS, except Section 4.

B. Perform inspections and tests listed in NETA STD ATS, Section 7.5.
C. Touch-up scratched or marred surfaces to match original finish.

D. Clean all debris from enclosure interiors.

E. Test all shunt trip and under voltage trip units.

3.3 LABELING

A. Provide nameplates on all switch enclosures wherein new circuits are modified or installed. Indicate the following information:
   1. Equipment Switch Serves.
   2. Branch Circuit.
   3. Normal (Black with white letters), Emergency Critical (Orange with black letters), Emergency Equipment (Green with black letters), or Emergency Life safety (Yellow with black letters)
   4. Voltage, phase, wire, short circuit current rating
   5. Date installed

3.4 CLEARANCE AND WORKSPACE

A. Maintain workspace and clearances as required by the NEC for the voltage encountered. No pipes or ducts shall pass above the outline of the switch enclosure. It shall be the responsibility of this Contractor to make sure that other trades do not encroach on this space.

END OF SECTION 262816
SECTION 26 43 00
SURGE PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 SUBMITTALS
A. Refer to section 260510.

1.2 QUALITY ASSURANCE
A. Reference Standard: Comply with the latest edition of the applicable provisions and recommendations of the following, except as otherwise stated in this document:
   1. UL 1449 3rd Edition 2009 Revision
   2. UL 1283.
   5. IEEE 1100 Emerald Book.

1.3 WARRANTY
A. Provide a 5 year product warranty

PART 2 - PRODUCTS

2.1 BASIS OF DESIGN
A. Acceptable manufacturers, contingent upon compliance with the contract documents, are as listed below. Bidders shall carefully review the requirements listed in the technical specifications and only submit products that are equal or better. Equal products by other manufacturers are acceptable providing substitutions are submitted in accordance with requirements listed in the front end specifications and approved by the A/E. Bidders shall carefully review the front end documents and submit all information required to allow the A/E the ability to make a fully informed decision.
   1. Current Technology – or equal

2.2 ELECTRICAL REQUIREMENTS
A. Declared Maximum Continuous Operating Voltage (MCOV) shall be greater than 115 percent of the nominal system operating voltage and in compliance with test and evaluation procedures outlined in the nominal discharge surge current test of UL1449 3rd Edition, section 37.7. MCOV values claimed based on the component’s value or on the 30-minute 115% operational voltage test, section 38 in UL1449 will not be accepted.
B. Unit shall have not more than 10% deterioration or degradation of the UL1449 3rd Edition Voltage Protective Rating (VPR) due to repeated surges. Unit shall have a monitoring option available to be able to test and determine the percentage of protective available at all times.
C. Protection Modes: SVR(6kV, 500A) and UL1449 3rd Edition VPR(6kV, 3kA) for grounded WYE/delta and High Leg Delta circuits with voltages of (480Y/277), (208Y/120), (600Y/347)
3-Phase/4 wire and (120/240) Split phase/3 wire circuits shall be as follows and comply with test procedures outlined in UL1449 3rd Edition section 37.6.

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<td>L-G</td>
<td>150</td>
<td>400/450</td>
<td>650/825</td>
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<td></td>
<td>L-L</td>
<td>300</td>
<td>400/500</td>
<td>950/1250</td>
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<td>277/480</td>
<td>L-N</td>
<td>320</td>
<td>550/600</td>
<td>1125/1225</td>
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<tr>
<td></td>
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<td>850/875</td>
<td>1075/1225</td>
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<td></td>
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<td>650/750</td>
<td>1950/2200</td>
<td>1500/1500</td>
<td>1800/1800</td>
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D. Electrical Noise Filter- each unit shall include a high performance EMI/RFI noise rejection filter. Noise attenuation for electric noise shall be as follows using the MIL-STD-220B insertion loss test method.
   1. 100 kHz at 44 db or better.
   2. All other frequencies should be 32 db or better.

E. Each fuse shall be individually sealed in a manner that eliminates the potential for cross arcing.

F. Each unit shall provide the following features:
   1. Phase Indicator lights, Form C dry contacts, surge counter and audible alarm.
   2. Field testable while installed.
   3. Measuring capability to indicate the percent protective available in SPD.

PART 3 - EXECUTION

3.1 INSTALLATION

A. SPD shall be installed per manufacturer’s installation instructions with lead lengths as short (less than 24”) and straight as possible. Gently twist conductors together.

B. Provide a circuit breaker in the electrical panel in accordance with manufacturer’s installation instructions.

C. The UL 1449 Voltage Protective Rating (VPR) shall be permanently affixed to the SPD unit.

D. The UL 1449 Nominal Discharge Surge Current Rating shall be a minimum of 20kA.

E. Surge Current Rating of device shall be as noted on drawings.

F. The SCCR rating of the SPD shall be 200kAIC without requiring an upstream protective device for safe operation.

G. The unit shall be listed as a Type 1 SPD, suitable for use in both Type 1 and Type 2 locations per UL1449 3rd Edition.
PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the requirements for the following:
   1. Interior luminaires and accessories.
   2. Emergency lighting units.
   3. Exit signs.
   4. Luminaire accessories.

1.2 SUBMITTALS

A. Refer to section 260510.

1.3 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70 and NFPA 101.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

C. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.4 REFERENCE STANDARDS


E. IESNA LM-80-08 – Approved Method: Measuring Lumen Maintenance of LED Light Sources.


G. NEMA WD 6 - Wiring Devices - Dimensional Requirements; National Electrical Manufacturers Association; current edition.


PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Basis of design is as scheduled on drawings. Acceptable manufacturers, contingent upon compliance with the contract documents, are as follows: Lithonia, Columbia, Metalux. Equal products by other manufacturers are acceptable providing substitutions are submitted in accordance with requirements listed elsewhere in the Bid Documents and approved by the A/E.

B. Prior Approved Equal Manufacturer(s) are listed in lighting fixture schedule on drawings.

C. LM-79 reports must be submitted with all proposed LED substitutions from Basis of Design, regardless of whether manufacturer is listed as an approved equal.

2.2 LUMINAIRES

A. Furnish products as indicated in Schedule on plans.

2.3 EMERGENCY LED DRIVERS

A. Regardless of catalogue number shown in fixture schedule, all fixtures indicated to be emergency type shall be provided with emergency type driver battery packs conforming to the following:

1. **Fixture Using Integral Emergency Driver/Battery Pack**: Provide emergency driver installed within the fixture. The charging light and test switch shall be accessible/visible from below. Driver/Battery must be capable of operating fixture at 75% of fixture lumens for a minimum of 90 minutes. Drivers/batteries shall have full 5-year warranty.

2. **Fixture Using Remote Emergency Driver/Battery Pack**: Provide Iota or Bodine emergency driver/battery pack installed remotely above accessible ceiling. Driver/Battery must be capable of operating fixture at 75% of fixture lumens for a minimum of 90 minutes. Drivers/batteries shall have full 5-year warranty.

B. Integral emergency drivers/batteries shall be factory installed whenever possible.

C. Drivers/batteries installed in fixtures located outdoors or unheated spaces shall be suitable for the ambient temperatures encountered or remotely located in a nearby accessible space.

2.4 EMERGENCY LIGHTING INVERTERS

A. Emergency lighting inverter shall be provided by a Bodine ELI Series inverter or prior approved equal with the following characteristics:


2. Upon failure of normal power, the device shall instantly begin providing emergency power to the connected lighting load for a minimum of 90 minutes. The device shall support lumen output at 91% of the lamp’s rating throughout the 90-minute duration.

3. The device shall operate at 120 or 277 VAC, 60 Hz and an ambient temperature of 68 degrees F to 86 degrees F.

4. The device shall have self-diagnostics operation in addition to a momentary test switch.

5. The unit shall be provided with a 3-year full coverage warranty and the battery shall have a 3-year warranty.

6. The unit shall have a recharge time of 24 hours and display a charging indicator light.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Install fixtures securely, in a neat and workmanlike manner, as specified in NECA 500 (commercial lighting).

B. Install suspended luminaires and exit signs using pendants supported from swivel hangers. Provide pendant length required to suspend luminaire at indicated height.

C. Locate recessed ceiling luminaires as indicated on reflected ceiling plan.

D. Install surface mounted luminaires and exit signs plumb and adjust to align with building lines and with each other. Secure to prevent movement.

E. Install recessed luminaires to permit removal from below.

F. Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.

G. Install clips to secure recessed grid-supported luminaires in place.

H. Install wall mounted luminaires, emergency lighting units, and exit signs at height as indicated on Drawings.

I. Install accessories furnished with each luminaire.

J. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.

K. Bond products and metal accessories to branch circuit equipment grounding conductor.

L. Install specified lamps in each emergency lighting unit, exit sign, and luminaire.

3.2 FIELD QUALITY CONTROL

A. Perform field inspection in accordance with Section 01 40 00.

B. Operate each luminaire after installation and connection. Inspect for proper connection and operation.

3.3 ADJUSTING

A. Aim and adjust luminaires as indicated.

B. Position exit sign directional arrows as indicated.

3.4 CLEANING

A. Clean electrical parts to remove conductive and deleterious materials.

B. Remove dirt and debris from enclosures.

C. Clean photometric control surfaces as recommended by manufacturer.
D. Clean finishes and touch up damage.

3.5 CLOSEOUT ACTIVITIES

A. Demonstrate luminaire operation for minimum of two hours.

3.6 PROTECTION

A. Replace/Repair luminaires that have failed at Substantial Completion.

END OF SECTION 265100
PART 1 - GENERAL

1.1 SUBMITTALS
   A. Refer to Section 260510.

1.2 QUALITY ASSURANCE
   A. Conform to requirements of NFPA 70 and NFPA 101.
   B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.3 REFERENCE STANDARDS

1.4 DELIVERY, STORAGE, AND HANDLING
   A. Poles: Do not store poles on ground. Store poles so they are at least 305 mm (one foot) above ground level and growing vegetation. Do not remove factory-applied pole wrappings until just before installing pole.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
   A. As scheduled or listed on the contract documents. Acceptable manufacturers, contingent upon compliance with the contract documents, are as follows: Lithonia, Columbia, Metalux. Equal products by other manufacturers are acceptable providing substitutions are submitted in accordance with requirements listed elsewhere in the Bid Documents and approved by the A/E.

2.2 LUMINAIRES
   A. Furnish products as indicated in Schedule on the contract documents.
   B. UL 1598 and NEMA C136.17. Luminaries shall be weatherproof, heavy duty, outdoor types designed for efficient light utilization, adequate dissipation of driver heat and safe cleaning.
   C. Lenses shall be frame-mounted heat-resistant, borosilicate glass, prismatic refractors. Attach the frame to the luminaire housing by hinges or chain. Use heat and aging resistant resilient gaskets to seal and cushion lenses and refractors in luminary doors.
   D. Materials shall be rustproof. Latches and fittings shall be non-ferrous metal.
   E. IESNA Cutoff Category: cutoff
PART 3 - EXECUTION

3.1 INSTALLATION
   A. Install lighting in accordance with the NEC, as shown on the drawings, and in accordance with manufacturer’s recommendations.
   B. Install fixtures securely, in a neat and workmanlike manner, as specified in NECA 500 (commercial lighting).
   C. Install accessories furnished with each luminaire.
   D. Connect luminaires and exit signs to branch circuit outlets provided under Section 26 05 37 using flexible conduit.
   E. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.
   F. Bond products and metal accessories to branch circuit equipment grounding conductor.
   G. Install specified lamps in each emergency lighting unit, exit sign, and luminaire.

3.2 GROUNDING
   A. Ground noncurrent-carrying parts of equipment including metal poles, luminaries, mounting arms, brackets, and metallic enclosures as specified in Section 26 05 26. Where copper grounding conductor is connected to a metal other than copper, provide specially treated or lined connectors suitable and listed for this purpose.

