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1.01 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.

1.02 SECTION INCLUDES
   A. This Section specifies administrative and procedural requirements for handling and processing Contract modifications.

1.03 RELATED SECTIONS
   A. Division 01 Section "Allowances" for procedural requirements for handling and processing allowances.
   B. Division 01 Section "Unit Prices" for administrative requirements for using unit prices.
   C. Division 01 Section "Product Requirements" for administrative procedures for handling requests for substitutions made after Contract award.

1.04 MINOR CHANGES IN THE WORK
   A. Architect will issue supplemental instructions authorizing Minor Changes in the Work, not involving adjustment to the Contract Sum or the Contract Time, on AIA Document G710, "Architect's Supplemental Instructions."

1.05 CHANGE ORDER BULLETINS (COB)
   A. Owner-Initiated COBs: Architect will issue a detailed description of proposed changes in the Work on State of Colorado Building Programs' Form SC-6.311 that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
      1. COBs issued by Architect are for information only. Do not consider them instructions either to stop work in progress or to execute the proposed change.
      2. Within time specified in COB after receipt of COB, submit a Change Order Proposal (COP) estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.
         a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
         b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
         c. Include costs of labor and supervision directly attributable to the change.
         d. Include an updated Contractor's Construction Schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
   B. Contractor-Initiated COPs: If latent or unforeseen conditions require modifications to the Contract, Contractor may propose changes by submitting a request for a change to Architect.
1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.

2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.

3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.

4. Include costs of labor and supervision directly attributable to the change.

5. Include an updated Contractor's Construction Schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.

6. Comply with requirements in Division 01 Section "Product Requirements" if the proposed change requires substitution of one product or system for product or system specified.

C. COP Form: Use State of Colorado Building Programs' Form SC-6.312 for COBs.

1.06 ALLOWANCES

A. Allowance Adjustment: To adjust allowance amounts, base each Change Order Proposal on the difference between purchase amount and the allowance, multiplied by final measurement of work-in-place. If applicable, include reasonable allowances for cutting losses, tolerances, mixing wastes, normal product imperfections, and similar margins.

1. Include installation costs in purchase amount only where indicated as part of the allowance.

2. If requested, prepare explanation and documentation to substantiate distribution of overhead costs and other margins claimed.

3. Submit substantiation of a change in scope of work, if any, claimed in Change Orders related to unit-cost allowances.

B. Submit claims for increased costs because of a change in scope or nature of the allowance described in the Contract Documents, whether for the Purchase Order amount or Contractor's handling, labor, installation, overhead, and profit. Submit claims within 21 days of receipt of the Change Order or Emergency Field Change Order authorizing work to proceed. Owner will reject claims submitted later than 21 days after such authorization.

1. Do not include Contractor's or subcontractor's indirect expense in the Change Order cost amount unless it is clearly shown that the nature or extent of work has changed from what could have been foreseen from information in the Contract Documents.

2. No change to Contractor's indirect expense is permitted for selection of higher- or lower-priced materials or systems of the same scope and nature as originally indicated.

1.07 CHANGE ORDER PROCEDURES

A. On Owner's approval of a COP, Architect will issue a Change Order for signatures of Owner and Contractor on State of Colorado Building Programs' Form SC-6.31.

1. Charge Orders will be incorporated into the Construction Manager/General Contractor Agreement by means of a contract Amendment.
1.08 EMERGENCY FIELD CHANGE ORDER

A. Architect may issue an Emergency Field Change Order on State of Colorado Building Programs' Form SC-6.31E. An Emergency Field Change Order instructs Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.

1. Emergency Change Orders authorize extra work or make changes in the case of an emergency that is a threat to life or property or where the likelihood of delays in processing a normal change order will result in substantial delays and/or significant cost increases for the project.
   a. Emergency Field Change Orders are not to be used solely to expedite normal Change Order processing absent a clear showing of a high potential for significant and substantial cost or delay.

2. An Emergency Field Change Order contains a complete description of change in the Work. It also designates method to be followed to determine change in the Contract Sum or the Contract Time.

B. If the amount of the adjustment of the Contract price and time for completion can be determined at the time of issuance of the Emergency Field Change Order, those adjustments shall be reflected on the face of the Emergency Field Change Order.

C. If the amount of the adjustment of the Contract price and time for completion cannot be determined at the time of issuance of the Emergency Field Change Order, a Not-to-Exceed (NTE) amount for any schedule adjustment (increasing or decreasing the time for completion) and an NTE amount for any adjustment to Contract sum, which NTE amount shall represent the maximum amount of adjustment to which the Contractor will be entitled, including direct and indirect costs of changed work, as well as any direct or indirect costs attributable to delays, inefficiencies or other impacts arising out of the change.

   1. Maintain detailed records on a time and material basis of work required by the Emergency Field Change Order.
      a. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION
SECTION 01 29 00
PAYMENT PROCEDURES

PART 1 - GENERAL

1.01 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.

1.02 SUMMARY
A. This Section specifies administrative and procedural requirements necessary to prepare and process Applications for Payment.
B. Related Sections include the following:
   1. Division 01 Section "Allowances" for procedural requirements governing handling and processing of allowances.
   2. Division 01 Section "Contract Modification Procedures" for administrative procedures for handling changes to the Contract.
   3. Division 01 Section "Unit Prices" for administrative requirements governing use of unit prices.
   4. Division 01 Section "Construction Progress Documentation" for administrative requirements governing preparation and submittal of Contractor's Construction Schedule and Submittals Schedule.

1.03 DEFINITIONS
A. Schedule of Values: A statement furnished by Contractor allocating portions of the Contract Sum to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.

1.04 SCHEDULE OF VALUES
A. Coordination: Coordinate preparation of the Schedule of Values with preparation of Contractor's Construction Schedule. Cost-loaded CPM Schedule may serve to satisfy requirements for the Schedule of Values.
   1. Correlate line items in the Schedule of Values with other required administrative forms and schedules, including the following:
      a. Application for Payment forms with Continuation Sheets.
      b. Submittals Schedule.
      c. Contractor's Construction Schedule.
   2. Allow for tracking of progress based upon CSI Division, funding sources, sub-trades, combinations of sub-trades, building systems, Bid Packages or combinations thereof.
   3. Aggregate sum should total to the Guaranteed Maximum Price; and be supported by such data to substantiate its accuracy as the Architect and Owner may require.
      a. Contractor's fee and the estimated Project General Conditions costs shall be set forth as a separate line item(s).
B. Submit the Schedule of Values to Architect at earliest possible date but no later than seven days before the date scheduled for submittal of initial Applications for Payment.
1. Subschedules: Where the Work is separated into phases requiring separately phased payments, provide subschedules showing values correlated with each phase of payment.

C. At least 10 days before submission of the first Certificate and Application for Contractor's Payment for the Construction Phase, a conference attended by the Contractor, Architect and Owner will be held to finalize the Schedule of Values. The finalized Schedule of Values will serve as the basis for progress payments and will be incorporated into the form of a Project Certificate and Application for Contractor's Payment acceptable to the Architect and Owner. Subject to the prior approval of the Owner, the finalized Schedule of Values shall be adjusted to reflect changes made to the Work by Amendment.

D. Format and Content: Use the Project Manual table of contents as a guide to establish line items for the Schedule of Values. Provide at least one line item for each Specification Section.

1. Identification: Include the following Project identification on the Schedule of Values:
   a. Project name and location.
   b. Name of Architect.
   c. Architect's project number.
   d. Contractor's name and address.
   e. Date of submittal.

2. Submit draft of AIA Document G703 Continuation Sheets.

3. Arrange the Schedule of Values in tabular form with separate columns to indicate the following for each item listed:
   a. Related Specification Section or Division.
   b. Description of the Work.
   c. Name of subcontractor.
   d. Name of manufacturer or fabricator.
   e. Name of supplier.
   f. Change Orders (numbers) that affect value.
   g. Dollar value.
      1) Percentage of the Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent.

4. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with the Project Manual table of contents. Provide several line items for principal subcontract amounts, where appropriate.

5. Round amounts to nearest whole dollar; total shall equal the Contract Sum.

6. Provide a separate line item in the Schedule of Values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.
   a. Differentiate between items stored on-site and items stored off-site. If specified, include evidence of insurance or bonded warehousing.

7. Provide separate line items in the Schedule of Values for initial cost of materials, for each subsequent stage of completion, and for total installed value of that part of the Work.

8. Allowances: Provide a separate line item in the Schedule of Values for each allowance. Show line-item value of unit-cost allowances, as a product of the unit cost, multiplied by measured quantity. Use information indicated in the Contract Documents to determine quantities.

9. Each item in the Schedule of Values and Applications for Payment shall be complete. Include total cost and proportionate share of general overhead and profit for each item.
PAYMENT PROCEDURES

1.05 APPLICATIONS FOR PAYMENT

A. Each Application for Payment shall be consistent with previous applications and payments as certified by Architect and paid for by Owner.
1. Initial Application for Payment, Application for Payment at time of Completion, and final Application for Payment involve additional requirements.

B. Payment Application Times:
1. Submit Application for Payment to Architect on the first day of each month.
a. Do not submit Application for Payment sooner than 3 days prior to the first day of each month.
2. The period of construction Work covered by each Application for Payment one month.

C. Payment Application Forms: Use State of Colorado Building Programs' Form SBP-7.2 as form for Applications for Payment.

D. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. Architect will return incomplete applications without action.
1. Entries shall match data on the Schedule of Values and Contractor's Construction Schedule. Use updated schedules if revisions were made.
2. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.
3. Retainage:
   a. 10 percent of the amount shown to be due the Contractor on each Application for Payment shall be withheld until 50 percent of the Work required by the Contract Documents has been performed.
      1) Ensuing applications shall be paid without retaining additional funds if, in the opinion of the Architect and Owner, satisfactory progress is being made in the Work.

E. Transmittal: Submit 4 signed and notarized original copies of each Application for Payment to Architect by a method ensuring receipt within 24 hours. One copy shall include waivers of lien and similar attachments if required.
1. Transmit each copy with a transmittal form listing attachments and recording appropriate information about application.

F. Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's liens from subcontractors, sub-subcontractors, and suppliers for construction period covered by the previous application.
1. Submit partial waivers on each item for amount requested in previous application, after deduction for retainage, on each item.
2. When an application shows completion of an item, submit final or full waivers.
3. Owner reserves the right to designate which entities involved in the Work must submit waivers.
4. Submit final Application for Payment with or preceded by final waivers from every entity involved with performance of the Work covered by the application who is lawfully entitled to a lien.
5. Waiver Forms: Submit waivers of lien on forms, executed in a manner acceptable to Owner.

G. Architect, within 5 days after the receipt of each Application for Payment, shall review the application and either execute a Project Certificate for Payment to the Owner for such amounts the Architect reasonably determines are properly due, or notify the Contractor in writing of the reasons for withholding a Certificate.

1. The issuance of a Certificate and Application for Contractor’s Payment shall constitute a representation by the Architect to the Owner that based on the Architect’s observations at the site and the data comprising the Certificate and Application for Contractor’s Payment, the Work has progressed to the point indicated; that, to the best of the Architect's knowledge, information and belief, the quality of the Work is in accordance with the Contract Documents (subject to an evaluation of the Work for conformance with the Contract Documents upon completion of the Work, to the results of any subsequent tests required by or performance under the Contract Documents, to minor deviations from the Contract Documents correctable prior to completion, and to any specific qualifications stated in the Certificate and Application for Contractor’s Payment); and that the Contractor is entitled to payment in the amount certified.

a. Issuance of a Certificate and Application for Contractor’s Payment shall not be a representation that the Architect has made exhaustive or continuous on-site inspections to check the quality or quantity of the Work, has reviewed the construction means, methods, techniques, sequences, or procedures, or has made any examination to ascertain how or for what purpose the Contractor has used the funds paid on account of the Contract Sum.

2. No certification of a progress payment, or any partial or entire use or occupancy of the Project by the Owner, shall constitute an acceptance of any Work not in accordance with the Contract Documents.

H. After the Architect has issued a Certificate and Application for Contractor’s Payment, the Owner shall make payment within 28 days.

1. The Contractor shall promptly pay each subcontractor and supplier upon receipt of payment from the Owner, out of the amount paid to the Contractor on account of each subcontractor or supplier's work or materials furnished, less retainage.

a. The Contractor shall, by an appropriate agreement with each subcontractor or supplier, require each subcontractor or supplier to make payments to their sub-subcontractors or suppliers in similar manner.

I. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:

1. List of subcontractors.
2. Schedule of Values.
3. Contractor's Construction Schedule (preliminary if not final).
4. Schedule of unit prices.
5. Submittals Schedule (preliminary if not final).
6. List of Contractor's staff assignments.
7. Copies of building permits.
11. Certificates of insurance and insurance policies.
13. Data needed to acquire Owner's insurance.
J. Application for Payment at Completion: Upon receipt of Architect's Notice of Completion Letter, submit an Application for Payment showing 100 percent completion for portion of the Work claimed as complete.
   1. Include documentation supporting claim that the Work is complete and a statement showing an accounting of changes to the Contract Sum.
   2. This application shall reflect Certificates of Partial Completion issued previously for Owner occupancy of designated portions of the Work.

K. Final Payment Application: Upon receipt of Owner's Notice of Acceptance, submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:
   1. Evidence of completion of Project closeout requirements.
   2. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
   3. Updated final statement, accounting for final changes to the Contract Sum.
   4. AIA Document G706, "Contractor's Affidavit of Payment of Debts and Claims."
   6. AIA Document G707, "Consent of Surety to Final Payment."
   7. Evidence that claims have been settled.
      a. Submit a complete and final waiver and/or release of any and all lien rights and liens from each subcontractor of all tiers, material supplier, manufacturer and dealer for all labor, equipment and material used or furnished by each on the Work.
   8. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Completion or when Owner took possession of and assumed responsibility for corresponding elements of the Work.

L. Upon completion of the foregoing, Owner shall advertise that the Work has been completed in accordance with the Notice of Contractor's Settlement, by 2 publications of notice.
   1. The last publication shall appear at least 10 days prior to the time of final settlement.
   2. On the date of final settlement advertised, after the Contractor has submitted a written notice to the Architect that no claims have been filed, final payment and settlement shall be made in full.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION
SECTION 01 31 00

PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.01 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.

1.02 SUMMARY
A. This Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
   1. Coordination Drawings.
   2. Administrative and supervisory personnel.
   3. Project meetings.
   4. Requests for Interpretation (RFIs).
B. Each contractor shall participate in coordination requirements. Certain areas of responsibility will be assigned to a specific contractor.
C. Related Sections include the following:
   1. Division 01 Section "Construction Progress Documentation" for preparing and submitting Contractor's Construction Schedule.
   2. Division 01 Section "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
   3. Division 01 Section "Closeout Procedures" for coordinating closeout of the Contract.

1.03 DEFINITIONS
A. RFI: Request from Contractor seeking interpretation or clarification of the Contract Documents.

1.04 COORDINATION
A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections, that depend on each other for proper installation, connection, and operation.
   1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
   2. Make adequate provisions to accommodate items scheduled for later installation.
   3. Where availability of space is limited, coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair of all components, including mechanical and electrical.
B. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
   1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.
C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and activities of other contractors to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
1. Preparation of Contractor's Construction Schedule.
2. Preparation of the Schedule of Values.
3. Installation and removal of temporary facilities and controls.
4. Delivery and processing of submittals.
5. Progress meetings.
6. Preinstallation conferences.
7. Project closeout activities.
8. Startup and adjustment of systems.
9. Project closeout activities.

D. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials.
1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. Refer to other Sections for disposition of salvaged materials that are designated as Owner's property.

1.05 SUBMITTALS
A. Coordination Drawings:
1. Content: Project-specific information, drawn accurately to scale. Do not base Coordination Drawings on reproductions of the Contract Documents or standard printed data. Include the following information, as applicable:
   a. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
   b. Indicate required installation sequences.
   c. Indicate dimensions shown on the Contract Drawings and make specific note of dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Architect for resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
2. Sheet Size: At least 8-1/2 by 11 inches but no larger than 30 by 42 inches.
3. Number of Copies: Submit two opaque copies of each submittal. Architect will return one copy.
   a. Mark up and maintain returned copy as a Project Record Drawing.
4. Refer to individual Sections for Coordination Drawing requirements for Work in those Sections.

B. Key Personnel Names: Within 15 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home and office telephone numbers. Provide names, addresses, and telephone numbers of individuals assigned as standbys in the absence of individuals assigned to Project.

1.06 PROJECT MEETINGS
A. General: Schedule and conduct meetings and conferences at Project site, unless otherwise indicated.
1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Architect of scheduled meeting dates and times.
2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
3. Minutes: Record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Architect, within three days of the meeting.

B. Preconstruction Conference: Schedule a preconstruction conference before starting construction, at a time convenient to Owner and Architect, but no later than 15 days after execution of the Agreement. Hold the conference at Project site or another convenient location. Conduct the meeting to review responsibilities and personnel assignments.

1. Attendees: Authorized representatives of Owner, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.

2. Agenda: Discuss items of significance that could affect progress, including the following:
   a. Tentative construction schedule.
   b. Phasing.
   c. Critical work sequencing and long-lead items.
   d. Designation of key personnel and their duties.
   e. Procedures for processing field decisions and Change Orders.
   f. Procedures for RFIs.
   g. Procedures for testing and inspecting.
   h. Procedures for processing Applications for Payment.
   i. Distribution of the Contract Documents.
   j. Submittal procedures.
   k. LEED requirements.
   l. Preparation of Record Documents.
   m. Use of the premises and existing building.
   n. Work restrictions.
   o. Owner's occupancy requirements.
   p. Responsibility for temporary facilities and controls.
   q. Construction waste management and recycling.
   r. Parking availability.
   s. Office, work, and storage areas.
   t. Equipment deliveries and priorities.
   u. First aid.
   w. Progress cleaning.
   x. Working hours.

3. Minutes: Record and distribute meeting minutes.

C. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity that requires coordination with other construction.

1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect of scheduled meeting dates.

2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
   b. Options.
   c. Related RFIs.
   d. Related Change Orders.
   e. Purchases.
   f. Deliveries.
g. Submittals.
h. Review of mockups.
i. Possible conflicts.
j. Compatibility problems.
k. Time schedules.
l. Weather limitations.
m. Manufacturer's written recommendations.
n. Warranty requirements.
o. Compatibility of materials.
p. Acceptability of substrates.
q. Temporary facilities and controls.
r. Space and access limitations.
s. Regulations of authorities having jurisdiction.
t. Testing and inspecting requirements.
u. Installation procedures.
v. Coordination with other work.
w. Required performance results.
x. Protection of adjacent work.
y. Protection of construction and personnel.

3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.

4. Reporting: Distribute minutes of the meeting to each party present and to parties who should have been present.

5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.

D. Progress Meetings: Conduct progress meetings at weekly intervals. Coordinate dates of meetings with preparation of payment requests.
   1. Attendees: In addition to representatives of Owner and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
   2. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
      a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's Construction Schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
         1) Review schedule for next period.
      b. Review present and future needs of each entity present, including the following:
         1) Interface requirements.
         2) Sequence of operations.
         3) Status of submittals.
         4) Deliveries.
         5) Off-site fabrication.
         6) Access.
         7) Site utilization.
         8) Temporary facilities and controls.
9) Work hours.
10) Hazards and risks.
11) LEED considerations.
12) Progress cleaning.
13) Quality and work standards.
14) Status of correction of deficient items.
15) Field observations.
16) RFIs.
17) Status of proposal requests.
18) Pending changes.
19) Status of Change Orders.
20) Pending claims and disputes.
21) Documentation of information for payment requests.

3. Minutes: Record the meeting minutes.
4. Reporting: Distribute minutes of the meeting to each party present and to parties who should have been present.
   a. Schedule Updating: Revise Contractor's Construction Schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

1.07 REQUESTS FOR INTERPRETATION (RFIs)

A. Procedure: Immediately on discovery of the need for interpretation of the Contract Documents, and if not possible to request interpretation at Project meeting, prepare and submit an RFI in the form specified.
   1. RFIs shall originate with Contractor. RFIs submitted by entities other than Contractor will be returned with no response.
   2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.

B. Content of the RFI: Include a detailed, legible description of item needing interpretation and the following:
   1. Project name.
   2. Date.
   3. Name of Contractor.
   5. RFI number, numbered sequentially.
   6. Specification Section number and title and related paragraphs, as appropriate.
   7. Drawing number and detail references, as appropriate.
   8. Field dimensions and conditions, as appropriate.
   9. Contractor's suggested solution(s). If Contractor's solution(s) impact the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
   10. Contractor's signature.
   11. Attachments: Include drawings, descriptions, measurements, photos, Product Data, Shop Drawings, and other information necessary to fully describe items needing interpretation.
       a. Supplementary drawings prepared by Contractor shall include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments.

C. Hard-Copy RFIs: CSI Form 13.2A.
   1. Identify each page of attachments with the RFI number and sequential page number.

D. Software-Generated RFIs: Software-generated form with substantially the same content as indicated above.
1. Attachments shall be electronic files in Adobe Acrobat PDF format.

E. Architect's Action: Architect will review each RFI, determine action required, and return it. Allow 10 days for Architect's response for each RFI. RFIs received after 1:00 p.m. will be considered as received the following working day.
   1. The following RFIs will be returned without action:
      a. Requests for approval of submittals.
      b. Requests for approval of substitutions.
      c. Requests for coordination information already indicated in the Contract Documents.
      d. Requests for adjustments in the Contract Time or the Contract Sum.
      e. Requests for interpretation of Architect's actions on submittals.
      f. Incomplete RFIs or RFIs with numerous errors.

2. Architect's action may include a request for additional information, in which case Architect's time for response will start again.
3. Architect's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Division 01 Section "Contract Modification Procedures."
   a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect in writing within 10 days of receipt of the RFI response.

F. On receipt of Architect's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect within seven days if Contractor disagrees with response.

G. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log at each Progress Meeting. Include the following:
   1. Project name.
   2. Name and address of Contractor.
   3. Name and address of Architect.
   4. RFI number including RFIs that were dropped and not submitted.
   5. RFI description.
   6. Date the RFI was submitted.
   7. Date Architect's response was received.
   8. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION
PART 1 - GENERAL

1.01 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.

1.02 SUMMARY
   A. This Section includes administrative and procedural requirements for documenting the
      progress of construction during performance of the Work, including the following:
      1. Preliminary Construction Schedule.
      2. Contractor’s Construction Schedule.
      4. Daily construction reports.
      5. Material location reports.
      6. Field condition reports.
      7. Special reports.
   B. Related Sections include the following:
      1. Division 01 Section "Payment Procedures" for submitting the Schedule of Values.
      2. Division 01 Section "Project Management and Coordination" for submitting and
         distributing meeting and conference minutes.
      3. Division 01 Section "Photographic Documentation" for submitting construction
         photographs.
      4. Division 01 Section "Submittal Procedures" for submitting schedules and reports.
      5. Division 01 Section "Quality Requirements" for submitting a schedule of tests and
         inspections.

1.03 DEFINITIONS
   A. Activity: A discrete part of a project that can be identified for planning, scheduling,
      monitoring, and controlling the construction project. Activities included in a construction
      schedule consume time and resources.
      1. Critical activities are activities on the critical path. They must start and finish on
         the planned early start and finish times.
      2. Predecessor Activity: An activity that precedes another activity in the network.
      3. Successor Activity: An activity that follows another activity in the network.
   B. Cost Loading: The allocation of the Schedule of Values for the completion of an activity
      as scheduled. The sum of costs for all activities must equal the total Contract Sum,
      unless otherwise approved by Architect.
   C. CPM: Critical path method, which is a method of planning and scheduling a construction
      project where activities are arranged based on activity relationships. Network
      calculations determine when activities can be performed and the critical path of Project.
   D. Critical Path: The longest connected chain of interdependent activities through the
      network schedule that establishes the minimum overall Project duration and contains no
      float.
   E. Event: The starting or ending point of an activity.
   F. Float: The measure of leeway in starting and completing an activity.
1. Float time is not for the exclusive use or benefit of either Owner or Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and Contract completion date.

2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the successor activity.

3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.

G. Fragnet: A partial or fragmentary network that breaks down activities into smaller activities for greater detail.

H. Major Area: A story of construction, a separate building, or a similar significant construction element.

I. Milestone: A key or critical point in time for reference or measurement.

J. Network Diagram: A graphic diagram of a network schedule, showing activities and activity relationships.

K. Resource Loading: The allocation of manpower and equipment necessary for the completion of an activity as scheduled.

1.04 SUBMITTALS

A. Submittals Schedule: Submit two copies of schedule. Arrange the following information in a tabular format:
   1. Scheduled date for first submittal.
   2. Specification Section number and title.
   3. Submittal category (action or informational).
   4. Name of subcontractor.
   5. Description of the Work covered.
   6. Scheduled date for Architect's final release or approval.

B. Preliminary Construction Schedule: Submit two opaque copies.
   1. Approval of cost-loaded preliminary construction schedule will not constitute approval of Schedule of Values for cost-loaded activities.

C. Preliminary Network Diagram: Submit two opaque copies, large enough to show entire network for entire construction period. Show logic ties for activities.

D. Contractor's Construction Schedule: Submit two opaque copies of initial schedule, large enough to show entire schedule for entire construction period.
   1. Submit an electronic copy of schedule, using software indicated, on CD-R, and labeled to comply with requirements for submittals. Include type of schedule (Initial or Updated) and date on label.

E. CPM Reports: Concurrent with CPM schedule, submit two copies of each of the following computer-generated reports. Format for each activity in reports shall contain activity number, activity description, cost and resource loading, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float in calendar days.
   1. Activity Report: List of all activities sorted by activity number and then early start date, or actual start date if known.
   2. Logic Report: List of preceding and succeeding activities for all activities, sorted in ascending order by activity number and then early start date, or actual start date if known.
   3. Total Float Report: List of all activities sorted in ascending order of total float.
   4. Earnings Report: Compilation of Contractor's total earnings from commencement of the Work until most recent Application for Payment.
1.05 QUALITY ASSURANCE

A. Prescheduling Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." Review methods and procedures related to the Preliminary Construction Schedule and Contractor's Construction Schedule, including, but not limited to, the following:
   1. Review software limitations and content and format for reports.
   2. Verify availability of qualified personnel needed to develop and update schedule.
   3. Discuss constraints, including phasing, work stages, area separations, interim milestones, and partial Owner occupancy.
   4. Review delivery dates for Owner-furnished products.
   5. Review schedule for work of Owner's separate contracts.
   6. Review time required for review of submittals and resubmittals.
   7. Review requirements for tests and inspections by independent testing and inspecting agencies.
   8. Review time required for completion and startup procedures.
   9. Review and finalize list of construction activities to be included in schedule.
  10. Review submittal requirements and procedures.
  11. Review procedures for updating schedule.