3.3 FIELD QUALITY CONTROL
   A. Operate each luminaire after installation and connection. Inspect for proper connection and operation.

3.4 ADJUSTING
   A. Aim and adjust luminaires as indicated.
   B. Position exit sign directional arrows as indicated.

3.5 CLEANING
   A. Clean electrical parts to remove conductive and deleterious materials.
   B. Remove dirt and debris from enclosures.
   C. Clean photometric control surfaces as recommended by manufacturer.
   D. Clean finishes and touch up damage.

3.6 CLOSEOUT ACTIVITIES
A. Demonstrate luminaire operation for minimum of two hours.

3.7 PROTECTION

A. Replace/Repair luminaires that have failed at Substantial Completion.

END OF SECTION 265600
SECTION 276410
RADIO FREQUENCY (RF) BASED SIGNAL BOOSTER SYSTEMS
(IN-BUILDING RADIO ENHANCEMENT SYSTEM) (DAS)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. The contractor will design full functional signal booster system for the local first responders
   radio systems and furnish, install and provide a one-year warranty for the system.

1.3 SUBMITTALS

A. Refer to section 260510.

PART 2 - PRODUCTS

2.1 RADIO FREQUENCY (RF) BASED SIGNAL BOOSTER SYSTEMS

A. Completed cabling installations must comply with all applicable code and standards, including
   the NEC, NFPA, ANSI, NEC, OSHA, EIA, IEEE, R-56, etc. as well as the FC Rules and
   Regulations, as applicable. Equipment provided must be UL listed and FCC type accepted for
   this specification application. Compliance to codes and standards must extend to include
   proper grounding, bonding and surge protection.

B. The contractor shall provide a system that has digital signal strength coverage over 95% area
   of the equipped building. Provide coverage for all radio frequencies required by the AHJ and
   local first responders.

C. The system must provide a minimum digital and analog overage of Circuit Merit (CM) 3, with
   a reliability factor of 95%. A Coverage Acceptance Test must be executed prior to final
   acceptance of an installed system. Coverage acceptance testing must be based on audio
   quality performance in evenly spaced test grids in the defined service areas. A minimum of
   20 tests will be taken for floor/level. Total number of test grids will be determined by the
   Owner, based on the size of the space per floor/level.

D. The original Proof of Performance report must be submitted to the Engineer, and a copy of
   the Proof of Performance report must be affixed to its associated equipment.

E. Design and appearance will be of “finished” construction. i.e. must be concealed and/or
   unobtrusive. Surface raceway and/or exposed conduit installations are not acceptable.

F. All cabling shall be installed in conduit, unless otherwise noted on the drawings.
G. Brace roof mounted antennas to 165 MPH wind. Antennas shall not be visible from grade. Aim antennas to the local first responder radio repeater antenna.

H. The secondary power source shall consist of the following:
   1. A storage battery dedicated to the system with at least 12 hours of 100 percent system operation capacity and arranged in accordance with NFPA 72 (10.6.10) if the building is not equipped with an automatic-starting, engine-driven generator.

I. In-building radio systems required by this ordinance must provide the following signal strengths: Downlink - Minimum signal strength of -95 dBm throughout the coverage area. Minimum signal strength of -95 dBm received at the public safety Radio System.

J. The signal booster and all other active components shall be listed for the intended purpose. UL 2524 – UL listing, In-building 2-Way Emergency Radio Communication Enhancement Systems.

K. All signal booster components shall be contained in a type-4 approved waterproof cabinet. All enclosures shall be painted red with a locking mechanism.

L. Antenna isolation shall be maintained between the donor antenna and all inside antennas (D.A.S.) to a minimum of 20dB under all operating conditions.

M. To prevent radio interference and degradation of public safety radio systems, signal boosters shall not emit any measurable uplink noise while idle. The signal booster shall contain an automatic uplink noise suppression function.

N. The In-Building Radio system shall include automatic supervisory and trouble signals for malfunctions of the signal booster(s) and power supplies that are annunciated by the fire alarm system. System and Signal booster supervisory signals shall include Antenna Malfunction and Signal booster failure.

O. The In-Building Radio system shall be monitored by a listed fire alarm control unit, or where approved by the fire code official, shall sound an audible signal at a constantly attended 24/7 on-site location.

PART 3 - EXECUTION

3.1 WARRANTY

A. The contactor shall provide a full one-year warranty to cover installation and all components; the warranty must commence upon the Owner’s final acceptance of the facility. Under warranty coverage, the successful contactor shall provide same business day response time for system malfunctions.

B. Test fault reporting system for proper operation and reporting of system faults.

C. All as-builts shall be submitted to the owner at completion, which shall include cable system layout, along with product information sheets.
D. Test the system and submit signal strength heat maps showing compliance with requirements.

E. Provide a functional test of the system for the AHJ.

END OF SECTION 276410
PART 1 - GENERAL

1.1 RELATED SECTIONS

A. All division 28 work shall, in addition to all division 1 specification sections, comply with all of the requirements in the following specification sections:

26 05 00 Common Work Results for Electrical
26 05 10 Electrical Submittals
26 05 11 Electrical Work Closeout
26 05 12 Electrical Coordination
26 05 19 Low-Voltage Electrical Conductors and Cables
26 05 26 Grounding and Bonding for Electrical Systems
26 05 29 Hangers and Supports for Electrical Systems
26 05 33 Raceway and Boxes for Electrical Systems
26 05 48 Vibration and Seismic Controls for Electrical Systems
26 05 53 Identification for Electrical Systems
26 27 26 Wiring Devices

END OF SECTION 28 05 00
SECTION 28 31 11
DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Fire-alarm control unit.
   3. System smoke detectors.
   5. Device guards.
   7. Digital alarm communicator transmitter.
   8. Network communications.

1.2 DEFINITIONS

A. EMT: Electrical Metallic Tubing.

B. FACP: Fire Alarm Control Panel.

C. HLI: High Level Interface.


E. PC: Personal computer.

F. VESDA: Very Early Smoke-Detection Apparatus.

1.3 ACTION SUBMITTALS

A. Refer to Specification 260510 Electrical Submittals.

1.4 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. NFPA Certification: Obtain certification according to NFPA 72 by an NRTL (nationally recognized testing laboratory).

1.5 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.
   1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Source Limitations for Fire-Alarm System and Components: Provide system manufacturer's certification that all components provided have been tested as, and will operate as, a system.

B. Noncoded, UL-certified addressable system, with multiplexed signal transmission and horn/strobe evacuation.

C. Automatic sensitivity control of certain smoke detectors.

D. All components provided shall be listed for use with the selected system.

E. 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.

F. Provide TVSS for any exterior mounted or remote from building annunciation or alarm devices.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire-alarm signal initiation shall be by one or more of the following devices:
   2. Smoke detectors.
   3. Duct smoke detectors.

B. Fire-alarm signal shall initiate the following actions:
   1. Continuously operate alarm notification appliances.
   2. Identify alarm and specific initiating device at fire-alarm control unit connected network control panels, off-premises network control panels and remote annunciators.
   3. Transmit an alarm signal to the remote alarm receiving station.
   4. Release fire and smoke doors held open by magnetic door holders.
   5. Activate voice/alarm communication system.
   6. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
   7. Close fire smoke dampers.
   8. Activate emergency shutoffs for gas and fuel supplies.
   9. Record events in the system memory.
  10. Indicate device in alarm on the remote annunciator.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:
   1. Independent fire-detection and -suppression systems.
   2. User disabling of zones or individual devices.
   3. Loss of communication with any panel on the network.

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 communication with any addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
   4. Loss of primary power at fire-alarm control unit.
   5. Ground or a single break in internal circuits of fire-alarm control unit.
   6. Abnormal ac voltage at fire-alarm control unit.
   7. Break in standby battery circuitry.
   8. Failure of battery charging.
9. Abnormal position of any switch at fire-alarm control unit or annunciator.
10. Defibrillator cabinet door open.

E. System Supervisory Signal Actions:
1. Initiate notification appliances.
2. Identify specific device initiating the event at fire-alarm control unit.
3. Record the event on system printer.
4. After a time delay of 200 seconds, transmit a trouble or supervisory signal to the remote alarm receiving station.
5. Transmit system status to building management system.
6. Display system status on graphic annunciator.

2.3 FIRE-ALARM CONTROL UNIT

A. Acceptable manufacturers, contingent upon compliance with the contract documents, are as listed below. Bidders shall carefully review the requirements listed in the technical specifications and only submit products that are equal or better. Equal products by other manufacturers are acceptable providing substitutions are submitted in accordance with requirements listed in the front end specifications and approved by the A/E. Bidders shall carefully review the front end documents and submit all information required to allow the A/E the ability to make a fully informed decision.
1. GAMEWELL.
2. Notifier.
4. SimplexGrinnell LP.
5. Edwards
6. Honeywell Fire Lite
7. Eaton/ Cooper

B. General Requirements for Fire-Alarm Control Unit:
1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.
   a. System software and programs shall be held in nonvolatile flash, electrically erasable, programmable, read-only memory, 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.
   c. Provide communication between the FACP and remote circuit interface panels, annunciators, and displays.
   d. The FACP shall be listed for connection to a central-station signaling system service.
   e. Provide nonvolatile memory for system database, logic, and operating system and event history. The system shall require no manual input to initialize in the event of a complete power down condition. The FACP shall provide a minimum 500-event history log.

2. Addressable Initiation Device Circuits: The FACP shall indicate which communication zones have been silenced and shall provide selective silencing of alarm notification appliance by building communication zone.
3. Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: The FACP shall be listed for releasing service.

C. 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.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.

D. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:
1. Pathway Class Designations: NFPA 72, Class B.

E. Notification-Appliance Circuit:
1. Audible appliances shall sound in a three-pulse temporal pattern, as defined in NFPA 72.
2. Where notification appliances provide signals to sleeping areas, the alarm signal shall be a 520-Hz square wave with an intensity 15 dB above the average ambient sound level or 5 dB above the maximum sound level, or at least 75 dBA, whichever is greater, measured at the pillow.
3. Visual alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.

F. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.

G. 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 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.

H. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

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. Single-action mechanism, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
2. Station Reset: Key- or wrench-operated switch.
3. Indoor Protective Shield: Factory-fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.
4. 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. 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.
3. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
4. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
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 for smoke detection in HVAC system ducts.
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.

2.6 NOTIFICATION APPLIANCES

A. 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.

B. 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.
1. Basis of design color shall be white, coordinate with architect.

C. Visible Notification Appliances: Xenon strobe lights complying 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.
2.7 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.

2.8 DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632.

B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture two 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 either 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.
   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.
   5. Loss of power.
   6. Low battery.
   7. Abnormal test signal.

E. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
   1. Verify that manufacturer’s written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.
B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EQUIPMENT INSTALLATION

A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."
   1. Devices placed in service before all other trades have completed cleanup shall be replaced.
   2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.

B. Install wall-mounted equipment, with tops of cabinets not more than 78 inches (1980 mm) above the finished floor.
   1. Comply with requirements for seismic-restraint devices specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

C. Manual Fire-Alarm Boxes:
   1. Install manual fire-alarm box in the normal path of egress within 60 inches (1520 mm) of the exit doorway.
   3. The operable part of manual fire-alarm box shall be between 42 inches (1060 mm) and 48 inches (1220 mm) above floor level. All devices shall be mounted at the same height unless otherwise indicated.

D. Smoke- or Heat-Detector Spacing:
   1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
   2. Comply with the "Heat-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, 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 Annex A in NFPA 72.
   5. HVAC: Locate detectors not closer than 60 inches (1520 mm) 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 and not directly above pendant mounted or indirect lighting.

E. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.

F. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Tubes more than 36 inches (9100 mm) long shall be supported at both ends.
   1. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.