1.06 COORDINATION

A. Coordinate Contractor's Construction Schedule with the Schedule of Values, list of subcontracts, Submittals Schedule, progress reports, payment requests, and other required schedules and reports.
   1. Secure time commitments for performing critical elements of the Work from parties involved.
   2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

PART 2 - PRODUCTS

2.01 SUBMITTALS SCHEDULE

A. Preparation: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, resubmittal, ordering, manufacturing, fabrication, and delivery when establishing dates.
   1. Coordinate Submittals Schedule with list of subcontracts, the Schedule of Values, and Contractor's Construction Schedule.
   2. Initial Submittal: Submit concurrently with Preliminary Construction Schedule. Include submittals required during the first 60 days of construction. List those required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
      a. At Contractor's option, show submittals on the Preliminary Construction Schedule, instead of tabulating them separately.
   3. Final Submittal: Submit concurrently with the first complete submittal of Contractor's Construction Schedule.

2.02 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

A. Procedures: Comply with procedures contained in AGC's "Construction Planning & Scheduling."

B. Time Frame: Extend schedule from date established for commencement of the Work to date of Final Completion.
   1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.
C. Activities: Treat each story or separate area as a separate numbered activity for each principal element of the Work. Comply with the following:

1. **Activity Duration:** Define activities so no activity is longer than 20 days, unless specifically allowed by Architect.

2. **Procurement Activities:** Include procurement process activities for long lead items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
   a. **Submittal Review Time:** Include review and resubmittal times indicated in Division 01 Section "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's Construction Schedule with Submittals Schedule.

3. **Startup and Testing Time:** Include not less than 10 days for startup and testing.

4. **Completion:** Indicate completion in advance of date established for Completion, and allow time for Architect's administrative procedures necessary for certification of Completion.

D. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.

1. **Phasing:** Arrange list of activities on schedule by phase.

2. **Work by Owner:** Include a separate activity for each portion of the Work performed by Owner.

3. **Products Ordered in Advance:** Include a separate activity for each product. Include delivery date indicated in Division 01 Section "Summary." Delivery dates indicated stipulate the earliest possible delivery date.

4. **Owner-Furnished Products:** Include a separate activity for each product. Include delivery date indicated in Division 01 Section "Summary." Delivery dates indicated stipulate the earliest possible delivery date.

5. **Work Restrictions:** Show the effect of the following items on the schedule:
   a. Coordination with existing construction.
   b. Limitations of continued occupancies.
   c. Uninterruptible services.
   d. Partial occupancy before Completion.
   e. Use of premises restrictions.
   g. Seasonal variations.
   h. Environmental control.

6. **Work Stages:** Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:
   a. Subcontract awards.
   b. Submittals.
   c. Purchases.
   d. Mockups.
   e. Fabrication.
   f. Sample testing.
   g. Deliveries.
   h. Installation.
   i. Tests and inspections.
   j. Adjusting.
   k. Curing.
   l. Startup and placement into final use and operation.

7. **Area Separations:** Identify each major area of construction for each major portion of the Work. Indicate where each construction activity within a major area...
must be sequenced or integrated with other construction activities to provide for the following:
   a. Structural completion.
   b. Permanent space enclosure.
   c. Completion of mechanical installation.
   d. Completion of electrical installation.
   e. Completion.

E. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Completion, and Final Completion.

F. Cost Correlation: At the head of schedule, provide a cost correlation line, indicating planned and actual costs. On the line, show dollar volume of the Work performed as of dates used for preparation of payment requests.
   1. Refer to Division 01 Section "Payment Procedures" for cost reporting and payment procedures.
   2. Contractor shall assign cost to construction activities on the CPM schedule. Costs shall not be assigned to submittal activities unless specified otherwise but may, with Architect's approval, be assigned to fabrication and delivery activities. Costs shall be under required principal subcontracts for testing and commissioning activities, operation and maintenance manuals, punch list activities, Project Record Documents, and demonstration and training (if applicable), in the amount of 5 percent of the Contract Sum.
   3. Each activity cost shall reflect an accurate value subject to approval by Architect.
   4. Total cost assigned to activities shall equal the total Contract Sum.

G. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time-impact analysis using fragnets to demonstrate the effect of the proposed change on the overall project schedule.

H. Computer Software: Prepare schedules using a program that has been developed specifically to manage construction schedules.

2.03 PRELIMINARY CONSTRUCTION SCHEDULE

A. Bar-Chart Schedule: Submit preliminary horizontal bar-chart-type construction schedule within seven days of date established for commencement of the Work.

B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line. Outline significant construction activities for first 60 days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.

2.04 CONTRACTOR'S CONSTRUCTION SCHEDULE (CPM SCHEDULE)

A. General: Prepare network diagrams using AON (activity-on-node) format.

B. Preliminary Network Diagram: Submit diagram within 14 days of date established for commencement of the Work. Outline significant construction activities for the first 60 days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.

   1. Develop network diagram in sufficient time to submit CPM schedule so it can be accepted for use no later than 30 days after date established for commencement of the Work.
      a. Failure to include any work item required for performance of this Contract shall not excuse Contractor from completing all work within applicable completion dates, regardless of Architect's approval of the schedule.
2. Conduct educational workshops to train and inform key Project personnel, including subcontractors' personnel, in proper methods of providing data and using CPM schedule information.

3. Establish procedures for monitoring and updating CPM schedule and for reporting progress. Coordinate procedures with progress meeting and payment request dates.

4. Use "one workday" as the unit of time. Include list of nonworking days and holidays incorporated into the schedule.

D. CPM Schedule Preparation: Prepare a list of all activities required to complete the Work. Using the preliminary network diagram, prepare a skeleton network to identify probable critical paths.

1. Activities: Indicate the estimated time duration, sequence requirements, and relationship of each activity in relation to other activities. Include estimated time frames for the following activities:
   a. Preparation and processing of submittals.
   b. Mobilization and demobilization.
   c. Purchase of materials.
   d. Delivery.
   e. Fabrication.
   f. Utility interruptions.
   g. Installation.
   h. Work by Owner that may affect or be affected by Contractor's activities.
   i. Testing and commissioning.

2. Critical Path Activities: Identify critical path activities, including those for interim completion dates. Scheduled start and completion dates shall be consistent with Contract milestone dates.

3. Processing: Process data to produce output data on a computer-drawn, time-scaled network. Revise data, reorganize activity sequences, and reproduce as often as necessary to produce the CPM schedule within the limitations of the Contract Time.

4. Format: Mark the critical path. Locate the critical path near center of network; locate paths with most float near the edges.
   a. Subnetworks on separate sheets are permissible for activities clearly off the critical path.

E. Initial Issue of Schedule: Prepare initial network diagram from a list of straight "early start-total float" sort. Identify critical activities. Prepare tabulated reports showing the following:

1. Contractor or subcontractor and the Work or activity.
2. Description of activity.
3. Principal events of activity.
4. Immediate preceding and succeeding activities.
5. Early and late start dates.
6. Early and late finish dates.
7. Activity duration in workdays.
8. Total float or slack time.
10. Dollar value of activity (coordinated with the Schedule of Values).

F. Schedule Updating: Concurrent with making revisions to schedule, prepare tabulated reports showing the following:

1. Identification of activities that have changed.
2. Changes in early and late start dates.
3. Changes in early and late finish dates.
5. Changes in the critical path.
6. Changes in total float or slack time.

G. Value Summaries: Prepare two cumulative value lists, sorted by finish dates.
1. In first list, tabulate activity number, early finish date, dollar value, and cumulative dollar value.
2. In second list, tabulate activity number, late finish date, dollar value, and cumulative dollar value.
3. In subsequent issues of both lists, substitute actual finish dates for activities completed as of list date.
4. Prepare list for ease of comparison with payment requests; coordinate timing with progress meetings.
   a. In both value summary lists, tabulate "actual percent complete" and "cumulative value completed" with total at bottom.
   b. Submit value summary printouts with each Application for Payment.

2.05 REPORTS

A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:
1. List of subcontractors at Project site.
2. List of separate contractors at Project site.
3. Approximate count of personnel at Project site.
4. Equipment at Project site.
5. Material deliveries.
6. High and low temperatures and general weather conditions.
7. Accidents.
8. Meetings and significant decisions.
9. Unusual events (refer to special reports).
10. Stoppages, delays, shortages, and losses.
11. Meter readings and similar recordings.
13. Orders and requests of authorities having jurisdiction.
14. Change Orders received and implemented.
15. Construction Change Directives received and implemented.
16. Services connected and disconnected.
17. Equipment or system tests and startups.
18. Partial Completions and occupancies.
19. Completions authorized.

B. Material Location Reports: At monthly intervals, prepare and submit a comprehensive list of materials delivered to and stored at Project site. List shall be cumulative, showing materials previously reported plus items recently delivered. Include with list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from Project site.

C. Field Condition Reports: Immediately on discovery of a difference between field conditions and the Contract Documents, prepare and submit a detailed report. Submit with a request for interpretation. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

2.06 SPECIAL REPORTS

A. General: Submit special reports directly to Owner within three day(s) of an occurrence. Distribute copies of report to parties affected by the occurrence.

B. Reporting Unusual Events: When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, response by Contractor's personnel,
evaluation of results or effects, and similar pertinent information. Advise Owner in advance when these events are known or predictable.

PART 3 - EXECUTION

3.01 CONTRACTOR’S CONSTRUCTION SCHEDULE

A. Contractor’s Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before submitting monthly Application for Payment.
   1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
   2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
   3. As the Work progresses, indicate Actual Completion percentage for each activity.

B. Distribution: Distribute copies of approved schedule to Architect Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.
   1. Post copies in Project meeting rooms and temporary field offices.
   2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

END OF SECTION
SECTION 01 32 33
PHOTOGRAPHIC DOCUMENTATION

PART 1 - GENERAL

1.01 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.

1.02 SUMMARY
A. This Section includes administrative and procedural requirements for the following:
   1. Preconstruction photographs.
   2. Periodic construction photographs.
   3. Final Completion construction photographs.
B. Related Sections include the following:
   1. Division 01 Section "Submittal Procedures" for submitting photographic documentation.
   2. Division 01 Section "Closeout Procedures" for submitting digital media as Project Record Documents at Project closeout.
   3. Division 01 Section "Demonstration and Training" for submitting videotapes of demonstration of equipment and training of Owner's personnel.
   4. Division 02 Section "Selective Structure Demolition" for photographic documentation before selective demolition operations commence.

1.03 SUBMITTALS
A. Key Plan: Submit key plan of Project site and building with notation of vantage points marked for location and direction of each photograph. Indicate elevation or story of construction. Include same label information as corresponding set of photographs.
B. Construction Photographs: Submit digital media containing each photographic view within seven days of taking photographs.
   1. Digital Images: Submit a complete set of digital image electronic files with each submittal of prints and as a Project Record Document on CD-ROM. Identify electronic media with date photographs were taken. Submit images that have same aspect ratio as the sensor, uncropped.

1.04 USAGE RIGHTS
A. Transfer copyright usage rights to Owner for unlimited reproduction of photographic documentation.

PART 2 - PRODUCTS

2.01 PHOTOGRAPHIC MEDIA
A. Digital Images: Provide images in uncompressed TIFF format, produced by a digital camera with minimum sensor size of 4.0 megapixels, and at an image resolution of not less than 1024 by 768 pixels.
PART 3 - EXECUTION

3.01 CONSTRUCTION PHOTOGRAPHS

A. General: Take photographs using the maximum range of depth of field, and that are in focus, to clearly show the Work. Photographs with blurry or out-of-focus areas will not be accepted.
  1. Maintain key plan with each set of construction photographs that identifies each photographic location.

B. Digital Images: Submit digital images exactly as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.
  1. Date and Time: Include date and time in filename for each image.
  2. Field Office Images: Maintain one set of images on CD-ROM in the field office at Project site, available at all times for reference. Identify images same as for those submitted to Architect.

C. Preconstruction Photographs: Before commencement of demolition, take color, digital photographs of Project site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by Architect.
  1. Flag excavation areas and construction limits before taking construction photographs.
  2. Take eight photographs to show existing conditions adjacent to property before starting the Work.
  3. Take eight photographs of existing buildings either on or adjoining property to accurately record physical conditions at start of construction.
  4. Take additional photographs as required to record settlement or cracking of adjacent structures, pavements, and improvements.

D. Periodic Construction Photographs: Take 12 color, digital photographs monthly, coinciding with the cutoff date associated with each Application for Payment. Select vantage points to show status of construction and progress since last photographs were taken.

E. Architect-Directed Construction Photographs: From time to time, Architect will amend number and frequency of color, digital photographs and general directions on vantage points. Select actual vantage points and take photographs to show the status of construction and progress since last photographs were taken.

F. Final Completion Construction Photographs: Take eight color photographs after date of Substantial Completion for submission as Project Record Documents. Architect will select desired vantage points.
  1. Do not include date stamp.

G. Additional Photographs: Architect may issue requests for additional photographs, in addition to periodic photographs specified. Additional photographs will be paid for by Change Order and are not included in the Contract Sum.
  1. Three days’ notice will be given, where feasible.
  2. In emergency situations, take additional photographs within 24 hours of request.
  3. Circumstances that could require additional photographs include, but are not limited to, the following:
     a. Special events planned at Project site.
     b. Immediate follow-up when on-site events result in construction damage or losses.
     c. Photographs to be taken at fabrication locations away from Project site. These photographs are not subject to unit prices or unit-cost allowances.
     d. Substantial Completion of a major phase or component of the Work.
e. Extra record photographs at time of final acceptance.
f. Owner's request for special publicity photographs.

END OF SECTION
SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.01 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.

1.02 SUMMARY
A. This Section includes administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.
B. Related Sections include the following:
   1. Division 01 Section "Payment Procedures" for submitting Applications for Payment and the Schedule of Values.
   2. Division 01 Section "Project Management and Coordination" for submitting and distributing meeting and conference minutes and for submitting Coordination Drawings.
   3. Division 01 Section "Construction Progress Documentation" for submitting schedules and reports, including Contractor's Construction Schedule and the Submittals Schedule.
   4. Division 01 Section "Photographic Documentation" for submitting construction photographs.
   5. Division 01 Section "Quality Requirements" for submitting test and inspection reports and for mockup requirements.
   7. Division 01 Section "Closeout Procedures" for submitting warranties.
   8. Division 01 Section "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
   9. Division 01 Section "Operation and Maintenance Data" for submitting operation and maintenance manuals.
   10. Division 01 Section "Demonstration and Training" for submitting videotapes of demonstration of equipment and training of Owner's personnel.
   11. Division 01 Section "Sustainable Design Requirements" for submittal of LEED documentation materials.
   12. Divisions 02 through 49 Sections for specific requirements for submittals in those Sections.

1.03 DEFINITIONS
A. Action Submittals: Written and graphic information that requires Architect's responsive action.
B. Informational Submittals: Written information that does not require Architect's responsive action. Submittals may be rejected for not complying with requirements.

1.04 PERFORMANCE REQUIREMENTS
A. Perform no portion of the Work for which the Contract Documents require submittal and review of Shop Drawings, Product Data, samples or similar submittals until the respective submittal has been approved by the Architect.
1.05 SUBMITTAL PROCEDURES

A. General: Electronic copies of electronic Drawings of the Contract Drawings will be provided by Architect for Contractor's use in preparing submittals.

B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
   1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
   2. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
      a. Architect reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

C. Submittals Schedule: Comply with requirements in Division 01 Section "Construction Progress Documentation" for list of submittals and time requirements for scheduled performance of related construction activities.
   1. Architect reserves the right to reject Submittals received prior to receipt of the Initial Submittals Schedule.
   2. Architect reserves the right to reject Submittals received prior to the time they are indicated on the Submittal Schedule to be submitted.

D. Processing Time: Allow enough time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
   1. Initial Review: Allow 15 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Architect will advise Contractor when a submittal being processed must be delayed for coordination.
   2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
   3. Resubmittal Review: Allow 15 days for review of each resubmittal.
   4. Sequential Review: Where sequential review of submittals by Architect's consultants, Owner, or other parties is indicated, allow 21 days for initial review of each submittal.
   5. Concurrent Consultant Review: Where the Contract Documents indicate that submittals may be transmitted simultaneously to Architect and to Architect's consultants, allow 15 days for review of each submittal. Submittal will be returned to Architect before being returned to Contractor.

E. Identification: Place a permanent label or title block on each submittal for identification.
   1. Indicate name of firm or entity that prepared each submittal on label or title block.
   2. Provide a space on label or beside title block to record Contractor's review and approval markings and action taken by Architect.
   3. Include the following information on label for processing and recording action taken:
      a. Project name.
      b. Date.
      c. Name and address of Architect.
      d. Name and address of Contractor.
      e. Name and address of subcontractor.
      f. Name and address of supplier.
      g. Name of manufacturer.
      h. Submittal number or other unique identifier, including revision identifier.
         1) Submittal number shall use Specification Section number followed by a decimal point and then a sequential number (e.g., 06 10 00.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., 06 10 00.01.A).
SUBMITTAL PROCEDURES

1.06 CONTRACTOR’S USE OF ARCHITECT’S ELECTRONIC FILES

A. General: At Contractor's written request, copies of Architect's electronic files will be provided to Contractor for Contractor's use in connection with Project, subject to the following conditions:

1. Execute Electronic File Transfer Agreement provided at end of this Section to obtain files.
2. The electronic files are provided for the Contractor’s convenience and their use will be at the Contractors risk.
   a. There are no assurances that the information in the electronic files is current. All dimensions must be field-verified.

G. Additional Copies: Unless additional copies are required for final submittal, and unless Architect observes noncompliance with provisions in the Contract Documents, initial submittal may serve as final submittal.

a. Submit two copies of submittal to concurrent reviewer in addition to specified number of copies to Architect.

H. Transmittal: Package each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form. Architect will return submittals, without review, received from sources other than Contractor.

1. Transmittal Form: Provide locations on form for the following information:
   a. Project name.
   b. Date.
   c. Destination (To:).
   d. Source (From:).
   e. Names of subcontractor, manufacturer, and supplier.
   f. Category and type of submittal.
   g. Submittal purpose and description.
   h. Specification Section number and title.
   i. Drawing number and detail references, as appropriate.
   j. Submittal and transmittal distribution record.
   k. Remarks.
   l. Signature of transmitter.

2. On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Architect on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same label information as related submittal.

I. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.

1. Note date and content of previous submittal.
2. Note date and content of revision in label or title block and clearly indicate extent of revision.
3. Resubmit submittals until they are marked "REVIEWED (No Exceptions Taken), or REVIEWED WITH COMMENTS (make corrections noted, re-submittal not required.)

J. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
PART 2 - PRODUCTS

2.01 ACTION SUBMITTALS

A. General: Prepare and submit Action Submittals required by individual Specification Sections.

B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
   1. If information must be specially prepared for submittal because standard printed data are not suitable for use, submit as Shop Drawings, not as Product Data.
   2. Mark each copy of each submittal to show which products and options are applicable.
   3. Include the following information, as applicable:
      a. Manufacturer's written recommendations.
      b. Manufacturer's product specifications.
      c. Manufacturer's installation instructions.
      d. Standard color charts.
      e. Manufacturer's catalog cuts.
      f. Wiring diagrams showing factory-installed wiring.
      g. Printed performance curves.
      h. Operational range diagrams.
      i. Mill reports.
      j. Standard product operation and maintenance manuals.
      k. Compliance with specified referenced standards.
      l. Testing by recognized testing agency.
      m. Application of testing agency labels and seals.
      n. Notation of coordination requirements.
   4. Submit Product Data before or concurrent with Samples.
   5. Number of Copies: Submit two copies of Product Data, unless otherwise indicated. When submitting for Concurrent Consultant Review, submit two copies to Consultant and one copy to Architect. Architect will return one copy. Mark up and retain returned copy as a Project Record Document. Reproduction and cost of reproduction of processed Submittals for distribution to concerned parties is Contractor’s responsibility.

C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.
   1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
      a. Dimensions.
      b. Identification of products.
      c. Fabrication and installation drawings.
      d. Roughing-in and setting diagrams.
      e. Wiring diagrams showing field-installed wiring, including power, signal, and control wiring.
      f. Shopwork manufacturing instructions.
      g. Templates and patterns.
      h. Schedules.
      i. Design calculations.
      j. Compliance with specified standards.
      k. Notation of coordination requirements.
      l. Notation of dimensions established by field measurement.
      m. Relationship to adjoining construction clearly indicated.
      n. Seal and signature of professional engineer if specified.
o. Wiring Diagrams: Differentiate between manufacturer-installed and field-installed wiring.

2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches but no larger than 30 by 42 inches.

3. Number of Copies: Submit two copies of each submittal. When submitting for Concurrent Consultant Review, submit two copies to Consultant and one copy to Architect. Architect will return one copy. Mark up and retain one returned copy as a Project Record Drawing.

D. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.

1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.

2. Identification: Attach label on unexposed side of Samples that includes the following:
   a. Generic description of Sample.
   b. Product name and name of manufacturer.
   c. Sample source.
   d. Number and title of appropriate Specification Section.

3. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
   a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
   b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.

4. Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
   a. Number of Samples: Submit two sets of Samples. Architect will retain one Sample set; the other will be returned.
      1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
      2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least two sets of paired units that show approximate limits of variations.

E. Submittals Schedule: Comply with requirements specified in Division 01 Section "Construction Progress Documentation."

F. Application for Payment: Comply with requirements specified in Division 01 Section "Payment Procedures."

G. Schedule of Values: Comply with requirements specified in Division 01 Section "Payment Procedures."
H. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Use CSI Form 1.5A. Include the following information in tabular form:
1. Name, address, and telephone number of entity performing subcontract or supplying products.
2. Number and title of related Specification Section(s) covered by subcontract.
3. Drawing number and detail references, as appropriate, covered by subcontract.
4. Number of Copies: Submit two copies of subcontractor list, unless otherwise indicated. Architect will return one copy.
   a. Mark up and retain returned copy as a Project Record Document.

I. LEED Submittals: Comply with requirements specified in Division 01 Section "Sustainable Design Requirements."
1. Number of Copies: Submit two copies of LEED submittals, unless otherwise indicated.

J. Material Safety Data Sheets (MSDSs) for LEED Certification: Submit information necessary to show compliance with LEED certification requirements, which will be the limit of the Architect's review.
1. Architect will not review non-LEED submittals that include MSDSs and will return the entire submittal for resubmittal.

2.02 INFORMATIONAL SUBMITTALS
A. General: Prepare and submit Informational Submittals required by other Specification Sections.
1. Number of Copies: Submit [] one copy of each submittal, unless otherwise indicated. Architect will not return copy.
2. Certificates and Certifications: Provide a notarized statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
3. Test and Inspection Reports: Comply with requirements specified in Division 01 Section "Quality Requirements."

B. Coordination Drawings: Comply with requirements specified in Division 01 Section "Project Management and Coordination."

C. Contractor's Construction Schedule: Comply with requirements specified in Division 01 Section "Construction Progress Documentation."

D. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

E. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification (WPS) and Procedure Qualification Record (PQR) on AWS forms. Include names of firms and personnel certified.

F. Installer Certificates: Prepare written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.

G. Manufacturer Certificates: Prepare written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
H. Product Certificates: Prepare written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.

I. Material Certificates: Prepare written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.

J. Material Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.

K. Product Test Reports: Prepare written reports indicating current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.

L. Research/Evaluation Reports: Prepare written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
   1. Name of evaluation organization.
   2. Date of evaluation.
   3. Time period when report is in effect.
   4. Product and manufacturers' names.
   5. Description of product.
   6. Test procedures and results.
   7. Limitations of use.

M. Schedule of Tests and Inspections: Comply with requirements specified in Division 01 Section "Quality Requirements."

N. Preconstruction Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.

O. Compatibility Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.

P. Field Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.

Q. Maintenance Data: Prepare written and graphic instructions and procedures for operation and normal maintenance of products and equipment. Comply with requirements specified in Division 01 Section "Operation and Maintenance Data."

R. Design Data: Prepare written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.

S. Manufacturer's Instructions: Prepare written or published information that documents manufacturer's recommendations, guidelines, and procedures for installing or operating a product or equipment. Include name of product and name, address, and telephone number of manufacturer. Include the following, as applicable:
   1. Preparation of substrates.
   2. Required substrate tolerances.
   3. Sequence of installation or erection.
   4. Required installation tolerances.
5. Required adjustments.
6. Recommendations for cleaning and protection.

T. Manufacturer's Field Reports: Prepare written information documenting factory-authorized service representative's tests and inspections. Include the following, as applicable:
   1. Name, address, and telephone number of factory-authorized service representative making report.
   2. Statement on condition of substrates and their acceptability for installation of product.
   3. Statement that products at Project site comply with requirements.
   4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
   5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
   6. Statement whether conditions, products, and installation will affect warranty.
   7. Other required items indicated in individual Specification Sections.

U. Insurance Certificates and Bonds: Prepare written information indicating current status of insurance or bonding coverage. Include name of entity covered by insurance or bond, limits of coverage, amounts of deductibles, if any, and term of the coverage.

V. Construction Photographs: Comply with requirements specified in Division 01 Section "Photographic Documentation."

W. Material Safety Data Sheets (MSDs): Submit information directly to Owner; do not submit to Architect, except as required in "Action Submittals" Article.

2.03 DELEGATED DESIGN

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
   1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.

B. Delegated-Design Submittal: In addition to Shop Drawings, Product Data, and other required submittals, submit two copies of a statement, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional. When submitting for Concurrent Consultant Review, submit two copies to Consultant and one copy to Architect.
   1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

PART 3 - EXECUTION

3.01 CONTRACTOR'S REVIEW

A. Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect.

B. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.
3.02 ARCHITECT’S ACTION

A. General: Architect will not review submittals that do not bear Contractor's approval stamp and will return them without action.

B. Action Submittals: Architect will review each submittal, make marks to indicate corrections or modifications required, and return it. Architect will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action taken, as follows:
   1. Reviewed (no exceptions taken).
   2. Reviewed with Comments (make corrections noted, re-submittal not required).
   3. Reviewed: Re-submit (revise as noted and re-submit for review).
   4. Rejected (reasons noted, new submittal or other action required).

C. Informational Submittals: Architect will review each submittal and will not return it, or will return it if it does not comply with requirements. Architect will forward each submittal to appropriate party.

D. Partial submittals are not acceptable, will be considered nonresponsive, and will be returned without review.

E. Submittals not required by the Contract Documents may not be reviewed and may be discarded.

END OF SECTION
ELECTRONIC FILE TRANSFER AGREEMENT

This Agreement, is made in reference to the construction of the ____________ for ____________, hereafter referred to as Owner.

The Owner has requested that Anderson Mason Dale and its consultants, hereinafter referred to as Consultant, furnish ________________________, hereafter referred to as Contractor, a disk or electronic file which contains machine readable information in the form of a DWG format file, of certain drawings of the above referenced project.

Because of the possibility that information and data delivered in machine readable form may be altered, either intentional or unintentional due to, among other causes, transmission, conversion, media degradation, software error, or human alteration, Consultant reserves the right to retain hard copy originals of the electronic documentation delivered to Contractor, in machine readable form, which originals shall be referred to and shall govern in the event of any inconsistency between the two.

The Contractor and the Owner understand that the automated conversion (translation) of information and data from the system and format used by Consultant to an alternate system or format cannot be accomplished without the introduction of anomalies and/or errors. electronic files are not the contract documents. Accordingly the electronic documents provided to Owner are for informational purposes only and are not intended as an end-product. electronic files may not contain all addenda (especially written addenda), direction given in RFI's, ASI's etc. Also, the quality, scale, accuracy and completeness of electronic files cannot be guaranteed. The Contractor agrees to assume all risks associated therewith, and to the fullest extent permitted by law to hold harmless and indemnify Consultant from and against all claims, liabilities, losses, damages, and costs, including but not limited to attorney's fees, arising therefrom or in connection therewith.