G. Air-Sampling Smoke Detectors: If using multiple pipe runs, the runs shall be pneumatically balanced.
H. 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.

I. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.

J. 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. Install all devices at the same height unless otherwise indicated.

K. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches (150 mm) below the ceiling. Install all devices at the same height unless otherwise indicated.

L. Device Location-Indicating Lights: Locate in public space near the device they monitor.

3.3 PATHWAYS

A. Fire alarm cabling shall be run in J-hooks above accessible ceilings and in exposed to structure areas. Fire alarm cable shall not be supported by building structure or above other ceiling systems. The fire alarm cabling must be supported by a dedicated support system.

1. Exposed pathways located less than 96 inches (2440 mm) above the floor shall be installed in EMT.

B. Pathways shall be installed in red EMT.

C. Exposed EMT in public areas shall be painted to match the background color of the ceiling area.

3.4 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 Section 087100 "Door Hardware." Connect hardware and devices to fire-alarm system.

1. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.

B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches (910 mm) from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.

1. Smoke dampers in air ducts of designated HVAC duct systems.
2. Magnetically held-open doors.
3. Alarm-initiating connection to elevator recall system and components.
4. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
5. Supervisory connections at valve supervisory switches.
6. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
7. Supervisory connections at elevator shunt-trip breaker.
8. Supervisory connections at defibrillator locations.
9. Supervisory connections at fire-pump power failure including a dead-phase or phase-reversal condition.
10. Supervisory connections at fire-pump engine control panel.
3.5 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.
B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.6 CIRCUIT BREAKERS
A. Circuit breakers serving fire alarm devices shall be provided with a red fire alarm circuit breaker lockout kit that permanently identifies circuit as "FIRE ALARM".

3.7 FIELD QUALITY CONTROL
A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
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 the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
   b. Comply with the "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.
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" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
B. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
C. Fire-alarm system will be considered defective if it does not pass tests and inspections.
D. Prepare test and inspection reports.
E. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.
F. 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.

3.8 MAINTENANCE SERVICE
A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months’ full maintenance by skilled employees of manufacturer's designated service
organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

1. Include visual inspections according to the "Visual Inspection Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

3.9 SOFTWARE SERVICE AGREEMENT

A. Comply with UL 864.

B. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

C. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

3.10 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 28 31 11
SECTION 31 10 00
SITE CLEARING

PART 1 - GENERAL

1.01 SUMMARY OF WORK:

A. The specification section covers the extent of site clearing as indicated on the contract drawings. Site clearing work includes, but is not limited to, protection of existing trees, removal of trees, stumps, shrub and other vegetation; grubbing out of roots and root systems; stripping and stockpiling topsoil from the project site.

1.02 RELATED DOCUMENTS

A. General: Drawings and general provisions of Contract, including General Conditions apply to work of this section.

B. Site Demolition: Coordinate work with the requirements of Section 02 41 13 SELECTIVE SITE DEMOLITION.

1.03 JOB CONDITIONS:

A. Traffic: Conduct site clearing operations to ensure minimum interference with 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. Sediment & Erosion Control Measures: Comply with the erosion control measures indicated on the drawings, as specified in Section 01 57 13 TEMPORARY EROSION CONTROL, and as required in the approved SWPPP/SCDHEC Permit. Perform inspections and certifications on erosion control system as required in the approved SWPPP and as specified.

C. Protection of Existing Improvements:
   1. Provide protections necessary to prevent damage to existing improvements indicated to remain in place.
   2. Protect improvements on adjoining properties and on Owner's property.
   3. Restore damaged improvements to their original condition, as acceptable to parties having jurisdiction.

D. Protection of Existing Trees and Vegetation:
   1. Protect existing trees and other vegetation indicated to remain in place, against unnecessary cutting, breaking or skinning of roots, skinning and bruising or bark, smothering of trees by stockpiling construction materials or excavated materials within drip line. Prohibit vehicular traffic, or parking of vehicles within drip line.
   2. Erect and secure a temporary tree barricade or fence barrier as indicated on the construction drawings.
   2. Water trees and other vegetation to remain within limits of contract work as required to maintain their health during course of construction operations.
3. Provide protection for roots over 1-1/2" diameter cut during construction operations. Coat cut faces with 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.

4. Replace any tree designated to remain that is damaged during the work under this contract with like-kind or as approved by the Architect. Employ licensed arborist to repair damage to trees and shrubs.

PART 2 - PRODUCTS

Not applicable to work of this section.

PART 3 - EXECUTION

3.01 SITE CLEARING:

A. General: Remove trees, shrubs, grass and other vegetation, interfering with installation of new construction. Remove such items elsewhere on site or premises as specifically indicated in accordance with Section 02 41 13 SELECTIVE SITE DEMOLITION. Removal includes digging out stumps and roots. Carefully and cleanly cut roots and branches of trees indicated to be left standing, where such roots and branches obstruct new construction.

B. Topsoil:

1. Topsoil is defined as friable clay loam surface soil found in a depth of not less than 6". 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.

2. Strip topsoil to whatever depths encountered in a manner to prevent intermingling with underlying subsoil or other objectionable material.

3. Remove heavy growths of grass from areas before stripping.

4. Where trees are indicated to be left standing, stop topsoil stripping a sufficient distance to prevent damage to main root system.

5. Stockpile topsoil in storage piles in areas shown, or where directed. Construct storage piles to freely drain surface water. Cover storage piles if required to prevent wind-blown dust.

6. Dispose of unsuitable or excess topsoil same as waste material, herein specified.

C. Clearing and Grubbing:

1. Clear site of trees, shrubs and other vegetation, except for those indicated to be left standing. 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 be left standing.

3. Fill depressions caused by clearing and grubbing operations with satisfactory soil material,
unless further excavation or earthwork is indicated. Place fill material in horizontal layers not exceeding 8” loose depth, and thoroughly compact to a density equal to adjacent original ground. Comply with Section 31 20 00 EARTH MOVING for backfilling and compaction operations.

3.02 REMOVAL OF IMPROVEMENTS:

A. Remove existing above-grade and below-grade improvements necessary to permit construction, and other work as indicated, and in conformance with Section 02 41 13 SELECTIVE SITE DEMOLITION.

3.03 DISPOSAL OF WASTE MATERIALS:

A. Burning will not be allowed.

B. Removal of Waste Materials: Transport and dispose of non-combustible waste materials and unsuitable or surplus topsoil materials offsite, at the Contractors expense.
PART 1 - GENERAL

1.01 SUMMARY OF WORK

A. Work included: Excavate, backfill, compact, and grade the site to the elevations shown on the Drawings, as specified herein, and as needed for the installation of underground utilities, storm drainage, systems, roadway subgrades, building pads, foundation structures, and general site grading, and also to meet the requirements of the construction shown in the Contract Documents.

B. Related Work: Documents affecting work of this section include, but are not necessarily limited to, General Provisions and Modifications of these Specifications.

1.02 QUALITY ASSURANCE

A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

B. Use equipment adequate in size capacity, and numbers to accomplish the work of this Section in a timely manner.

C. In addition to complying with requirements of governmental agencies having jurisdiction, comply with the directions of the Engineer. Where the term “Engineer” is used herein, it is inferred to include the Project Civil Engineer Designer of Record, the Geotechnical (Soil) Engineer, or Project Architect, as assigned by the Owner as his representative.

D. Testing required for this part of the work will be furnished by the Contractor.

PART 2 - PRODUCTS

2.01 SOIL MATERIALS

A. Fill and backfill materials:

1. General Requirements: Utilize existing on-site soils from on-site excavations for general site fill and backfill where feasible and suitable. Soils used for site fill and backfill should generally consist of sands classified as SP, SP-SC, SC, SP-SM, or SM soils according to the Unified Soil Classification System. In addition, soil used for fill and backfill should be free of roots, organics, debris and other deleterious matter. Provide soil materials in lawns and landscape beds that have a maximum of 25% fines (material passing the No.200 sieve).

2. Off-site Fill (Borrow) Material: Borrow material is that material removed from excavations and imported from off-site borrow areas and may vary in composition depending on its intended use in the work. Provide off-site borrow where insufficient soil exists on site to accomplish the backfilling and filling required to achieve the indicated grades or elevations, or if unsuitable soils are found on site for the work. Off-site borrow material is subject to the approval of the Engineer. In this specification it refers to predominantly granular, non-expansive soils free from roots and other deleterious matter, normally referred to as
“Select Fill”, “Structural Fill” or “Controlled Fill”. For the purposes of this specification, it shall be referred to as “Controlled Fill.”

Controlled fill borrow material shall be free from roots, debris, organic matter, and deleterious substances, containing no rocks or lumps larger than 2" in their greatest dimension, and containing no more than 12% fines (material passing No. 200 sieve) and having a maximum Dry Density as defined by ASTM D-1557 of 105 pcf. Submit samples of materials to soils laboratory for testing and approval prior to execution of filling.

3. Do not permit rocks having a dimension greater than 1" in the upper 12" of fill or embankment.

4. Cohesionless materials used for trench backfill: Utilize existing material excavated from the trench provided it meets the General Requirements specified above. Borrow material utilized for trench backfill shall meet the requirements specified for Select borrow material, and approved by the Engineer, unless specifically required otherwise in other sections or indicated on the drawings.

2.02 GRAVEL BEDDING

A. Aggregate Gradation: Provide coarse aggregate, Number 57 stone, with gradation as shown on Table A-4 of the SCDOT 2007 Edition of the Standard Specification for Highway Construction. Aggregate shall be composed of crushed angular granite.

PART 3 - EXECUTION

3.01 SURFACE CONDITIONS

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

B. Erosion and Sediment Control: Coordinate and comply with the erosion control measures indicated on the drawings, and as specified in Section 02 41 10, SITE DEMOLITION AND EROSION CONTROL.

C. Topsoiling: Remove all topsoil and surface deleterious matter in accordance with:

1. Strip topsoil to whatever depths encountered in a manner to prevent intermingling with underlying subsoil or other objectionable material.

2. Remove heavy growths of grass from areas before stripping.

3. Stockpile topsoil in storage piles on-site in areas directed. Construct storage piles to freely drain surface water. Cover storage piles if required to prevent wind-blown dust.

4. Dispose of unsuitable or excess topsoil same as waste material, herein specified

D. Densification and Proof-rolling:

1. Proof roll testing will be required in vehicular pavement areas and building foundation areas, except it is not required over pile supported building foundations. After removal of topsoil, and other surface overburden (cut soils) to design subgrade elevation, but prior to installation of any required fill material, densify existing soils to a uniform consistency by making six to eight passes with a large (10-ton or larger) vibratory roller. If water is drawn to the surface, the vibrator should be disengaged, and the densification continued.

2. After completion of the densification process, proof roll the densified subgrade with a dump truck or pneumatic tire roller with a minimum weight of 15 tons.
3. Proof-roll over all areas at speeds of 2.5 to 3.5 miles per hour. Proof-rolling shall be done in the presence of the Engineer. Rutting or pumping may indicate unsatisfactory material or satisfactory material with a high moisture content.

4. Undercut areas as directed and replace with approved controlled fill material.

5. Proof-roll only when weather conditions permit. Do not proof-roll wet or saturated subgrades. Materials degraded by proof-rolling of wet subgrades shall be replaced by the Contractor at no cost to the Owner.

E. Mucking:

1. When unsatisfactory or unsuitable soils (muck) are encountered and are required to be removed by the Engineer, the cost of the removal and replacement shall be determined according to the contract provisions, when payment is to be based upon a unit price, such price shall be determined as noted below.