The Contractor recognizes that changes or modifications to Consultant's instruments of professional service introduced by anyone other than Consultant may result in adverse consequences which Consultant can neither predict nor control. Therefore, and in consideration of Consultant's agreement to deliver its instruments of professional service in machine readable form, the Contractor agrees to the fullest extent permitted by law to hold harmless and indemnify Consultant from and against all claims, liabilities, losses, damages, and costs including but not limited to attorney's fees arising out of or in any way connected with the modification, misinterpretation, misuse or reuse by others of the machine readable information and data provided by Consultant under this agreement. The foregoing indemnification applies, without limitation, to any use of the project documentation on other projects, for additions to this project or for completion of this project by others, excepting only such use as may be authorized, in writing, by Consultant.

The transfer which is the subject matter of this Agreement shall not be considered as and is not a sale. Consultant makes no warranties, express or implied, with respect to the data transferred.

In witness thereof, the parties hereto have executed this agreement as of the dates stated below.

Owner
Title
Date of Execution
Witness

Contractor
Title
Date of Execution
Witness
PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:

1. Indoor Air Quality Management Plan.
   a. During construction:
      1) Protection of heating, ventilating, and air conditioning systems.
      2) Reducing emissions through source control.
      3) Pathway interruption.
      4) Housekeeping.
      5) Scheduling.

B. Related Sections:
   1. Division 01 Section "Sustainable Design Requirements" for additional LEED requirements.

1.02 SUBMITTALS

A. Credit EQ 3.1:

1. Indoor Air Quality Management Plan:
   a. Submit Indoor Air Quality Management Plan for review within 14 days after date of Notice to Proceed. Include:
      1) Procedures for implementing requirements of Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) "IAQ Guidelines for Occupied Buildings Under Construction, ANSI/SMACNA 008-2008".
      2) Substitution procedures for products that are responsibility of Contractor and proposed source control implementation measures to minimize building contamination.
      3) Construction sequencing and storage plans for protection of stored on-site or installed absorptive materials against moisture absorption and contamination.
      4) Filter media change schedule.
      5) Name and phone number of Contractor's personnel responsible for instructing workers and overseeing and documenting results of Indoor Air Quality Management Plan.
   b. Revise and resubmit plan within ten days after receipt of comments.
   c. Distribute copies of approved Indoor Air Quality Management Plan to concerned parties.
   d. Photographs: Submit 6 photographs at 3 different times during the construction period, along with a brief description of the SMACNA approach employed, documenting implementation of the indoor-air-quality management measures, such as protection of ducts and on-site stored or installed absorptive materials.

B. Credit EQ 3.2:

1. Signed detailed narrative describing the project's pre-occupancy (or pre-occupancy and post-occupancy) flush-out process including data regarding temperature, airflow, and duration of flush-out and any special considerations.
2. Report from testing and inspecting agency indicating results of indoor-air-quality testing and documentation showing compliance with indoor-air-quality testing procedures and requirements.

1.03 QUALITY ASSURANCE
A. Review and discuss Indoor Air Quality Management Plan implementation and progress at Preconstruction Conference and Progress Meetings.

1.04 DELIVERY, STORAGE AND HANDLING
A. Designate specific storage areas to facilitate protection of stored absorptive materials.
   1. Clearly identify storage areas. Keep clean and orderly; prevent contamination of materials.
   2. Monitor storage areas for contamination; correct problems and implement preventative measures.
B. Protect ductwork during shipping. Pre-wrap duct ends; seal with polyethylene sheeting and duct-tape. Transport ducts on enclosed trucks.
   1. Minimize quantities of ductwork store on-site.

1.05 TRAINING
A. Provide training of indoor air quality management methods to be used at appropriate stages of Project.
   1. Require participation of all subcontractors.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 IMPLEMENTATION - DURING CONSTRUCTION
A. Meet or exceed SMACNA minimum requirements for heating, ventilating, and air conditioning system protection, source control, pathway interruption, housekeeping, and scheduling.
B. Protect stored on-site or installed absorptive materials from moisture damage and volatile organic compound contamination through construction sequencing and proper storage.
C. If air handlers are used during construction, use filtration media with Minimum Efficiency Reporting Value (MERV) of 13 per American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) 52.2 “Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.”
D. Replace filtration media just prior to occupancy.
E. Heating, Ventilating, and Air Conditioning System Protection:
   1. Keep duct systems including supply air system, return air system, exhaust air system, and associated equipment, including air handlers, variable air volume boxes, silencers, fans, and filter boxes, clean and uncontaminated.
   2. Seal taps and open ends not actively being worked-on with plastic and tape.
   3. Provide 1 inch polyester filter media over return and exhaust air inlets during construction and until Completion.
   4. Ensure that temporary and permanent filters are in place openings before running fans.
F. Source Control:
1. For temporary and ancillary materials used in construction, follow requirements of similar products in Divisions 2 through 49 to minimize indoor air quality impacts.
2. Use nontoxic formulations and implement other control measures to minimize building contamination.

G. Pathway Interruption: Isolate areas where work is being performed to prevent contamination of clean spaces.

H. Housekeeping:
1. Implement cleaning activities concentrating on heating, ventilating, and air conditioning systems and building space to remove contaminants prior to occupancy.
2. Protect materials from weather and store in clean area prior to unpacking.
3. Clean coils, air filters, and fans before performing testing and balancing.
4. Restrict access points to the building, toilet, and trash facilities.
   a. Provide temporary walk-off mats at all entrances.
5. Make vacuum cleaners available to construction personnel at all times.
   a. Vacuum cleaners must have a working filter system. Replace vacuum cleaners that do not vacuum or filter dust.
6. Equip saws, sanders and other construction tools that create dust with vacuums during use.
   a. Vacuums must have a working filter system. Replace vacuums that do not vacuum or filter dust.

I. Scheduling:
1. Sequence construction activities to reduce absorption of and volatile organic compounds by materials.
2. Complete applications of wet and odorous materials before installing absorptive materials.

3.02 IMPLEMENTATION - BEFORE OCCUPANCY

A. Credit EQ 3.2:[ Comply with one of the following requirements:]
1. After construction ends, prior to occupancy and with all interior finishes installed, perform a building flush-out by supplying a total volume of 14,000 cu. ft. of outdoor air per sq. ft. of floor area while maintaining an internal temperature of at least 60 deg F and a relative humidity no higher than 60 percent.
   a. <Insert operating requirements>.
2. If occupancy is desired prior to flush-out completion, the space may be occupied following delivery of a minimum of 3500 cu. ft. of outdoor air per sq. ft. of floor area to the space. Once a space is occupied, it shall be ventilated at a minimum rate of 0.30 cfm per sq. ft. of outside air or the design minimum outside air rate determined in EQ Prerequisite 1, whichever is greater. During each day of the flush-out period, ventilation shall begin a minimum of three hours prior to occupancy and continue during occupancy. These conditions shall be maintained until a total of 14,000 cu. ft./sq. ft. of outside air has been delivered to the space.
   a. <Insert operating requirements>.
3. Air-Quality Testing:
   a. Conduct baseline indoor-air-quality testing, after construction ends and prior to occupancy, using testing protocols consistent with the EPA's "Compendium of Methods for the Determination of Air Pollutants in Indoor Air," and as additionally detailed in the USGBC's "[LEED-NC] [LEED-CI]: Reference Guide."
b. Demonstrate that the contaminant maximum concentrations listed below are not exceeded:
   1) Formaldehyde: 50 ppb.
   2) Particulates (PM10): 50 micrograms/cu. m.
   3) Total Volatile Organic Compounds (TVOC): 500 micrograms/cu. m.
   4) 4-Phenylcyclohexene (4-PH): 6.5 micrograms/cu. m.
   5) Carbon Monoxide: 9 ppm and no greater than 2 ppm above outdoor levels.

c. For each sampling point where the maximum concentration limits are exceeded, conduct additional flush-out with outside air and retest the specific parameter(s) exceeded to indicate the requirements are achieved. Repeat procedure until all requirements have been met. When retesting noncomplying building areas, take samples from same locations as in the first test.

d. Air-sample testing shall be conducted as follows:
   1) All measurements shall be conducted prior to occupancy but during normal occupied hours, and with building ventilation system starting at the normal daily start time and operated at the minimum outside air flow rate for the occupied mode throughout the duration of the air testing.
   2) Building shall have all interior finishes installed including, but not limited to, millwork, doors, paint, carpet, and acoustic tiles. Nonfixed furnishings such as workstations and partitions are encouraged, but not required, to be in place for the testing.
   3) Number of sampling locations will vary depending on the size of building and number of ventilation systems. For each portion of building served by a separate ventilation system, the number of sampling points shall not be less than one per 25,000 sq. ft. or for each contiguous floor area, whichever is larger, and shall include areas with the least ventilation and greatest presumed source strength.
   4) Air samples shall be collected between 3 and 6 feet from the floor to represent the breathing zone of occupants, and over a minimum four-hour period.

END OF SECTION
PART 1 - GENERAL

1.01 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.

1.02 SUMMARY
A. This Section includes administrative and procedural requirements for quality assurance and quality control.
B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
1. Specific quality-assurance and -control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and -control procedures that facilitate compliance with the Contract Document requirements.
3. Requirements for Contractor to provide quality-assurance and -control services required by Architect, Owner, or authorities having jurisdiction are not limited by provisions of this Section.
C. Related Sections include the following:
1. Division 01 Section "Allowances" for testing and inspecting allowances.
2. Division 01 Section "Construction Progress Documentation" for developing a schedule of required tests and inspections.
3. Division 01 Section "Cutting and Patching" for repair and restoration of construction disturbed by testing and inspecting activities.
4. Divisions 02 through 49 Sections for specific test and inspection requirements.

1.03 DEFINITIONS
A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.
B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by Architect.
C. Mockups: Full-size, physical assemblies that are constructed on-site. Mockups are used to verify selections made under sample submittals, to demonstrate aesthetic effects and, where indicated, qualities of materials and execution, and to review construction, coordination, testing, or operation; they are not Samples. Approved mockups establish the standard by which the Work will be judged.
D. Laboratory Mockups: Full-size, physical assemblies that are constructed at testing facility to verify performance characteristics.
E. Preconstruction Testing: Tests and inspections that are performed specifically for the Project before products and materials are incorporated into the Work to verify performance or compliance with specified criteria.

F. Product Testing: Tests and inspections that are performed by an NRTL, an NVLAP, or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with industry standards.

G. Source Quality-Control Testing: Tests and inspections that are performed at the source, i.e., plant, mill, factory, or shop.

H. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.

I. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.

J. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.

1. Using a term such as "carpentry" does not imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as "carpenter." It also does not imply that requirements specified apply exclusively to tradespeople of the corresponding generic name.

K. Experienced: When used with an entity, "experienced" means having successfully completed a minimum of five previous projects similar in size and scope to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

1.04 CONFLICTING REQUIREMENTS

A. General: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer uncertainties and requirements that are different, but apparently equal, to Architect for a decision before proceeding.

B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.

1.05 SUBMITTALS

A. Qualification Data: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.

B. Reports: Prepare and submit certified written reports that include the following:

1. Date of issue.
2. Project title and number.
3. Name, address, and telephone number of testing agency.
4. Dates and locations of samples and tests or inspections.
5. Names of individuals making tests and inspections.
6. Description of the Work and test and inspection method.
8. Complete test or inspection data.
9. Test and inspection results and an interpretation of test results.
10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
12. Name and signature of laboratory inspector.
13. Recommendations on retesting and reinspecting.

C. Permits, Licenses, and Certificates: For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

1.06 QUALITY ASSURANCE

A. General: Qualifications paragraphs in this Article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.

B. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

C. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

D. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar to those indicated for this Project in material, design, and extent.

F. Specialists: Certain sections of the Specifications require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.
   1. Requirement for specialists shall not supersede building codes and regulations governing the Work.

G. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated, as documented according to ASTM E 548; and with additional qualifications specified in individual Sections; and where required by authorities having jurisdiction, that is acceptable to authorities.
   1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
   2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.

H. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

I. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:
1. Contractor responsibilities include the following:
   a. Provide test specimens representative of proposed products and construction.
   b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
   c. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
   d. Build site-assembled test assemblies and mockups using installers who will perform same tasks for Project.
   e. Build laboratory mockups at testing facility using personnel, products, and methods of construction indicated for the completed Work.
   f. When testing is complete, remove test specimens, assemblies, mockups, and laboratory mockups; do not reuse products on Project.

2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Architect, with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.

J. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:

   1. Build mockups in location and of size indicated or, if not indicated, as directed by Architect.
   2. Notify Architect seven days in advance of dates and times when mockups will be constructed.
   3. Demonstrate the proposed range of aesthetic effects and workmanship.
   4. Obtain Architect's approval of mockups before starting work, fabrication, or construction.
      a. Allow seven days for initial review and each re-review of each mockup.
   5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
   6. Demolish and remove mockups when directed, unless otherwise indicated.

7. Exterior Sample Panel:
   a. Before beginning work, build a sample wall at a location acceptable to the Architect. Size of sample wall panel shall be approximately 8'16'-0" long by 8'10'-0" high, and have a "Z" shape to provide both inside and outside corners.
      1) Architect will provide drawing of sample panel to be constructed.
   b. The wall shall be placed on a 1'-0" x 1'-8" concrete spread footing and stem wall approximating the grade beams/foundation condition.
   c. The sample wall is to include:
      1) Concrete masonry units. Panel shall include units in all of the proposed colors, sizes, and textures. Demonstrate workmanship to be expected in the completed project. Include typical inside corner and typical outside corners in CMU and typical control joint.
      2) Dampproofing and rigid insulation at exterior face of stemwall, and inside face of masonry wall.
      3) Metal stud back-up at inside face of wall.
         a) Include all required miscellaneous framing and trim pieces.
      4) Sheathing.
5) Rigid insulation at exterior face of stem wall, and face of sheathing.
6) Masonry reinforcing.
7) Face brick, including one control joint.
8) Metal wall panels, patterns 1 and 2.
   a) Include at least one lap-seam for each type of panel.
9) Aluminum storefront window of type to be provided, size 2'-0" by 2'-0", located in masonry portion of sample.
   a) Include cast stone sill.
   b) Include lintel over the opening.
10) Curtain wall window of type to be provided, size 2'-0" by 2'-0", located in metal panel portion of the sample.
    a) Include metal sill.
    b) Include sun shade.
11) Joint Sealants at control joint and window perimeter.
12) Weep holes.
13) Through wall flashing and cavity venting materials.
14) Provide typical aluminum storefront window opening with window frame of type specified, size 2'-0" by 2'-0". Include sill trim piece.
    a) Provide lintel over the opening indicated.
15) All ties, accessories and other components required to complete the assembly for review.
16) Coping.
17) Roof edge flashing.

K. Laboratory Mockups: Comply with requirements of preconstruction testing and those specified in individual Sections in Divisions 02 through 49.

1.07 QUALITY CONTROL

A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.
   1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspecting they are engaged to perform.
   2. Payment for these services will be made from testing and inspecting allowances, as authorized by Change Orders.
   3. Costs for retesting and reinspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor.

B. Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
   1. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.
      a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
   2. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
   3. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
   4. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
5. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.

C. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Division 01 Section “Submittal Procedures.”

D. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.

   1. Notify Architect and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
   2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
   3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
   4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
   5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
   6. Do not perform any duties of Contractor.

F. Associated Services: Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
   1. Access to the Work.
   2. Incidental labor and facilities necessary to facilitate tests and inspections.
   3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
   4. Facilities for storage and field curing of test samples.
   5. Preliminary design mix proposed for use for material mixes that require control by testing agency.
   6. Security and protection for samples and for testing and inspecting equipment at Project site.

G. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
   1. Schedule times for tests, inspections, obtaining samples, and similar activities.

1.08 SPECIAL TESTS AND INSPECTIONS

A. Special Tests and Inspections: Conducted by a qualified special inspector as required by authorities having jurisdiction, as indicated in individual Specification Sections, and as follows:
   1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviewing the completeness and adequacy of those procedures to perform the Work.
   2. Notifying Architect and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
3. Submitting a certified written report of each test, inspection, and similar quality-control service to Architect with copy to Contractor and to authorities having jurisdiction.
4. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
5. Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.
6. Retesting and reinspecting corrected work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 REPAIR AND PROTECTION

A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
   1. Comply with the Contract Document requirements for Division 01 Section "Cutting and Patching."

B. Protect construction exposed by or for quality-control service activities.

C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION
SECTION 01 50 00
TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.01 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.

1.02 SUMMARY
A. This Section includes requirements for temporary utilities, support facilities, and security and protection facilities.
B. Related Sections include the following:
   1. Division 01 Section "Summary" for limitations on utility interruptions and other work restrictions.
   2. Division 01 Section "Submittal Procedures" for procedures for submitting copies of implementation and termination schedule and utility reports.
   3. Division 01 Section "Execution" for progress cleaning requirements.
   4. Divisions 02 through 49 Sections for temporary heat, ventilation, and humidity requirements for products in those Sections.
   5. Division 32 Section "Dewatering" for disposal of ground water at Project site.
   6. Division 31 Section "Termite Control" for pest control.
   7. Division 31 Section "Asphalt Paving" for construction and maintenance of asphalt paving for temporary roads and paved areas.

1.03 DEFINITIONS
A. Permanent Enclosure: As determined by Architect, permanent or temporary roofing is complete, insulated, and weathertight; exterior walls are insulated and weathertight; and all openings are closed with permanent construction or substantial temporary closures.

1.04 USE CHARGES
A. General: Cost or use charges for temporary facilities shall be included in the Contract Sum. Allow other entities to use temporary services and facilities without cost, including, but not limited to, Owner's construction forces, Architect, occupants of Project, testing agencies, and authorities having jurisdiction.
B. Sewer Service: Pay sewer service use charges for sewer usage by all entities for construction operations.
C. Water Service: Pay water service use charges for water used by all entities for construction operations.
D. Electric Power Service: Electric power from Owner's existing system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.

1.05 SUBMITTALS
A. Site Plan: Show temporary facilities, utility hookups, staging areas, and parking areas for construction personnel.
B. Submit a Traffic Control Plan with phasing for the entire duration of the project.
C. Submit a Water, Erosion, and Sedimentation Control Plan prior to start of construction, including but not limited to:
1. Description of the sequence of construction.
2. Description of control facilities. Indicate the location of the vehicle tracking control areas, straw bales, sediment traps, silt fence, and other facilities.
3. Description of inspection and maintenance procedures.
   b. Prepare schedules for accomplishing all required temporary and permanent erosion control work and submit them for acceptance at the preconstruction conference. Include all construction activities within the project, haul roads, borrow pits, storage and pallet sites, and the plan for disposal of waste material. Do not start Work until temporary erosion control schedules have been accepted.
   c. Where required, submit plan to Authorities Having Jurisdiction for approval prior to commencing Work.

1.06 QUALITY ASSURANCE

A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.

B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

1.07 PROJECT CONDITIONS

A. Temporary Use of Permanent Facilities: Installer of each permanent service shall assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Pavement: Comply with Division 32 pavement Sections.

B. Chain-Link Fencing: Minimum 2-inch, 0.148-inch thick, galvanized steel, chain-link fabric fencing; minimum 6 feet high with galvanized steel pipe posts; minimum 2-3/8-inch-OD line posts and 2-7/8-inch-OD corner and pull posts, with 1-5/8-inch-OD top rails.


D. Lumber and Plywood: Comply with requirements in Division 06 Section "Miscellaneous Rough Carpentry."

E. Gypsum Board: Minimum 1/2 inch thick by 48 inches wide by maximum available lengths; regular-type panels with tapered edges. Comply with ASTM C 36/C 36M.

F. Insulation: Unfaced mineral-fiber blanket, manufactured from glass, slag wool, or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.

G. Paint: Comply with requirements in Division 09 painting Sections.
2.02 TEMPORARY FACILITIES
   A. Field Offices, General: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.
   B. Common-Use Field Office: Of sufficient size to accommodate needs of construction personnel. Keep office clean and orderly. Furnish and equip offices as follows:
      1. Furniture required for Project-site documents including file cabinets, plan tables, plan racks, and bookcases.
      2. Conference room of sufficient size to accommodate meetings of [] minimum of 10 individuals. Provide electrical power service and 120-V ac duplex receptacles, with not less than 1 receptacle on each wall. Furnish room with conference table, chairs, and 4-foot- square tack board.
      3. Drinking water and private toilet.
      5. Heating and cooling equipment necessary to maintain a uniform indoor temperature of 68 to 72 deg F.
      6. Lighting fixtures capable of maintaining average illumination of 20 fc at desk height.
   C. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.
      1. Store combustible materials apart from building.

2.03 EQUIPMENT
   A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.
   B. HVAC Equipment: Unless Owner authorizes use of permanent HVAC system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.
      1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
      2. Heating Units: Listed and labeled for type of fuel being consumed, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
      3. Permanent HVAC System: If Owner authorizes use of permanent HVAC system for temporary use during construction, provide filter with MERV of 8 at each return air grille in system and remove at end of construction.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL
   A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.
   B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.02 TEMPORARY UTILITY INSTALLATION
   A. General: Install temporary service or connect to existing service.
      1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.
B. Sewers and Drainage: Provide temporary utilities to remove effluent lawfully.
   1. Connect temporary sewers to local system as directed by authorities having jurisdiction.

C. Water Service: Install water service and distribution piping in sizes and pressures adequate for construction.

D. Water Service: Use of Owner's existing water service facilities will be permitted, as long as facilities are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore these facilities to condition existing before initial use.
   1. Where installations below an outlet might be damaged by spillage or leakage, provide a drip pan of suitable size to minimize water damage. Drain accumulated water promptly from pans.

E. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.

F. Heating and Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.

G. Ventilation and Humidity Control: Provide temporary ventilation required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce ambient condition required and minimize energy consumption.

H. Electric Power Service: Use of Owner's existing electric power service will be permitted, as long as equipment is maintained in a condition acceptable to Owner.

I. Electric Power Service: Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations.
   1. Install electric power service overhead, unless otherwise indicated.
   2. Connect temporary service to Owner's existing power source, as directed by Owner.

J. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.
   1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.

K. Telephone Service: Provide temporary telephone service in common-use facilities for use by all construction personnel. Install one telephone line for each field office.
   1. Provide additional telephone lines for the following:
      a. Provide a dedicated telephone line for each facsimile machine and computer in each field office.
   2. At each telephone, post a list of important telephone numbers.
      a. Police and fire departments.
      b. Ambulance service.
      c. Contractor's home office.
      d. Architect's office.
      e. Engineers' offices.
      f. Owner's office.
      g. Principal subcontractors' field and home offices.
3. Provide superintendent and other key personnel with cellular telephone and portable two-way radio for use when away from field office.

L. Internet Service: Provide, maintain, and pay for temporary internet service, including electronic mail, in field office at time of mobilization.
   1. Provide DSL with minimum internet connection of 256K download capacity.
   2. Service shall be 24/7 with no dial up.
   3. Provide a minimum of 1 routable internet I.P. address.

3.03 SUPPORT FACILITIES INSTALLATION

A. General: Comply with the following:
   1. Provide incombustible construction for offices, shops, and sheds located within construction area or within 30 feet of building lines. Comply with NFPA 241.
   2. Maintain support facilities until near Substantial Completion. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to Owner.

B. Temporary Roads and Paved Areas: Construct and maintain temporary roads and paved areas adequate for construction operations. Locate temporary roads and paved areas within construction limits indicated on Drawings.
   1. Provide dust-control treatment that is nonpolluting and non-tracking. Reapply treatment as required to minimize dust.

C. Traffic Controls: Comply with requirements of authorities having jurisdiction.
   1. Protect existing site improvements to remain including curbs, pavement, and utilities.
   2. Furnish, install, maintain, and remove temporary traffic control signs and devices for vehicular and pedestrian traffic.
      a. Barricades and markers shall meet the requirements of the Manual on Uniform Traffic Control Devices, the M & S Standard plans of Colorado Department of Transportation, and the requirements of the local Traffic Engineer for work in the streets.
   3. Provide traffic control flag persons as necessary during entire period of construction.
      a. Flag-persons shall be properly qualified, equipped, and trained per the Manual on Uniform Traffic Control Devices.
   4. Maintain a minimum of one 12-foot lane on all adjacent streets at all times during construction. Traffic may be disrupted through the use of flag persons to accommodate the safe movement of construction related vehicles in, out and across the through traffic lanes.
      a. Maintain access for fire-fighting equipment and access to fire hydrants.

D. Parking: Provide temporary parking areas for construction personnel.
   1. Control construction-related parking to preclude interference with public traffic and parking, access by emergency vehicles, Owner's operations, and construction operations.
      a. Monitor parking areas for construction personnel's private vehicles to preclude them from becoming a public nuisance or endangering public safety.

E. Dust Control: Use one of the following, or both, methods:
   1. Water Method:
      a. Apply water by means of pipelines and sprinklers, or by mobile units with a minimum tank capacity of 1000 gallons.
         1) If mobile units are utilized, they shall be present at site at all times and tanks shall be kept full, except when in-use.
b. Apply water for compacting embankment material, fill materials, sub-bases, base, and surfacing material, and for controlling dust by means of pressure type distribution or pipelines with a spray system, or hoses with nozzles that will ensure a uniform application of water.

2. Resin Emulsion Method:
   a. Provide resin emulsion products composed of 56 to 63 percent semi-liquid petroleum resin and water with emulsifier, readily miscible with normal or hard water. Do not use resin emulsion which has been stored for more than 3 months unless tested and found acceptable.
      1) Mix binders with water at the rate of 4 to 19 parts of water to one part binder, the exact rate to be determined by dust control requirements. Mix by placing binder and water in spreading equipment or by other mixing method that will produce equivalent results.
   b. Apply the mixture with a spray system or pressure type asphalt distributors at an approximate rate of 0.2 to 0.8 gallons per square yard as required for effective dust control.

F. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.
   1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties nor endanger permanent Work or temporary facilities.
   2. Remove snow and ice as required to minimize accumulations.

G. Project Identification and Temporary Signs: Provide Project identification and other signs. Install signs where required to inform public and individuals seeking entrance to Project. Unauthorized signs are not permitted.
   1. Provide temporary, directional signs for construction personnel and visitors.
   2. Maintain and touchup signs so they are legible at all times.

H. Waste Disposal Facilities: Comply with requirements specified in Division 01 Section "Construction Waste Management and Disposal."
   1. Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction. Comply with Division 01 Section "Execution" for progress cleaning requirements.

I. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.
   1. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.

J. Temporary Elevator Use: Refer to Division 14 Sections for temporary use of new elevators.

K. Temporary Stairs: Until permanent stairs are available, provide temporary stairs where ladders are not adequate.

L. Temporary Use of Permanent Stairs: Cover finished, permanent stairs with protective covering of plywood or similar material so finishes will be undamaged at time of acceptance.