2. Mucking Unit Price: Contractor shall provide a unit price for mucking (removable of unsuitable soils). The unit price shall include the removal of unsuitable soils below the area of stripping (assume 6" stripping and indicated subgrade cut) and shall include the disposal of muck offsite. The unit price shall also include backfilling and compacting with approved controlled fill. The unit cost submitted shall be based upon in-place measurement. No truck measures will be allowed. The approved or negotiated unit price will be used to modify the contract price.

F. Undercutting and Gravel Bedding: Where specified or indicated, provide gravel bedding (#57 stone) below all subsurface or infiltration drains. Depth of bedding will be as indicated. Assume groundwater will be encountered at the depth of excavation required to install the gravel bedding and provide a dewatering system to control groundwater levels during trenchwork construction.

3.02 PROCEDURES:

A. Protection of Utilities:

1. Contractor shall contact Palmetto Utilities Protection Services (PUPS) at 1-888-721-7877 or "811", a minimum of three (3) business days prior to beginning construction.

2. Unless shown to be removed, protect active utility lines shown on the drawings or otherwise made known to the Contractor prior to excavating. If damaged, repair or replace at no additional cost to the Owner.

3. If active utility lines are encountered and are not shown on the Drawings or otherwise made known to the Contractor, promptly take necessary steps to assure that service is not interrupted.

4. If service is interrupted as a result of work under this Section, immediately restore service by repairing the damaged utility at no additional cost to the Owner.

5. If existing utilities are found to interfere with the permanent facilities being constructed under this section, immediately notify the Engineer and secure his instructions.

6. Do not proceed with permanent relocations of utilities until written instructions are received from the Engineer.

B. Protection of persons and property:

1. Barricade open holes and depressions occurring as part of the Work, and post warning lights on property adjacent to or with public access.

2. Operate warning lights during hours from dusk to dawn each day and as otherwise
required.

3. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, washout, and other hazards created by operations under this Section.

C. Dewatering: The Contractor is responsible for managing all surface rainfall runoff water in a manner to protect the stability of the exposed soils in excavations and subgrades in paved areas on the site. This includes both surface water and subsurface water. Surface water control may include temporary ditches, temporary swales, temporary drain holes and or inlet openings in storm boxes to prevent ponding around inlets located in paved areas. Coordinate all temporary drainage devices with the approved SWPPP plan and Section 02 41 10, SITE DEMOLITION AND EROSION CONTROL.

D. Dust Control: Use means necessary to prevent dust becoming a nuisance to the public, to neighbors, and to other work being performed on or near the site. Airborne dust control is also a part of the environmental protection requirements, just as rainwater erosion. The use of watering trucks, or other such techniques shall be employed as needed to control wind-borne dust.

E. Maintain access to adjacent areas at all times.

3.03 GENERAL EXCAVATION

A. Perform excavating of every type of material encountered within the limits of the Work to the lines, grades, and elevations indicated and specified herein.

B. Unsatisfactory excavated materials:
   1. Excavate to a distance below grade as directed by the Engineer and replace with materials in accordance with the paragraph entitled "Mucking."
   2. Include excavation of unsatisfactory materials, and replacement by satisfactory materials, as parts of the work of this Section.

C. Surplus materials: All site surface strippings and surplus satisfactory excavated material shall be stockpiled on-site, in the designated stockpile storage area, unless specifically directed otherwise in writing by the Owner and Engineer.

D. Excavation of rock: Based on geotechnical subsurface report, no rock, or boulders will be encountered during excavation or earthwork.

E. Excavate and backfill in a manner and sequence that will provide proper drainage at all times.

F. Borrow: Obtain material required for fill or embankment in excess of that produced within the grading limits of the Work from borrow areas selected and paid for by the Contractor and approved by the Engineer.

G. Ditches and gutters:
   1. Cut accurately to the cross sections, grades, and elevations shown.
   2. Maintain excavations free from detrimental quantities of leaves, sticks, trash, and other debris until completion of the Work.
   3. Dispose of excavated materials as shown on the Drawings or directed by the Engineer; except do not, in any case, deposit materials less than 3'-0" from the edge of a ditch.
H. Unauthorized excavation:
   1. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific instruction from the Engineer.
   2. Under footings, foundations, or retaining walls:
      a. Fill unauthorized excavations by extending the indicated bottom elevation of the footing or base to the excavation bottom, without altering the required top elevation.
      b. When acceptable to the Engineer, gravel bedding may be used to bring the bottom elevation to proper position.
   3. Elsewhere, backfill and compact unauthorized excavations as specified for authorized excavations, unless otherwise directed by the Engineer.

I. Stability of excavations:
   1. Shore and brace where sloping is not possible because of space restrictions or stability of the materials being excavated.
   2. Maintain sides and slopes of excavations in a safe condition until completion of backfilling.

J. Shoring and bracing:
   1. Provide materials for shoring and bracing as may be necessary for safety personnel, protection of work, and compliance with requirements of governmental agencies having jurisdiction.
   2. Maintain shoring and bracing in excavations regardless of the time period excavations will be open.
   3. Carry shoring and bracing down as excavation progresses.

K. Excavating for structures: Conform the elevations and dimensions shown within a tolerance of 0.10 ft. and extending a sufficient distance from footings and foundations to permit placing and removing concrete formwork, installation of services, other construction required, and for inspection.

L. When excavating for pavements, cut surface to comply with cross sections, elevations, and grades.

M. Cold weather protection: Protect excavation bottoms against freezing when atmospheric temperature is less than 35 degrees F.

3.04 TRENCHING FOR UTILITIES

A. Provide sheeting and shoring necessary for protection of the work and for the safety of personnel.
   1. Prior to backfilling, remove all sheeting.
   2. Do not permit sheeting to remain in the trenches except when, in the opinion of the Engineer, field conditions or the type of sheeting or methods of construction such as use of concrete bedding are such as to make removal of sheeting impracticable. In such cases, the Engineer may permit portions of sheeting to be cut off and remain in the trench.

B. Open cut:
   1. Excavate for utilities by open cut.
   2. If conditions at the site prevent such open cut, and if approved by the Engineer trenching
may be used.

3. Short sections of a trench may be tunneled if, in the opinion of the Engineer, the conductor can be installed safely and backfill can be compacted properly into such tunnel.

4. Where it becomes necessary to excavate beyond the limits of normal excavation lines in order to remove boulders or other interfering objects, backfill the voids remaining after removal of the objects as directed by the Engineer.

5. When the void is below the subgrade for the utility bedding, use suitable earth material and compact as approved by the Engineer, but in no case to the relative density directed less than 90%.

6. When the void is in the side of the utility trench or open cut, use suitable earth or sand compacted or consolidated as approved by the Engineer, but in no case to a relative density less than 80%.

7. Remove boulders and other interfering objects, and backfill voids left by such removals, at no additional cost to the Owner.

8. Excavating for appurtenances:
   a. Excavate for manholes and similar structures to a distance sufficient to leave at least 12" clear between outer surfaces and the embankment or shoring that may be used to hold and protect the banks.
   b. Overdepth excavation beyond such appurtenances that has not been directed, will be considered unauthorized. Fill with sand, gravel, or lean concrete as directed by the Engineer, and at no additional cost to the Owner.

C. Trench to the minimum width necessary for proper installation of the utility, with sides as nearly vertical as possible. Accurately grade the bottom to provide uniform bearing for utility.

D. Depressions:
   1. Dig bell holes and depressions for joints after the trench has been graded. Provide uniform bearing for the pipe on prepared bottom of the trench.
   2. Do not excavate below the depth indicated or specified.

E. Where utility runs traverse public property or are subject to governmental or utility company jurisdiction, provide depth, bedding, cover, and other requirements as set forth by legally constituted authority having jurisdiction, but in no case less than the depth shown in the Contract.

3.05 BEDDING FOR UTILITIES

A. Provide bedding as indicated on the Drawings for each utility.

3.06 BACKFILLING OF UTILITY TRENCHES

A. General:
   1. Do not completely backfill trenches until required tests have been performed, and until the utilities systems as installed conform to the requirements specified in their pertinent Sections of these Specifications.
   2. Except as otherwise specified or directed for special conditions, backfill trenches to the ground surface with selected material approved by the Engineer.
   3. Reopen trenches which have been improperly backfilled, to a depth as required for proper
compaction. Refill and compact as specified, or otherwise correct to the approval of the Engineer.

4. Do not allow or cause any of the Work performed or installed to be covered up or enclosed by work of this Section prior to required inspections, tests, and approvals.

5. Should any of the Work be so enclosed or covered up before it has been approved, uncover all such work and, after approvals have been made, refill and compact as specified, all at no additional cost to the Owner.

B. Lower portion of trench:

1. Deposit approved backfill and bedding material in layers of 6” maximum thickness and compact with suitable tampers to the density of the adjacent soil, or grade as specified herein, until there is a cover of not less than 24” over sewer and 12” over other utility lines.

2. Take special care in backfilling and bedding operations as not to damage pipe and pipe coatings.

C. Remainder of trench:

1. Except for special materials for pavements, such as “flowable fill”, backfill the remainder of the trench with material free from stones larger than 6” or 1/2 the layered thickness, whichever is smaller, in any dimension.

2. Deposit backfill material in layers not exceeding the thickness specified and compact each layer to the minimum density indicated.

D. Adjacent to buildings: Mechanically compact backfill within ten feet of buildings.

3.07 GENERAL SITE FILLING AND BACKFILLING

A. General: For each classification listed below, place acceptable soil material layers to required subgrade elevations.

1. In excavations, use satisfactory excavated or borrow material.

2. Under asphalt pavements, use approved on-site fill or controlled fill borrow materials as approved by Engineer.

3. Under building slabs, use approved on-site fill or controlled fill borrow materials as approved by Engineer.

B. Backfill excavations as promptly as progress of the Work permits, but not until completion of the following.

1. Acceptance of construction below finish grade including, where applicable, damp-proofing and water-proofing.

2. Inspecting, testing, approving, and recording locations of underground utilities.

3. Removing concrete formwork.

4. Removing shoring and bracing and backfilling of voids with satisfactory materials.

5. Removing trash and debris.

6. Placement of horizontal bracing on horizontally supported walls.

C. Ground surface preparation:

1. Remove vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious matter from ground surface prior to placement of fills. Coordinate and comply with the
requirements of Section 31 10 00, SITE CLEARING.

2. Plow, strip, or break up sloped surfaces steeper than one vertical to four horizontal so that fill materials will bond with existing surfaces.

3. When existing ground surface has a density less than specified under "compacting" for the particular area, break up the ground surface, pulverize, moisture-condition to the optimum moisture content, and compact to required depth and percentage of maximum density.

D. Placing and Compacting:

1. Place backfill and fill materials in layers not more than 8" in loose depth. Conform with paragraph entitled "COMPACTING."

2. Before compacting, moisten or aerate each layer as necessary to provide the optimum moisture content.

3. Compact each layer to required percentage of maximum density for area.

4. Do not place backfill or fill material on surface that are muddy, frozen, or containing frost or ice.

5. Place backfill and fill materials evenly adjacent to structures, to required elevations.

6. Take care to prevent wedging action of backfill against structures by carrying the material uniformly around the structure to approximately the same elevation in each lift.

3.08 GRADING

A. General:

1. Uniformly grade the areas within limits of grading under this Section, including adjacent transition areas.

2. Smooth the finished surfaces within specified tolerance.

3. Compact with uniform levels or slopes between points where elevations are shown on the Drawings, or between such points and existing grades.

4. Where a change of slope is indicated on the Drawings, construct a rolled transition section having a minimum radius of approximately 8'0", unless adjacent construction will not permit such a transition, or if such a transition defeats positive control of drainage.