3.04 SECURITY AND PROTECTION FACILITIES INSTALLATION

A. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction in ways and by methods that comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.
   1. Comply with work restrictions specified in Division 01 Section "Summary."
B. Temporary Erosion and Sedimentation Control: Provide measures to prevent soil erosion and discharge of soil-bearing water runoff and airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction.

1. Develop a plan to temporarily divert, detain or otherwise control the diverted flow from drainage through the construction area as construction progresses. Determine the means to control alluvial or subsurface flow, springs, surface runoff, irrigation flow, excessive soil moisture, and any and all other forms of water which may occur during normal, drought, or flood conditions. Control water (surface water and/or groundwater) in such a manner that recently constructed portions of the project are not damaged by either normal or flood flows. Any such damage shall be deemed to be the result of the inadequate control measures, and shall be repaired at no cost to the Owner. Such repair shall include but not be limited to the re-establishment of soil, top soil, grading, sod or grass seed, replacement of damaged concrete work, or riprap and the removal of silt or debris which may be deposited within the project area by the flows of water.

   a. Use berms, dikes, dams, sediment basins and/or traps, geotextiles, stone checks, hay bales, silt fences, surface roughing, mats and nets, aggregate, mulch, grasses, slope drains, and other approved measures at the locations necessary to control erosion and water pollution.

      1) Temporarily relocate drainage ways, by-pass the flow, dewater excavated areas, or otherwise control the water so that the project can be constructed in accordance with the Drawings.

      2) Stabilize all cut and fill slopes with seeding, mulching, or other appropriate measures where construction activity will not occur for a period of 14 or more calendar days.

      3) Silt Fences: Set stakes, excavate 4 inch by 4 inch trench upslope of stakes, place filter fabric, backfill and compact trench.

      4) Straw Bales: Excavate 4 inch depth trench the width of bale. Place bales in trench with tight abutting ends. Stake each bale with two stakes.

          a) Remove and replace sediment laden and ineffective erosion bales with new straw bales.

      5) Vehicle Tracking Control: Maintain regularly by removing gravel that has been moved out onto streets. Place new gravel as required to ensure that gravel is functioning properly to remove mud from the tires of construction equipment.

   b. If Project is subject to a water quality permit, the quantities, locations, and composition of discharges, the quantities of dredging and fills, and the erosion and sediment control measures will be stated in the Permit. If changes from permit conditions are anticipated, or if construction activities result in noncompliance, submit the anticipated changes or noncompliance in a written report. Architect will approve or disapprove the request for change, or detail the course of action after non-compliance.

   c. Provide temporary erosion and pollution control measures for the purpose of correcting unforeseen conditions that develop during construction, or during an emergency situations, and for the purpose of providing continuous erosion and sediment control for the duration of the project.

2. Do not affect existing drainage patterns of adjacent property at any time during construction. Any damage to adjacent properties which results from the alteration of any drainage patterns, irrigation flows, alluvial or groundwater flows, or surface drainage shall be repaired at no expense to the Owner.
3. Hazardous Materials: The use of chemicals such as soil stabilizers, dust palliatives, sterilants, growth inhibitors, fertilizers, deicing salts, etc., during construction shall be in accordance with those materials’ manufacturer’s recommended application rates, frequency, and instructions. Such chemicals shall not be used, stored, or stockpiled within 50 feet of the ordinary high water line of any watercourse or impoundment. Where such chemicals are stored or stockpiled, take spill prevention and containment measures to prevent the pollution of any watercourse or impoundment due to accidental spills.

4. Do not store or stockpile any construction waste or salvable material, excavation excess material, fill material, or construction equipment within 50 feet of the ordinary high water line of any watercourse or impoundment.

5. Continuously maintain all erosion and sediment control measures so that they perform their intended function during the construction of the project.

6. Install permanent erosion and sediment control measures at the earliest practicable time.

7. Inspect, repair, and maintain erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

8. Remove water, erosion, and sedimentation control measures when no longer necessary and approved by Authority Having Jurisdiction.

C. Stormwater Control: Comply with authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.

D. Tree and Plant Protection: Comply with requirements specified in Division 01 Section "Temporary Tree and Plant Protection."

E. Tree and Plant Protection: Install temporary fencing located as indicated or outside the drip line of trees to protect vegetation from damage from construction operations. Protect tree root systems from damage, flooding, and erosion.

F. Pest Control: Engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals so Project will be free of pests and their residues at Substantial Completion. Obtain extended warranty for Owner. Perform control operations lawfully, using environmentally safe materials.

G. Site Enclosure Fence: Before construction operations begin, furnish and install site enclosure fence in a manner that will prevent people and animals from easily entering site except by entrance gates.
   1. Extent of Fence: As required to enclose entire Project site or portion determined sufficient to accommodate construction operations.
   2. Maintain security by limiting number of keys and restricting distribution to authorized personnel. Provide Owner with one set of keys.

H. Security Enclosure and Lockup: Install substantial temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security.

I. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.

J. Covered Walkway: Erect structurally adequate, protective, covered walkway for passage of individuals along adjacent public street(s). Coordinate with entrance gates, other facilities, and obstructions. Comply with regulations of authorities having jurisdiction.
   1. Construct covered walkways using scaffold or shoring framing.
   2. Provide wood-plank overhead decking, protective plywood enclosure walls, handrails, barricades, warning signs, lights, safe and well-drained walkways, and similar provisions for protection and safe passage.
3. Extend back wall beyond the structure to complete enclosure fence.
4. Paint and maintain in a manner approved by Owner and Architect.

K. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.
1. Where heating or cooling is needed and permanent enclosure is not complete, insulate temporary enclosures.

L. Temporary Partitions: Provide floor-to-ceiling dustproof partitions to limit dust and dirt migration and to separate areas occupied by Owner from fumes and noise.
1. Construct dustproof partitions with gypsum wallboard with joints taped on occupied side, and fire-retardant plywood on construction operations side.
   a. Construct vestibule and airlock at each entrance through temporary partition with not less than 48 inches between doors. Maintain water-dampened foot mats in vestibule.
3. Insulate partitions to provide noise protection to occupied areas.
4. Seal joints and perimeter. Equip partitions with dustproof doors and security locks.
5. Protect air-handling equipment.
7. Provide walk-off mats at each entrance through temporary partition.

1. Prohibit smoking in construction areas.
2. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of authorities having jurisdiction.
3. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.
4. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign stating that hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

3.05 PROTECTION OF CONCRETE SLABS TO BE PERMANENTLY EXPOSED

A. Take precautions to prevent damage and soiling of concrete slabs scheduled to be permanently exposed.
1. The following substances can penetrate the surface and stain concrete slabs:
   a. Red chalk.
   b. Permanent markers.
   c. Wax pencils.
   d. Adhesives.
   e. Oils.
   f. Gas.
   g. Primer.
   h. Paint.
   i. Stain.
   j. Sealants.
k. Caulk.
l. PVC primer/cleaner.
m. PVC adhesive.
n. Food.
o. Grease.
q. Rust from metal or nails.

2. Lumber, wood boards, sawdust plywood, thermo-ply, pressboard, insulation board and plastic draw moisture from the slab. If left on concrete slabs, they can transfer resins, tannins and water stains them.

B. Prevent damage to floor slabs from substances listed above.
C. Prohibit parking or driving of vehicles on concrete slabs until protective covering is installed.
   1. When construction equipment must be used for application, diaper all components that might drip oil, hydraulic fluid, or other liquids.
D. Prohibit temporary placement and storage of steel members on concrete slab.
E. Install protective covering of heavy cardboard, rosin paper, hardboard, plywood, or other protective sheeting over entire floor surface.
   1. 6 mil black plastic is acceptable, overlapping by one foot, and taped at the seams.
   2. Do not tape to the floor.
F. Prohibit pipe cutting and using pipe cutting machinery on concrete slabs.
G. Do not write on slabs with anything except light pencil.
H. Do not allow use of red chalk for lay-out lines.
I. Do not allow use of unprotected floors for lay down, staging, or use by any trades.
J. Floors must be completely protected during application of primer, paint, stain, or lacquer.
   1. Painters may use "Green Tape," 24-hour tape, craft paper, or drop cloths to protect floors.
K. Only "Green Tape" or lacquer-free tape is acceptable for the protection of acid-stained floors.
   1. Do not leave tape down for longer than 72 hours.
L. Keep area clean.
M. Coordinate requirements for concrete slab protection with manufacturer of concrete stain to assure compliance with stain requirements.

3.06 OPERATION, TERMINATION, AND REMOVAL

A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.
B. Maintenance: Maintain facilities in good operating condition until removal.
   1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.
C. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.
D. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction.
that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.

1. Materials and facilities that constitute temporary facilities are property of Contractor. Owner reserves right to take possession of Project identification signs.

2. Remove temporary paving not intended for or acceptable for integration into permanent paving. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at temporary entrances, as required by authorities having jurisdiction.

3. At Substantial Completion, clean and renovate permanent facilities used during construction period. Comply with final cleaning requirements specified in Division 01 Section "Closeout Procedures."

END OF SECTION
SECTION 01 60 00

PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.01 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.

1.02 SUMMARY
   A. This Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; product substitutions; and comparable products.
   B. Related Sections include the following:
      1. Division 01 Section "Allowances" for products selected under an allowance.
      2. Division 01 Section "Alternates" for products selected under an alternate.
      3. Division 01 Section "Closeout Procedures" for submitting warranties for Contract closeout.
      4. Divisions 02 through 49 Sections for specific requirements for warranties on products and installations specified to be warranted.

1.03 DEFINITIONS
   A. Products: Items purchased for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
      1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.
      2. New Products: Items that have not previously been incorporated into another project or facility, except that products consisting of recycled-content materials are allowed, unless explicitly stated otherwise. Products salvaged or recycled from other projects are not considered new products.
   B. Substitutions: Products, materials, equipment, and methods of construction proposed by Contractor in lieu of those specified.
   C. Basis-of-Design Product Specification: Where a specific manufacturer's product is named and accompanied by the words "basis of design," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of other named manufacturers. Plans, elevations, details, characteristics, and other requirements indicated are based upon standards of Basis of Design Products. Other manufacturers listed may be acceptable, provided their details and characteristics comply with size and profile requirements, and material and performance standards.

1.04 SUBMITTALS
   A. Substitution Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
1. Substitutions During the Bidding Phase:
   a. Timing: Architect will consider requests for substitution if received within 15 days prior to the Bid Date. Requests received after that time may be considered or rejected at discretion of Architect. Architect will take action on substitution requests no later than 7 days prior to the Bid Date.
   b. Substitution Request Form: Use CSI Form 1.5C, facsimile of form provided at end of Section.
   c. Form of Acceptance: Addendum to Bidding Documents.

2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
   a. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
   b. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
   c. Samples, where applicable or requested.
   d. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners.
   e. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
   f. Contractor's certification that proposed substitution complies with requirements in the Contract Documents and is appropriate for applications indicated.

3. Substitutions After the Bidding Phase:
   a. Timing: Architect will consider requests for substitution if received within 60 days after commencement of the Work. Requests received after that time may be considered or rejected at discretion of Architect. If necessary, Architect will request additional information or documentation for evaluation within 7 days of receipt of a request for substitution. Architect will notify Contractor of acceptance or rejection of proposed substitution within 15 days of receipt of request, or 7 days of receipt of additional information or documentation, whichever is later.
   b. Substitution Request Form: Use CSI Form 13.1A, facsimile of form provided at end of Section.
   c. Form of Acceptance: Change Order.
   d. Use product specified if Architect cannot make a decision on use of a proposed substitution within time allocated.

4. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
   a. Statement indicating why specified material or product cannot be provided.
   b. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by Owner and separate contractors, that will be necessary to accommodate proposed substitution.
   c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
   d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
   e. Samples, where applicable or requested.
f. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners.
g. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
h. Research/evaluation reports evidencing compliance with building code in effect for Project, from a model code organization acceptable to authorities having jurisdiction.
i. Detailed comparison of Contractor's Construction Schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating lack of availability or delays in delivery.
j. Cost information, including a proposal of change, if any, in the Contract Sum.
k. Contractor's certification that proposed substitution complies with requirements in the Contract Documents and is appropriate for applications indicated.
l. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

1.05 QUALITY ASSURANCE

A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, product selected shall be compatible with products previously selected, even if previously selected products were also options.

1.06 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft. Comply with manufacturer's written instructions.

B. Delivery and Handling:
   1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
   2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
   3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
   4. Inspect products on delivery to ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected.

C. Storage:
   1. Store products to allow for inspection and measurement of quantity or counting of units.
   2. Store materials in a manner that will not endanger Project structure.
   3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
   4. Store cementitious products and materials on elevated platforms.
   5. Store foam plastic away from exposure to sunlight, except to extent necessary for period of installation and concealment.
   6. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
   7. Protect stored products from damage and liquids from freezing.
8. Provide a secure location and enclosure at Project site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner.

1.07 PRODUCT WARRANTIES

A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.

1. Manufacturer's Warranty: Preprinted written warranty published by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.

2. Special Warranty: Written warranty required by or incorporated into the Contract Documents, either to extend time limit provided by manufacturer's warranty or to provide more rights for Owner.

B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution. Submit a draft for approval before final execution.

1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.

2. Refer to Divisions 02 through 49 Sections for specific content requirements and particular requirements for submitting special warranties.

C. Submittal Time: Comply with requirements in Division 01 Section "Closeout Procedures."

PART 2 - PRODUCTS

2.01 PRODUCT SELECTION PROCEDURES

A. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged and, unless otherwise indicated, that are new at time of installation.

1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.

2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.

3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.

4. Where products are accompanied by the term "as selected," Architect will make selection.

5. Where products are accompanied by the term "match sample," sample to be matched is Architect's.


7. Or Equal: Where products are specified by name and accompanied by the term "or equal" or "or approved equal" or "or approved," comply with provisions in Part 2 "Comparable Products" Article to obtain approval for use of an unnamed product.