B. Grading outside building lines:

1. Grade areas adjacent to buildings to achieve drainage away from the structures, and to prevent ponding.

2. Finish the surfaces to be free from irregular surface changes, and:

   a. Shape the surface of areas scheduled to be under walks to line, grade, and cross-section, with finished surface not more than 0.10 ft. above or below the required subgrade elevation.

   b. Shape the surface of areas scheduled to be under pavement to line, grade and cross section, with finished surface not more than 0.05 ft. above or below the required subgrade elevation.

3.09 COMPACTING

A. Control soil compaction for other than clay soils during construction to provide the minimum percentage of density specified for each area as determining according to ASTM D 1557.
B. Provide not less than the following maximum density of soil material compacted at optimum moisture content for the actual density of each layer of soil material in place, and as approved by the Engineer.

1. Lawn, playing field and other non-paved areas: Compact the top 8" of subgrade and each layer of fill material or backfill material at 90% of maximum density.

2. Walks: Compact the top 8" of subgrade and each layer of fill material or backfill material at 95% of maximum density.

3. Vehicular Pavements: Compact the top 12" of subgrade and each layer of fill material or backfill material at 95% of maximum density.

4. Utility Trenches: Compact initial backfill and top 12" above the utility at 95% of maximum density. Where utilities cross under paved areas compact the remainder of trench at 95% of maximum density; and at 90% of maximum density for unpaved areas.

5. Slabs and foundations:
   a. Where existing unstable soils have been removed, backfill shall be placed in thin successive layers 8 inches to 10 inches loose measurement. Each layer shall be compacted to at least 95% of its maximum laboratory dry density. All soil beneath building floor slabs and footings shall be compacted to at least 95% of its maximum density.
   b. The gravel bedding layer shall be lightly tamped to seat the stone into the underlying insitu soil and to dispel large voids. Vibratory compactors shall not be used.

C. Moisture Control:

1. Where subgrade or layer of soil material must be moisture-conditioned before compacting, uniformly apply water to surface of subgrade or layer of soil material to prevent free water appearing on surface during or subsequent to compacting operations.

2. Remove and replace, or scarify and air dry, soil material that is too wet to permit compacting to the specified density.

3. Soil material that has been removed because it is too wet to permit compacting may be stockpiled or spread and allowed to dry. Assist drying by discing, harrowing, or pulverizing until moisture content is reduced to a satisfactory value as determined by moisture-density relation tests approved by the Engineer.

3.10 QUALITY CONTROL

A. Secure the Engineer's inspection and approval of subgrades, and fill layers before subsequent construction is permitted thereon.

B. Provide at least the following tests to the approval of the Engineer:

1. At paved areas, each lift of fill or backfill shall be tested for density and moisture content at a frequency of one test for every 5000 square feet (sf), but not less than three tests.

2. In utility trenches, each lift of fill or backfill shall be tested for density and moisture content at a frequency of one test for every 50 linear feet of compacted trench

3.11 MAINTENANCE

A. Protection of newly graded areas:

1. Protect newly graded areas from traffic and erosion and keep free from trash and weeds.

2. Protect newly graded and excavated subgrade soils from standing water in low points or in open excavations. The contractor will be responsible for subgrades soils or excavation.
areas where the stability of the soils is damaged, or the soils made unstable due to failure to provide proper drainage during construction.

3. Repair and reestablish grades in settled, eroded, and rutted areas to the specified tolerances.

B. Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify the surface, reshape, and compact to the required density prior to further construction.

END OF SECTION
SECTION 31 31 16
TERMITE CONTROL

PART 1 GENERAL
1.01 SECTION INCLUDES
A. Chemical soil treatment.

1.02 REFERENCE STANDARDS

1.03 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Indicate toxicants to be used, composition by percentage, dilution schedule, intended application rate.
C. Test Reports: Indicate regulatory agency approval reports when required.
D. Manufacturer's Application Instructions: Indicate caution requirements.
E. Manufacturer's Certificate: Certify that toxicants meet or exceed specified requirements.
F. Maintenance Data: Indicate re-treatment schedule.
G. Warranty: Submit warranty and ensure that forms have been completed in Owner's name.

1.04 QUALITY ASSURANCE
A. Installer Qualifications: Company specializing in performing this type of work and:
   1. Having minimum of 4 documented experience.
   2. Licensed in the State in which the Project is located.

1.05 WARRANTY
A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
B. Provide five year installer's warranty against damage to building caused by termites.
   1. Include coverage for repairs to building and to contents damaged due to building damage.
   2. Repair damage and, if required, re-treat.

PART 2 PRODUCTS
2.01 MATERIALS
A. Toxicant Chemical: EPA approved; synthetically color dyed to permit visual identification of treated soil.
B. Diluent: Recommended by toxicant manufacturer.

2.02 MIXES
A. Mix toxicant to manufacturer's instructions.

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify that soil surfaces are unfrozen, sufficiently dry to absorb toxicant, and ready to receive treatment.
B. Verify final grading is complete.

3.02 APPLICATION
A. Comply with requirements of U.S. EPA and applicable state and local codes.
B. Spray apply toxicant in accordance with manufacturer's instructions.
C. Apply toxicant at following locations:
   1. Under Slabs-on-Grade.
   2. At Both Sides of Foundation Surface.
D. Under slabs, apply toxicant immediately prior to installation of vapor barrier.
E. At foundation walls, apply toxicant immediately prior to finish grading work outside foundations.
F. Apply extra treatment to structure penetration surfaces such as pipe or ducts, and soil penetrations such as grounding rods or posts.
G. Re-treat disturbed treated soil with same toxicant as original treatment.
H. If inspection or testing identifies the presence of termites, re-treat soil and re-test.

3.03 PROTECTION
A. Do not allow soil grading over treated work.

END OF SECTION
SECTION 32 12 16
ASPHALT PAVING AND BASE COURSE

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, and Specifications Section 31 20 00 EARTH MOVING, apply to work of this section.

B. All work shall be in conformance with the South Carolina State Highway Standard Specifications for Highway Construction, Edition of 2007, with the latest addenda and revisions as specified in the Supplemental Technical Specifications; hereafter referred to as "SCDOT-SS."

1.02 DESCRIPTION OF WORK

Extent of asphalt concrete paving work is as shown on construction drawings.

1.03 SUBMITTALS

A. Material Certificates: Provide copies of material certificates signed by material supplier and Contractor, certifying that each material item complies with, or exceeds, specified requirements.

B. Mx Design: Provide copies of each type of asphaltic concrete mix, approved by the SCDOT within the last 12 months, indicated to be used in the project.

C. Test Reports

1. Sampling and Testing of aggregate base course material. Contractor shall make the proposed source material stockpiles available to the approved testing laboratory for sampling and testing for sieve analysis. If recycled concrete is submitted, also provide a percent content by volume of foreign and deleterious material and a description of such foreign and deleterious material. Contractor must select a single type of aggregate material from the options allowed and that selected source, once approved may not be substituted or mixed with any other source or type of aggregate material without express written permission by the Engineer.

2. Field Density Tests: provide field density tests of the aggregate base course material in-place as specified.

1.04 QUALITY ASSURANCE

Sampling and testing are the responsibility of the Contractor and performed by an approved testing laboratory. Test the materials to establish compliance with the specified requirements; perform testing at the specified frequency. The Engineer may specify the time and location of the field density tests at his discretion; otherwise, the test points will be randomly selected. Furnish copies of test results to the Engineer within 24 hours of completion of the tests.

A. Sampling: Take samples of aggregate base course for laboratory testing in conformance with ASTM D 75/D 75M. When deemed necessary, the sampling will be observed by the Engineer. Test results of sampling shall confirm material supplied meets the specified gradation. If Crushed Recycled Concrete (CRC) material is used, sample testing shall also measure the quantity of any foreign material by volume.
B. Preconstruction Tests: Perform one of each of the following tests, on the proposed aggregate base course material prior to commencing construction, to demonstrate that the proposed material meets all specified requirements when furnished. If materials from more than one source are going to be utilized, this testing shall be completed for each source.

1. Sieve Analysis: Make sieve analysis in conformance with ASTM C 117 and ASTM C 136. Sieves shall conform to ASTM E 11. Submit certified copies of test results for approval not less than 30 days before material is required for the work.

2. Liquid Limit and Plasticity Index: Determine liquid limit and plasticity index in accordance with ASTM D 4318. Submit certified copies of test results for approval not less than 30 days before material is required for the work.

3. Moisture-Density Determinations: Determine the laboratory maximum dry density and optimum moisture content in accordance with AASHTO T 180, Method D and corrected with AASHTO T 224. Submit calibration curves and related test results prior to using the device or equipment being calibrated.

All sampling, testing, and documentation is the responsibility of the Contractor.

1.05 JOB CONDITIONS

Weather Limitations: Asphalt mixture shall be placed in conformance with Section 401.4.4 of the SCDOT-SS. Minimum ambient air temperature shall not be below 55 degrees F; minimum ground surface temperature shall not be below 45 degrees F.

1.06 GRADE CONTROL

Establish and maintain required lines and elevations as specified in Section 01 71 23, CONSTRUCTION STAKEOUT AND FIELD ENGINEERING.

1.07 CRITERIA FOR BIDDING

A. Lump Sum Price

1. The items listed in the proposal shall be considered as sufficient to complete the work in accordance with the plans and specifications. Any portion of the work not specifically listed in the bid form shall be deemed a part of the item with which it is associated and shall be included in the lump sum price. The price shall be full compensation for the material, compaction, shaping, finishing, dressing, disposal of surplus material, testing, construction supervision and all other work required for satisfactory completion of the asphaltic concrete pavement system.

2. Asphalt Index: The contract shall be adjusted based upon the amount of Asphalt Cement Binder placed (ton) multiplied by the adjustment per unit. For this project the Base Index date shall be the most current one as of the date of the bid. The index and adjustment table are available at https://www.scdot.org/business/docs/Fuel_and_AC_Index_Spreadsheet.xlsx.

   a. Method of Measurement: Asphalt base, binder, and surface courses will be measured by the ton. The quantity shall be the weight, using approved scales, used in the accepted work and no deduction will be made for the weight of asphalt materials in the mixture. The quantity of liquid asphalt binder in the paving mixture shall be the number of tons contained in the accepted work. The amount of asphalt binder in the mix shall be determined by either the centrifuge method of extraction, ignition oven, or at the option of the Engineer may be the amounts as printed on the load tickets by use of an approved ticket printer. In order to check scale accuracy when using a ticket printer for the payment of asphalt binder, periodic extraction tests will be made (not for pay purposes) on mixes other than those that contain...
marine limestone or slag. The quantity of asphalt will not include any asphalt that may be absorbed by the aggregate; therefore, if an absorbent type aggregate (such as marine limestone or slag) is used in the composition mixture and a discrepancy is determined between the centrifuge method of extraction or ignition oven and the ticket printer, the centrifuge method of extraction shall be used for payment of the asphalt binder. Samples from the extraction tests are to be made in order to determine the asphalt content may be taken from mixtures before or after incorporating the mix in the pavement structure. The frequency of sampling shall be submitted to the Engineer for approval. When the asphalt binder is not measured by ticket printout, the percentage of asphalt binder as determined by the field laboratory shall be used to determine the quantity of asphalt binder in the pavement mix, unless otherwise directed by the Engineer. Deductions will be made for asphalt mixture wasted or lost due to negligence of the Contractor; asphalt mix or asphalt binder applied in excess of the rate specified or directed in writing; and any asphalt mixture applied beyond the limits of work.

PART 2 - PRODUCTS

2.01 AGGREGATE BASE COURSE MATERIALS

A. Graded Aggregate Base Course (GABC): Graded aggregate base course (GABC) is well graded, durable aggregate uniformly moistened and mechanically stabilized by compaction. Provide GABC consisting of clean, sound, durable particles of crushed natural stone, crushed gravel, crushed recycled concrete, angular sand, or other approved material. GABC shall be free of lumps of clay, organic matter, and other objectionable materials or coatings. The portion retained on the No. 4 sieve is known as coarse aggregate; that portion passing the No. 4 sieve is known as fine aggregate. All material shall pass a 2-inch mesh sieve and shall be graded uniformly down to dust. Fine material shall consist entirely of dust of fracture. Liquid limit shall not exceed 35 and material shall be non-plastic as determined by ASTM D4318.

1. Crushed Gravel: Crushed gravel shall be manufactured by crushing gravels and shall meet all the requirements specified below.

2. Crushed Stone: Provide crushed stone consisting of freshly mined quarry rock, meeting all the requirements specified below.

3. Crushed Recycled Concrete: Provide crushed recycled concrete consisting of previously hardened Portland cement concrete. The recycled material shall be free of all reinforcing steel, bituminous concrete, surfacing materials, and any other foreign material (i.e. PVC or metal conduits, ceramic tile, composite floor tile, wood, plastics, wire or other metals, etc.) and shall be crushed and processed to meet the required gradations. The Owner has the right to reject any CRC base if the material supplied contains foreign matter and deleterious material.

B. Gradation Requirements: Apply the specified gradation requirements to the completed base course. The aggregates shall be continuously well graded within the limits specified in TABLE 1. Sieves shall conform to ASTM E 11.

<table>
<thead>
<tr>
<th>SIEVE</th>
<th>MACADAM*</th>
<th>MARINE LIMESTONE</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 inch</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>1 ½ inch</td>
<td>95-100</td>
<td>95-100</td>
</tr>
<tr>
<td>1 inch</td>
<td>70-100</td>
<td>70-100</td>
</tr>
<tr>
<td>½ inch</td>
<td>48-75</td>
<td>50-85</td>
</tr>
</tbody>
</table>

TABLE 1. GRADATION OF AGGREGATES
Percentage by Weight Passing Square-Mesh Sieve
2.02 ASPHALT MATERIALS

A. Asphaltic Concrete Intermediate Course

1. Asphaltic Concrete Intermediate Course shall comply with SCDOT-SS standard Hot Mixed Asphalt (HMA) Intermediate Course, Type B or Type C, as indicated and per the following specifications:
   b. Fine Aggregate: ASTM D 1073; except as modified herein

2. Mix: Produce mix in an approved plant from an approved job-mix formula based on the following:

<table>
<thead>
<tr>
<th>SIEVE</th>
<th>TYPE B</th>
<th>TYPE C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 inch</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>3/4 inch</td>
<td>98 – 100</td>
<td>90 - 100</td>
</tr>
<tr>
<td>1/2 inch</td>
<td>90 – 95</td>
<td>80 - 95</td>
</tr>
<tr>
<td>3/8 inch</td>
<td>72 – 90</td>
<td>68 - 87</td>
</tr>
<tr>
<td>No. 4</td>
<td>44 – 62</td>
<td>45 - 68</td>
</tr>
<tr>
<td>No. 8</td>
<td>23 – 43</td>
<td>30 - 46</td>
</tr>
<tr>
<td>No. 30</td>
<td>10 – 25</td>
<td>12 - 29</td>
</tr>
<tr>
<td>No. 100</td>
<td>4 – 12</td>
<td>4 - 13</td>
</tr>
<tr>
<td>No. 200</td>
<td>2 – 8</td>
<td>2 - 8</td>
</tr>
</tbody>
</table>

   a. Binder Limits, % 4.5 - 6.0* 4.0 – 6.0*
   b. Binder Grade: PG 64-22 PG 64-22
   c. Total Air Voids: 3.2 - 4.0 3.5 - 4.5
   d. Voids Filled w/Asphalt (VFA): 70% - 78% 70% - 77%
   e. The use of recycled asphalt pavement (RAP) in the mix shall be in conformance with the SCDOT-SS.

   * Asphalt binder content may be increased on percentage of aged binder in mixture as approved by SCDOT. AV & VFA limits will be allowed to extend outside of design ranges above once binder content is adjusted and approved by SCDOT OMR.

B. Asphaltic Concrete Surface Course

1. Asphaltic concrete surface course shall comply with SCDOT-SS standard Hot Mixed Asphalt (HMA) Surface Course, Type B or Type C, as indicated and per the following specifications:
   b. Fine Aggregate: ASTM D1073; except as modified herein
d. Asphalt Binder: AASHTO M 320, PG 64-22, Performance grade.

2. Mix: Produce mix in an approved plant from an approved job-mix formula based on the following:

<table>
<thead>
<tr>
<th>SIEVE</th>
<th>TYPE B</th>
<th>TYPE C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 inch</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>3/4 inch</td>
<td>98 - 100</td>
<td>100</td>
</tr>
<tr>
<td>1/2 inch</td>
<td>90 - 100</td>
<td>97 - 100</td>
</tr>
<tr>
<td>3/8 inch</td>
<td>72 - 90</td>
<td>83 - 100</td>
</tr>
<tr>
<td>No. 4</td>
<td>44 - 62</td>
<td>58 - 80</td>
</tr>
<tr>
<td>No. 8</td>
<td>23 - 43</td>
<td>42 - 62</td>
</tr>
<tr>
<td>No. 30</td>
<td>10 - 25</td>
<td>20 - 40</td>
</tr>
<tr>
<td>No. 100</td>
<td>4 - 12</td>
<td>8 - 20</td>
</tr>
<tr>
<td>No. 200</td>
<td>2 - 8</td>
<td>3 - 9</td>
</tr>
</tbody>
</table>

a. Binder Limits, %: 4.8 - 6.0*           5.0 – 6.8*
b. Binder Grade: PG 64-22 PG 64-22
c. Air Voids, %: 3.0 – 4.0 3.5 – 4.5
d. Voids Filled w/Asphalt: 70% - 80% 70% - 77%
e. The use of recycled asphalt pavement (RAP) in the mix shall be in conformance with the SCDOT-SS.

* Asphalt binder content may be increased on percentage of aged binder in mixture as approved by SCDOT. AV & VFA limits will be allowed to extend outside of design ranges above once binder content is adjusted and approved by SCDOT OMR.

2.03 BITUMINOUS PRIME COAT AND TACK COAT MATERIALS

A. Bituminous Prime Coat: Bituminous prime coat materials shall be RC-70 or RC-250, liquid asphalt conforming to ASTM D2028; or emulsified asphalt Grades SS-1 or SS-1h conforming to ASTM D977; or cationic emulsified asphalt grades CSS-1 or CSS-1h conforming to ASTM D2397. Emulsified asphalt may be diluted in equal proportion with water.

B. Bituminous Tack Coat: Provide a tack coat material consisting of binder or emulsified asphalt as identified on the SCDOT Qualified Product List 37 or 38. The acceptable grades of emulsified asphalt are RS-1, MS-1, MS-2, HFMS-1, HFMS-2, SS-1, CRS-1, CRS-2, CMS-2, and CSS-1. Emulsified asphalt, with the exception of Grades RS-1 and CRS-1, may be diluted with up to 50 percent with water provided the dilution occurs at the manufacturing plant using acceptable procedures and not diluted at the point of use.

C. Contractor’s Option: The contractor may use, at his option, any prime or tack coat material on the current SCDOT list of approved materials.

PART 3 - EXECUTION

3.01 SURFACE PREPARATION

A. Inspect finished subgrade surface for smoothness, compaction and stability (proof-roll) in
accordance with Section 31 20 00, EARTH MOVING. Remove loose material from compacted subgrade surface immediately prior to installation of base course material. Notify Engineer of unsatisfactory conditions. Do not begin installation of base course until deficient subgrade areas have been corrected.

3.02 INSTALLATION

A. Compacting and Finishing of Aggregate Base Course: Spread finished mixture uniformly and compact to at least 100 percent of maximum laboratory density as determined in accordance with ASTM D1557, Method D. Determine in-place density in accordance with ASTM D1556 or ASTM D2922. After compaction, finished surface of aggregate base course shall not vary more than 3/8 inch when tested with a 10-foot straightedge. Finished thickness of base course shall not vary more than 1/2 half inch from the required thickness at any point and the average of all depth measurements shall be at least that indicated. Areas not meeting the specified requirements will be rejected until corrected by the Contractor at no additional cost to the Owner.

B. Bituminous Prime Coat and Tack Coat

1. Prime Coat for Aggregate Base Course: When specifically indicated on construction drawings, apply bituminous prime coat to the completed and accepted aggregate base course after receiving approval for priming. For macadam or recycled concrete, apply at a rate of not less than 0.25 gallons per square yard and not more than 0.30 gallons per square yard. For marine limestone base course, apply at a rate of not less than 0.08 gallons per square yard and not more than 0.12 gallons per square yard. Obtain the Engineer's approval for the temperature of application and weather conditions for application. Do not permit traffic on the primed area until the prime coat has cured adequately.

2. Bituminous Tack Coat: Before laying any new asphalt pavement over existing pavement, uniformly apply the tack coat to the surface of the existing pavement at the rate of 0.05 to 0.15 gallons per square yard. Place lesser amounts on new pavements and greater amounts on older pavements to ensure a bond between the surface being paved and the new overlying asphalt paving course. Also apply tach to the edges of all pavements when patching pavements, tying new pavements into existing, or making trench repairs.

C. Spreading and Compacting of Asphaltic Concrete Intermediate and Surface Courses:

1. Spread wearing course with a bituminous spreader at a temperature of not less than 225 degrees F nor more than 325 degrees F. Roll, while hot with a steel-wheel roller weighing not less than 10 tons and a pneumatic-tired roller.

2. In areas where the use of machine-spreading is impractical, spread the mixture on approved dump boards or an adjacent approved area outside the area to be paved and distribute into place from the dump boards or from the approved area by means of hot shovels. Spread mixture with hot rakes in a uniformly loose layer of thickness that when compacted will conform to the required grade and thickness. During hand spreading, carefully place each shovelful of mixture by turning the shovel over in a manner that will prevent segregation. In no case shall the mixture be placed by throwing or broadcasting from a shovel. Do not dump the loads any faster than can be properly handled by the shovelers and rakers.

3. The finished thickness and surface tolerances shall be as specified in paragraph entitled FIELD QUALITY CONTROL. The average thickness of all depth measurements shall be at least the thickness indicated. Reject any area not meeting any one of the above requirements until corrected by the Contractor.
3.03 FIELD QUALITY CONTROL

A. General: Test in-place asphalt concrete courses for compliance with requirements for thickness and surface smoothness. Repair or remove and replace unacceptable paving as directed by Engineer.

B. Thickness: In-place compacted thickness will not be acceptable if exceeding following allowable variation from required thickness.
   1. Aggregate Base Course: 1/2", plus or minus
   2. HMA Intermediate Course: 1/4", plus or minus
   3. HMA Wearing Course: 1/4", plus or minus

C. Surface Smoothness: Test finished surface of each construction course, aggregate base and asphalt concrete course for smoothness, using 10' straightedge applied parallel with, and at right angles to centerline of paved area, at intervals as directed by the Engineer. Surfaces will not be acceptable if, exceeding the following tolerances of smoothness.
   1. Aggregate Base Course Surfaces: 3/8"
   2. HMA Intermediate Course Surfaces: 1/4"
   3. HMA Wearing Course Surfaces: 1/8"

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. The work shall include construction of pedestrian Portland cement concrete walkways on a prepared subgrade as specified herein and to the dimensions, typical sections and notations as shown on the Drawings. Construction shall be to the lines and grades as shown on the Drawings.

1.02 REFERENCE STANDARDS

Unless otherwise indicated, all referenced standards shall be the latest edition available at the time of bidding. Any requirements of these specifications shall in no way invalidate the minimum requirements of the referenced standards.

SCDOT SS  South Carolina State Highway Department Standard Specifications (2007 Edition), Section 720, "Concrete Curb, Gutter, Curb and Gutter, Sidewalk, Driveway, and Median"

ASTM C 31/C 31M  Standard Practice for Making and Curing Concrete Test Specimens in the Field

ASTM C 143/C 143M  Standard Test Method for Slump of Hydraulic-Cement Concrete

ASTM C 171  Standard Specification for Sheet Materials for Curing Concrete

ASTM C 172  Standard Practice for Sampling Freshly Mixed Concrete

ASTM C 309  Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete

ASTM C 31/C 31M  Standard Practice for Making and Curing Concrete Test Specimens in the Field

ASTM C 920  Standard Specification for Elastomeric Joint Sealants

ASTM D 1751  Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)

ASTM D 1752  Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction

ASTM D 5893  Cold Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements
1.03 WORKMANSHIP

A. The Contractor is responsible for correction of concrete work which does not conform to the specified requirements, including strength, tolerances and finishes. Correct deficient concrete as directed by the Engineer.

1.04 SUBMITTALS

The following shall be submitted for approval prior to starting work:

A. Product Data: Provide manufacturer’s product data sheets for the following items. Data sheets should include material dimensions and/or standards confirming material will meet indicated or specified standards of quality or performance.
   1. Expansion joint materials
   2. Concrete curing materials
   3. Joint sealants

B. Design Data
   1. Concrete Mix Design: Thirty days minimum prior to concrete placement, submit a mix design, with applicable tests, for each strength and type of concrete for approval. Submit a complete list of materials including type; brand; source and amount of cement, fly ash, slag, and admixtures; and applicable reference specifications. Submittal shall clearly indicate where each mix design will be used when more than one mix design is submitted. Submit a new mix design for each material source change.

C. Test Reports
   1. Field Quality Control Tests for Concrete
      a. Strength Test
      b. Slump Test
      c. Surface evaluation

Copies of all test reports within 24 hours of completion of the test

1.05 WEATHER LIMITATIONS

A. Placing During Cold Weather: Concrete placement shall not take place when the air temperature reaches 40 degrees F and is falling or is already below that point. Placement may begin when the air temperature reaches 35 degrees F and is rising, or is already above 40 degrees F. Provisions shall be made to protect the concrete from freezing during the specified curing period. If concrete must be placed when the temperature of the air, aggregates, or water is below 35 degrees F, placement and protection shall be approved in writing. Approval will be contingent upon full conformance with the following provisions. The underlying material shall be prepared and protected so that it is entirely free of frost when the concrete is deposited. Mixing water and aggregates shall be heated as necessary to result in the temperature of the in-place concrete being between 50 degrees and 85 degrees F. Methods and equipment for heating shall be approved. The aggregates shall be free of ice, snow, and frozen lumps before entering the mixer. Covering and other means shall be provided for maintaining the concrete at a temperature of at least 50 degrees F for not less than 72 hours after placing, and at a temperature above freezing for the remainder of the curing period.

B. Placing During Warm Weather: The temperature of the concrete as placed shall not exceed 85 degrees F except where an approved retarder is used. The mixing water and/or aggregates
shall be cooled, if necessary, to maintain a satisfactory placing temperature. The placing temperature shall not exceed 95 degrees F at any time.

PART 2 - PRODUCTS

2.01 FORMS

A. Forms shall be of wood or metal and of a depth equal to or greater than the typical section shown on Drawings. Provide flexible or curved forms where required or directed to prevent a "chord" effect between tangent points when placing forms in areas having specified radii as indicated on the Drawings.

B. Forms shall be free from warp, and of sufficient strength when staked to hold the alignment specified during concrete placing and finishing operations.

C. All forms shall be cleaned and oiled prior to placement of concrete.

2.02 PORTLAND CEMENT CONCRETE

A. Concrete shall be Class 3000 (3,000 psi 28-day compressive strength), as defined by the South Carolina State Highway Department Standard Specifications, (2007 Edition), Section 701, "Portland Cement Concrete for Structures." All concrete shall be ready mixed as produced by a reputable manufacturer, acceptable to the Engineer.

1. Air Content: Mixtures shall have air content by volume of concrete of 5 to 7 percent, based on measurements made immediately after discharge from the mixer.

2. Slump: The concrete slump for static formed work shall be 4 inches plus or minus 1 inch where determined in accordance with ASTM C 143/C 143M.

2.03 JOINTS AND JOINING MATERIALS

A. Expansion Joint Filler: Preformed expansion joint filler shall conform to ASTM D 1751 or ASTM D 1752, 1/2-inch-thick extending for the full depth of the concrete section, unless indicated otherwise.

B. Sealants:

1. Building Perimeter Expansion Joint Sealant: Joint sealant material for sealing the top of the expansion joint located around the exterior perimeter of the building where exterior concrete walk pavement abuts the building shall be a one-component moisture-curing polyurethane elastomeric compound, ASTM C 920, Type S, Grade NS, Class 35, color-Gray. Acceptable manufacturer is Master Seal NP-1 or equal.

2. Sidewalk Control Joint Sealant: Joint sealant material for sealing control joints in Portland cement concrete walkway pavements, where indicated, shall be a cold applied, single component, chemically curing silicone sealant, per ASTM D 5893. Does not apply to exterior perimeter expansion joints specified above.

2.04 CONCRETE CURING MATERIALS

A. Impervious Sheet Materials: Impervious sheet materials shall conform to ASTM C 171, type optional, except that polyethylene film, if used, shall be white opaque.

B. White Pigmented Membrane-Forming Curing Compound: White pigmented membrane-forming curing compound shall conform to ASTM C 309, Type 2, Class B, free of paraffin or petroleum.
PART 3 - EXECUTION

3.01 GENERAL

Construct forms to the exact sizes, shapes, lines, and dimensions shown, and as required to obtain accurate alignment, location, and grades.

3.02 SUBGRADE PREPARATION

The subgrade shall be constructed to the specified grade and cross section prior to concrete placement. Subgrade shall be placed and compacted in conformance with Section 31 20 00 EARTH MOVING.

A. Sidewalk Subgrade: The subgrade shall be tested for grade and cross section with a template extending the full width of the sidewalk and supported between side forms.

B. Maintenance of Subgrade: The subgrade shall be maintained in a smooth, compacted condition in conformity with the required section and established grade until the concrete is placed. The subgrade shall be in a moist condition when concrete is placed. The subgrade shall be prepared and protected to produce a subgrade free from frost when the concrete is deposited.

3.03 FORMWORK

A. Forms shall be set to the indicated alignment, grade and dimensions. Forms shall be held rigidly in place by a minimum of 3 stakes per form placed at intervals not to exceed 4 feet. Corners, deep sections, and radius bends shall have additional stakes and braces, as required. Clamps, spreaders, and braces shall be used where required to ensure rigidity in the forms. Forms shall be removed without injuring the concrete. Bars or heavy tools shall not be used against the concrete in removing the forms. Any concrete found defective after form removal shall be promptly and satisfactorily repaired. Forms shall be cleaned and coated with form oil each time before concrete is placed.

3.04 SIDEWALK CONCRETE PLACEMENT AND FINISHING

A. Formed Sidewalks: Concrete shall be placed in the forms in one layer. When consolidated and finished, the sidewalks shall be of the thickness indicated. After concrete has been placed in the forms, a strike-off guided by side forms shall be used to bring the surface to proper section to be compacted. The concrete shall be consolidated with an approved vibrator, and the surface shall be finished to grade with a strike off.

B. Concrete Finishing: After straight edging, when most of the water sheen has disappeared, and just before the concrete hardens, the surface shall be finished with a wood float or darby to a smooth and uniformly fine granular or sandy texture free of waves, irregularities, or tool marks. A scored surface shall be produced by brooming with a fiber-bristle brush in a direction transverse to that of the traffic, after edging.

C. Edge and Joint Finishing: All slab edges, including those at formed joints, shall be finished with an edger having a radius of 1/8-inch. Transverse joint shall be edged before brooming, and the brooming shall eliminate the flat surface left by the surface face of the edger. Corners and edges which have crumbled and areas which lack sufficient mortar for proper finishing shall be cleaned and filled solidly with a properly proportioned mortar mixture and then finished.

D. Surface and Thickness Tolerances: Finished surfaces shall not vary more than 5/16-inch from the testing edge of a 10-foot straightedge. Permissible deficiency in section thickness will be
3.05 SIDEWALK JOINTS

Sidewalk joints shall be constructed to divide the surface into rectangular areas. Transverse contraction joints shall be spaced at a distance equal to the sidewalk width or 5 feet on centers, whichever is less, unless indicated otherwise on the drawings, and shall be continuous across the slab. Longitudinal contraction joints shall be constructed along the centerline of all sidewalks 10 feet or more in width. Expansion joints shall be formed about structures and features which project through or into the sidewalk pavement, using joint filler of the type, thickness, and width indicated.

A. Sidewalk Contraction Joints: The contraction joints shall be formed in the fresh concrete by cutting a groove in the top portion of the slab to a depth of at least one-fourth of the sidewalk slab thickness, using a jointer to cut the groove, or by sawing a groove in the hardened concrete with a power-driven saw, unless otherwise approved. Sawed joints shall be constructed by sawing a groove in the concrete with a 1/8-inch blade to the depth indicated as soon as the concrete is hard enough to support the sawing operation, preferably within 3-6 hours, but not greater than 24 hours. The sawing shall be performed at the locations of the hand tooled joint groove to ensure the proper depth of ¼ of the total thickness is achieved at each joint location.

B. Sidewalk Expansion Joints: Expansion joints shall be formed with 1/2-inch joint filler strips. Joint filler shall be placed with top edge 1/4 inch below the surface and shall be held in place with steel pins or other devices to prevent warping of the filler during floating and finishing. Immediately after finishing operations are completed, joint edges shall be rounded with an edging tool having a radius of 1/8 inch, and concrete over the joint filler shall be removed. At the end of the curing period, expansion joints shall be cleaned and sealed with specified joint sealant.

3.06 INSTALLATION OF SEALANT

A. Time of Application: Seal joints immediately following final cleaning of the joint walls and following the placement of the separating or backup material. Open joints, that cannot be sealed under the conditions specified, or when rain interrupts sealing operations shall be recleaned and allowed to dry prior to installing the sealant.

B. Sealing Joints: Immediately preceding, but not more than 50 feet ahead of the joint sealing operations, perform a final cleaning with compressed air. Fill the joints from the bottom up to 1/4 inch plus or minus 1/16 inch below the pavement surface. Remove and discard excess or spilled sealant from the pavement by approved methods. Install the sealant in such a manner as to prevent the formation of voids and entrapped air. In no case shall gravity methods or pouring pots be used to install the sealant material. Traffic shall not be permitted over newly sealed pavement until authorized by the Architect. When a primer is recommended by the manufacturer, apply it evenly to the joint faces in accordance with the manufacturer's instructions. Check the joints frequently to ensure that the newly installed sealant is cured to a tack-free condition within the time specified.

3.07 CURING AND PROTECTION

A. General Requirements: Concrete shall be protected against loss of moisture and rapid temperature changes for at least 7 days from the beginning of the curing operation. Unhardened concrete shall be protected from rain and flowing water. All equipment needed for adequate curing and protection of the concrete shall be on hand and ready for use before actual concrete placement begins. Protection shall be provided as necessary to prevent
cracking of the pavement due to temperature changes during the curing period.

1. Impervious Sheeting Method: The entire exposed surface shall be wetted with a fine spray of water and then covered with impervious sheeting material. Sheets shall be laid directly on the concrete surface with the light-colored side up and overlapped 12 inches when a continuous sheet is not used. The curing medium shall not be less than 18-inches wider than the concrete surface to be cured and shall be securely weighted down by heavy wood planks, or a bank of moist earth placed along edges and laps in the sheets. Damaged sheets shall be repaired or replaced, if damaged during the curing period. The curing medium shall remain on the concrete surface to be cured for not less than 7 days.

2. Liquid Membrane Curing Method: A uniform coating of white-pigmented membrane-curing compound shall be applied to the entire exposed surface of the concrete as soon after finishing as the free water has disappeared from the finished surface. Formed surfaces shall be coated immediately after the forms are removed and in no case longer than 1 hour after the removal of forms. Concrete shall not be allowed to dry before the application of the membrane. If any drying has occurred, the surface of the concrete shall be moistened with a fine spray of water and the curing compound applied as soon as the free water disappears. Curing compound shall be applied in two coats by hand-operated pressure sprayers at a coverage of approximately 200 square feet per gallon for the total of both coats. The second coat shall be applied in a direction approximately at right angles to the direction of application of the first coat. The compound shall form a uniform, continuous, coherent film that will not check, crack, or peel and shall be free from pinholes or other imperfections. If pinholes, abrasion, or other discontinuities exist, an additional coat shall be applied to the affected areas within 30 minutes. Concrete surfaces that are subjected to heavy rainfall within 3 hours after the curing compound has been applied shall be resprayed by the method and at the coverage specified above. Areas where the curing compound is damaged by subsequent construction operations within the curing period shall be resprayed. Necessary precautions shall be taken to ensure that the concrete is properly cured at sawed joints. Concrete surfaces to which membrane-curing compounds have been applied shall be adequately protected during the curing period from pedestrian and vehicular traffic, except as required for joint-sawing operations and surface tests.

B. Backfilling: After curing, debris shall be removed and the area adjoining the concrete shall be backfilled, graded, and compacted to conform to the surrounding area in accordance with lines and grades indicated.

C. Protection: Completed concrete shall be protected from damage until accepted. The Contractor shall repair damaged concrete and clean concrete discolored during construction. Concrete that is damaged shall be removed and reconstructed for the entire length between regularly scheduled joints. Refinishing the damaged portion will not be acceptable. Removed damaged portions shall be disposed of as directed.

3.08 FIELD QUALITY CONTROL

A. General Requirements: The Contractor shall perform the inspection and tests described and meet the specified requirements for inspection details and frequency of testing. Based upon the results of these inspections and tests, the Contractor shall take the action and submit reports as required below, and any additional tests to ensure that the requirements of these specifications are met.

B. Sampling: The Contractor's approved laboratory shall collect samples of fresh concrete in accordance with ASTM C 172 during each working day as required to perform tests specified herein. Make test specimens in accordance with ASTM C 31/C 31M.

C. Concrete Testing:
1. **Strength Testing:** The Contractor shall provide molded concrete specimens for strength tests. Samples of concrete shall be taken for every 250 cubic yards of concrete placed, but not less than once a day. The samples for strength tests shall be taken in accordance with ASTM C 172. Cylinders for acceptance shall be molded in conformance with ASTM C 31/C 31M by an approved testing laboratory. Each strength test result shall be the average of 2 test cylinders from the same concrete sample tested at 28 days, unless otherwise specified or approved. Concrete will be considered satisfactory if the averages of all sets of three consecutive strength test results equal or exceed the specified strength, and no individual strength test result falls below the specified strength by more than 500 psi.

2. **Slump Test:** Two slump tests shall be made on randomly selected batches of each class of concrete for every 250 cubic yards, or fraction thereof, of concrete placed during each shift. Additional tests shall be performed when excessive variation in the workability of the concrete is noted.

3. **Surface Evaluation:** The finished surface of each category of the completed work shall be uniform in color and free of blemishes and form or tool marks.

### 3.09 SURFACE DEFICIENCIES AND CORRECTIONS

A. **Thickness Deficiency:** When measurements indicate that the completed concrete section is deficient in thickness by more than 1/4 inch the deficient section will be removed, between regularly scheduled joints, and replaced.

B. **High Areas:** In areas not meeting surface smoothness and plan grade requirements, high areas shall be reduced either by rubbing the freshly finished concrete with carborundum brick and water when the concrete is less than 36 hours old or by grinding the hardened concrete with an approved surface grinding machine after the concrete is 36 hours old or more. The area corrected by grinding the surface of the hardened concrete shall not exceed 5 percent of the area of any integral slab, and the depth of grinding shall not exceed 1/4 inch. Pavement areas requiring grade or surface smoothness corrections in excess of the limits specified above shall be removed and replaced.

C. **Appearance:** Exposed surfaces of the finished work will be inspected by the Engineer and any deficiencies in appearance will be identified. Areas which exhibit excessive cracking, discoloration, form marks, or tool marks or which are otherwise inconsistent with the overall appearances of the work shall be removed and replaced.

**END OF SECTION**
SECTION 32 92 23
SODDING

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. Extent of turfgrass work is limited to those areas disturbed during the course of construction and not indicated to be paved.

B. Subgrade Elevations: Excavation, filling and grading work required for establishing elevations shown on drawings is not specified in this section. Refer to Section 31 20 00 EARTH MOVING.

1.02 REFERENCES

A. ANSI Z 60 - American Standard for Nursery Stock

1.03 QUALITY ASSURANCE

A. General - Subcontract turfgrass work to a single firm specializing in such work. Ship materials with certificates of inspection required by governing authorities. Comply with regulations applicable to turf materials.

B. Analysis and Standards - Package standard products with Manufacturer's certified analysis. For other materials, provide analysis by the recognized laboratory made in accordance with methods established by the Association of Official Agricultural Chemists, wherever applicable.

C. Topsoil - Before delivery of topsoil, furnish Architect with written statement giving location of properties from which topsoil is to be obtained, names and addresses of owners, depth to be stripped, and crops grown during past 2 years.

D. Inspection - The Architect may inspect turf materials either at place of growth or at site before planting, for compliance with requirements for genus, species, variety, size and quality. Architect retains right to further inspect condition of root systems, insects, injuries and latent defects, and to reject unsatisfactory or defective material at any time during progress of work. Remove rejected materials immediately from project site.

1.04 SUBMITTALS

A. Certification-Submit certificates of inspection as required by Architect. Submit manufacturer's or vendor's certified analysis for soil amendments and fertilizer materials. Submit other data substantiating that materials comply with specified requirements.

1.05 DELIVERY, STORAGE AND HANDLING

A. Packaged Materials - Deliver packaged materials in containers showing weight, analysis and name of manufacturer. Protect materials from deterioration during delivery, and while stored at site.

B. Sod - Time delivery so that sod will be placed within 24 hours after stripping. Protect sod against drying and breaking of rolled strips.
1.06 JOB CONDITIONS

A. Proceed with and complete turfgrass work as rapidly as portions of site become available, working within seasonal limitations for kind of turf grass specified.

B. Excavation - When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage condition, or obstructions, notify Architect before planting.

1.07 SPECIAL PROJECT WARRANTY

A. Warranty grass, until final acceptance.

PART 2 - PRODUCTS

2.01 TOPSOIL

A. Topsoil has been (or will be) stockpiled for re-use in landscape work. If quantity of stockpiled topsoil is insufficient, provide additional topsoil as required to complete landscape work.

B. Provide new topsoil which is fertile, friable, natural, loam, surface soil, reasonably free of subsoil, clay lumps, brush, weeds and other litter, and free of roots, stumps, stones larger than 2" in any dimension, and other extraneous or toxic matter harmful to plant growth.

2.02 SOIL AMENDMENTS

A. Lime - Natural dolomitic limestone containing not less than 85% of total carbonates with a minimum of 30% magnesium carbonates, ground so that not less than 90% passes a 10-mesh sieve, not less than 50% passes a 100-mesh sieve.

B. Commercial Fertilizer - Complete fertilizer of neutral character, with some elements derived from organic sources. Provide fertilizer with percentage of nitrogen required to provide not less than 1 lb. of actual nitrogen per 100 sq. ft. of lawn area and not less than 4% phosphoric acid and 2% potassium. Provide nitrogen in a form that will be available to lawn during initial period of growth; at least 50% of nitrogen to be organic form.

2.03 SOD TURFGRASS

Species of sod shall be Centipedegrass (Eremochloa ophiuroides). Quality of sod shall meet requirements of ANSI Z60.1

Provide strongly rooted sod, not less than 2 years old, free of weeds and undesirable native grasses and machine cut to pad thickness of 3/4" (±1/4"), excluding top growth and development when planted (viable, not dormant). Provide sod of uniform pad sizes with maximum 5% deviation in either length or width. Broken pads or pads with uneven ends will not be acceptable. Sod pads incapable of supporting their own weight when suspended vertically with a firm grasp on upper 10% of pad will be rejected.

PART 3 - EXECUTION

3.01 PREPARATION
A. Preparation for Planting Lawns

1. Loosen subgrade of lawn areas to a minimum depth of 4". Remove stones over 1-1/2" in any dimension and sticks, roots, rubbish and other extraneous matter. Limit preparation to areas to be planted promptly after preparation.

2. Spread top soil to 4" minimum depth so as to meet lines, grades and elevations shown, after light rolling and natural settlement. Add specified soil amendments and mix thoroughly into upper 4" of topsoil.

3. Place approximately 1/2 of total amount of topsoil required. Work into top of loosened subgrade to create a transition layer and then place remainder of planting soil. Add specified soil amendments and mix thoroughly into upper 4" of topsoil.

4. Preparation of Unchanged Grades - Where lawns are to be planted in areas that have not been altered or disturbed by excavating, grading, or stripping operations, prepare soil for lawn planting as follows: Till to a depth of not less than 6"; apply soil amendments and initial fertilizers as specified; remove high areas and fill in depressions; till soil to a homogenous mixture of fine texture, free of lumps, clods, stones, roots and other extraneous matter.

5. Prior to preparation of unchanged areas, remove existing grass, vegetation and turf. Dispose of such material outside of Owner's property; do not turn over into soil being prepared for lawns.

6. Allow for sod thickness in areas to be sodded.

7. Apply specified commercial fertilizer at rates specified and thoroughly mix into upper 2" of topsoil. Delay application of fertilizer if lawn planting will not follow within a few days.

8. Fine grade lawn areas to smooth, even surface with loose, uniformly fine texture. Roll, rake and drag lawn areas, remove ridges and fill depressions, as required to meet finish grades. Limit fine grading to areas to be planted immediately after grading.

9. Moisten prepared lawn areas before planting if soil is dry. Water thoroughly and allow surface moisture to dry before planting lawns. Do not create a muddy soil condition.

10. Restore lawn areas to specified condition if eroded or otherwise disturbed after fine grading and prior to planting.

3.02 PLANTING

A. Sodding new lawns

1. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod strips; do not overlap. Stagger strips to offset joints in adjacent courses. Work from boards to avoid damage to subgrade or sod. Tamp or roll lightly to ensure contact with subgrade. Work sifted soil into minor cracks between pieces of sod; remove excess to avoid smothering of adjacent grass.

2. Anchor sod on slopes with wood pegs to prevent slippage.

3. Water sod thoroughly with a fine spray immediately after planting.

3.03 MAINTENANCE

A. Begin maintenance immediately after planting. Maintain lawns for the duration of the contract and through the establishment period until final acceptance.
3.04  INSPECTION AND ACCEPTANCE

A. When turfgrass work is completed, including maintenance, Architect will, upon request, make an inspection to determine acceptability. When inspected landscape work does not comply with requirements, replace rejected work and continue specified maintenance until reinspected by Architect and found to be acceptable. Remove rejected materials promptly from project site.

3.05  CLEANUP AND PROTECTION

A. During landscape work, keep pavements clean and work area in an orderly condition.

B. Protect landscape work and materials from damage due to landscape operations, operations by other contractors, trades and trespassers. Maintain protection during installation and maintenance periods. Treat, repair or replace damaged landscape work as directed.

END OF SECTION