B. Product Selection Procedures:

1. Products: Where Specifications include a list of names of both products and manufacturers, provide one of the products listed that complies with requirements.

2. Manufacturers: Where Specifications include a list of manufacturers’ names, provide a product by one of the manufacturers listed that complies with requirements.
3. **Product Options:** Where Specifications indicate that sizes, profiles, and dimensional requirements on Drawings are based on a specific product or system, provide the specified product or system. Comply with provisions in Part 2 "Product Substitutions" Article for consideration of an unnamed product or system.

4. **Basis-of-Design Product:** Where Specifications name a product and include a list of manufacturers, provide the specified product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with provisions in Part 2 "Comparable Products" Article for consideration of an unnamed product by the other named manufacturers.

5. **Visual Matching Specification:** Where Specifications require matching an established Sample, select a product that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches.
   a. If no product available within specified category matches and complies with other specified requirements, comply with provisions in Part 2 "Product Substitutions" Article for proposal of product.

6. **Visual Selection Specification:** Where Specifications include the phrase "as selected from manufacturer's colors, patterns, textures" or a similar phrase, select a product that complies with other specified requirements.
   a. **Standard Range:** Where Specifications include the phrase "standard range of colors, patterns, textures" or similar phrase, Architect will select color, pattern, density, or texture from manufacturer's product line that does not include premium items.
   b. **Full Range:** Where Specifications include the phrase "full range of colors, patterns, textures" or similar phrase, Architect will select color, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

### 2.02 PRODUCT SUBSTITUTIONS

**A.** Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:

1. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Architect for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.

2. Requested substitution does not require extensive revisions to the Contract Documents.
   a. Contractor shall compensate Architect for the cost of all such Document revisions.

3. Requested substitution is consistent with the Contract Documents and will produce indicated results.

4. Substitution request is fully documented and properly submitted.

5. Requested substitution will not adversely affect Contractor's Construction Schedule.

6. Requested substitution has received necessary approvals of authorities having jurisdiction.

7. Requested substitution is compatible with other portions of the Work.

8. Requested substitution has been coordinated with other portions of the Work.

9. Requested substitution provides specified warranty.
10. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

2.03 COMPARABLE PRODUCTS

A. Comparable products proposed where the terms "or equal" or "or approved equal" or "or approved," accompany the specified product will be approved when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:

1. Evidence that the proposed product does not require extensive revisions to the Contract Documents, that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.

2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.

3. Evidence that proposed product provides specified warranty.

4. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.

5. Samples, if requested.

PART 3 - EXECUTION (Not Used)

END OF SECTION
SUBSTITUTION REQUEST
(During the Bidding Phase)

Project: ________________________________ Substitution Request Number: ________________________________

To: ________________________________ From: ________________________________

Date: ________________________________ A/E Project Number: ________________________________

Re: ________________________________ Contract For: ________________________________

Specification Title: ________________________________ Description: ________________________________

Section: __________________ Page: _____________ Article/Paragraph: ________________________________

Proposed Substitution: ________________________________ Address: ________________________________

Trade Name: ________________________________ Phone: ________________________________

Manufacturer: ________________________________ Model No.: ________________________________

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

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

The Undersigned certifies:

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

Submitted by: ________________________________
Signed by: ________________________________

Firm: ________________________________ Telephone: ________________________________
Address: ________________________________

A/E’s REVIEW AND ACTION

☐ Substitution approved - Make submittals in accordance with Specification Section 01300.
☐ Substitution approved as noted - Make submittals in accordance with Specification Section 01300.
☐ Substitution rejected - Use specified materials.
☐ Substitution Request received too late - Use specified materials.

Signed by: ________________________________ Date: ________________________________

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

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Page of September 1996

CSI Form 1.5C
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| To: | |
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| Date: | |
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| A/E Project Number: | |
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| Proposed Substitution: | |
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| History: | |
|----------||
| New product | 2-5 years old | 5-10 yrs old | More than 10 years old |

| Differences between proposed substitution and specified product: | |
|---------------------------------------------------------------||
|                                                              | |

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

| Reason for not providing specified item: | |
|-----------------------------------------||
|                                        | |

<p>| Similar Installation: | |
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<th>Proposed substitution affects other parts of Work:</th>
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<th>Yes; explain</th>
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<th>Savings to Owner for accepting substitution:</th>
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<th>Yes [Add] [Deduct]</th>
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<th>Supporting Data Attached:</th>
<th>Drawings</th>
<th>Product Data</th>
<th>Samples</th>
<th>Tests</th>
<th>Reports</th>
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CSI Form 13.1A

Institute of Behavioral Science
2007025.00

October 17, 2008

100% Design Development

2007025.00

Institute of Behavioral Science
The Undersigned certifies:

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

Submitted by:

Signed by:

Firm:

Address:

Telephone:

Attachments:

A/E’s REVIEW AND ACTION

☐ Substitution approved - Make submittals in accordance with Specification Section 01300.
☐ Substitution approved as noted - Make submittals in accordance with Specification Section 01300.
☐ Substitution rejected - Use specified materials.
☐ Substitution Request received too late - Use specified materials.

Signed by: Date:

Additional Comments:  ☐ Contractor  ☐ Subcontractor  ☐ Supplier  ☐ Manufacturer  ☐ A/E  ☐
SECTION 01 73 00
EXECUTION

PART 1 - GENERAL

1.01 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.

1.02 SUMMARY
A. This Section includes general procedural requirements governing execution of the Work including, but not limited to, the following:
   2. Field engineering and surveying.
   4. Coordination of Owner-installed products.
   5. Progress cleaning.
   6. Starting and adjusting.
   7. Protection of installed construction.
   8. Correction of the Work.
B. Related Sections include the following:
   1. Division 01 Section "Project Management and Coordination" for procedures for coordinating field engineering with other construction activities.
   2. Division 01 Section "Submittal Procedures" for submitting surveys.
   3. Division 01 Section "Cutting and Patching" for procedural requirements for cutting and patching necessary for the installation or performance of other components of the Work.
   4. Division 01 Section "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, and final cleaning.

1.03 SUBMITTALS
A. Qualification Data: For land surveyor.
B. Landfill Receipts: Submit copy of receipts issued by a landfill facility, licensed to accept hazardous materials, for hazardous waste disposal.
C. Certified Surveys: Submit three copies signed by land surveyor.
D. Final Property Survey: Submit three copies showing the Work performed and record survey data.

1.04 QUALITY ASSURANCE
A. Land Surveyor Qualifications: A professional land surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing land-surveying services of the kind indicated.
PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 EXAMINATION

A. Existing Conditions: The existence and location of site improvements, utilities, and other construction indicated as existing are not guaranteed. Before beginning work, investigate and verify the existence and location of mechanical and electrical systems and other construction affecting the Work.
   1. Before construction, verify the location and points of connection of utility services.

B. Existing Utilities: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities and other construction affecting the Work.
   1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water-service piping; and underground electrical services.
   2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.

C. Acceptance of Conditions: Examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
   1. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
   2. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
   3. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
   4. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.02 PREPARATION

A. Existing Utility Information: Furnish information to Owner that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.

B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.

3.03 CONSTRUCTION LAYOUT

A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify Architect promptly.

B. General: Engage a land surveyor to lay out the Work using accepted surveying practices.
   1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
   2. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
   3. Inform installers of lines and levels to which they must comply.
   4. Check the location, level and plumb, of every major element as the Work progresses.
   5. Notify Architect when deviations from required lines and levels exceed allowable tolerances.
   6. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.

C. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and invert elevations.

D. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.

3.04 FIELD ENGINEERING

A. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.
   1. Do not change or relocate existing benchmarks or control points without prior written approval of Architect. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to Architect before proceeding.
   2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.

B. Benchmarks: Establish and maintain a minimum of two permanent benchmarks on Project site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.
   1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.
   2. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.
   3. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.

C. Certified Survey: On completion of foundation walls, major site improvements, and other work requiring field-engineering services, prepare a certified survey showing dimensions, locations, angles, and elevations of construction and sitework.

D. Final Property Survey: Prepare a final property survey showing significant features (real property) for Project. Include on the survey a certification, signed by land surveyor, that principal metes, bounds, lines, and levels of Project are accurately positioned as shown on the survey.
1. Show boundary lines, monuments, streets, site improvements and utilities, existing improvements and significant vegetation, adjoining properties, acreage, grade contours, and the distance and bearing from a site corner to a legal point.

2. Recording: At Completion, have the final property survey recorded by or with authorities having jurisdiction as the official "property survey."

3.05 INSTALLATION

A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
   1. Make vertical work plumb and make horizontal work level.
   2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
   3. Conceal pipes, ducts, and wiring in finished areas, unless otherwise indicated.
   4. Maintain minimum headroom clearance of 8 feet in spaces without a suspended ceiling.

B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.

C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Completion.

D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.

E. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.

F. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.

G. Anchors and Fasteners: Provide anchors and fasteners as required to anchor each component securely in place, accurately located and aligned with other portions of the Work.
   1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.
   2. Allow for building movement, including thermal expansion and contraction.
   3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

H. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.

I. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

3.06 OWNER-INSTALLED PRODUCTS

A. Site Access: Provide access to Project site for Owner's construction forces.

B. Coordination: Coordinate construction and operations of the Work with work performed by Owner's construction forces.
   1. Construction Schedule: Inform Owner of Contractor's preferred construction schedule for Owner's portion of the Work. Adjust construction schedule based on a mutually agreeable timetable. Notify Owner if changes to schedule are required due to differences in actual construction progress.
2. Preinstallation Conferences: Include Owner's construction forces at preinstallation conferences covering portions of the Work that are to receive Owner's work. Attend preinstallation conferences conducted by Owner's construction forces if portions of the Work depend on Owner's construction.

3.07 PROGRESS CLEANING

A. General: Clean Project site and work areas daily, including common areas. Coordinate progress cleaning for joint-use areas where more than one installer has worked. Enforce requirements strictly. Dispose of materials lawfully.
   2. Do not hold materials more than 7 days during normal weather or 3 days if the temperature is expected to rise above 80 deg F.
   3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.

B. Site: Maintain Project site free of waste materials and debris.

C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.
   1. Remove liquid spills promptly.
   2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.

D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.

E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.

F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Completion.

G. Waste Disposal: Burying or burning waste materials on-site will not be permitted. Washing waste materials down sewers or into waterways will not be permitted.

H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Completion.

I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.

J. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.08 STARTING AND ADJUSTING

A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.

B. Adjust operating components for proper operation without binding. Adjust equipment for proper operation.

C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
D. Manufacturer’s Field Service: If a factory-authorized service representative is required to inspect field-assembled components and equipment installation, comply with qualification requirements in Division 01 Section “Quality Requirements.”

3.09 PROTECTION OF INSTALLED CONSTRUCTION

A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Completion.

B. Do not cause deterioration or damage to other adjacent property or utilities, public or private, directly or indirectly.

C. Notify Architect and Owner immediately when any construction, new or existing, building, or grounds elements are damaged through fire, water, wind, or construction activities.
   1. Construction not specifically required to be modified or removed shall remain undisturbed throughout the execution of the work.
      a. Provide appropriate means of protection necessary to accomplish this objective.
      b. Provide protection from natural elements.

D. Provide, install, and maintain shoring, bracing, and other temporary construction necessary for the protection of existing construction to remain, and as required for the safety of personnel and public.

E. Handle mechanical and electrical equipment required to be removed and reinstalled to accommodate Work with the care and restore to full operation and function. Notify the Architect immediately if any product intended for relocation and reuse cannot be removed and re-installed without damage which will render it unable to function as intended.

F. Protect existing sod, trees, plants, bushes, ground cover, and landscaping not scheduled for removal.
   1. Restore or replace damaged landscape materials and elements upon completion of construction operations.
      a. Restore damaged lawn areas, whether damaged by construction activities or lack of water, by proper soil preparation and treatment, grading, filling, and laying new sod.

G. Repair damage to irrigation systems in the vicinity of construction (unless documented as pre-existing).
   1. Inspection and test the existing system in the presence of the Owner to establish performance criteria for the re-established system following construction.
      a. Notify Owner prior to dismantling portions of existing irrigation systems.

H. Take precautions to protect existing concrete and asphalt pavement from damage due to vehicle loads, parking, and storage.
   1. Schedule loading to minimize pavement material consolidation during hot weather. Distribute wheel loads to the greatest extent possible.

I. Maintain temperature and relative humidity for installed materials and products in accordance with manufacturer’s recommendations.

3.10 CORRECTION OF THE WORK

A. Repair or remove and replace defective construction. Restore damaged substrates and finishes. Comply with requirements in Division 01 Section “Cutting and Patching.”
   1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.

B. Restore permanent facilities used during construction to their specified condition.

C. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.
D. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.

E. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

END OF SECTION
SECTION 01 73 29
CUTTING AND PATCHING

1.01 GENERAL

1.02 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.

1.03 SUMMARY

A. This Section includes procedural requirements for cutting and patching.

B. Related Sections include the following:
   1. Division 02 Section "Selective Structure Demolition" for demolition of selected portions of the building.
   2. Divisions 2 through 49 Sections for specific requirements and limitations applicable to cutting and patching individual parts of the Work.
   3. Division 07 Section "Penetration Firestopping" for patching fire-rated construction.

1.04 DEFINITIONS

A. Cutting: Removal of in-place construction necessary to permit installation or performance of other Work.

B. Patching: Fitting and repair work required to restore surfaces to original conditions after installation of other Work.

1.05 SUBMITTALS

A. Structural Elements: Refer to the Structural Drawings for requirements.
   1. Architect's Approval: Obtain approval of cutting and patching proposal before cutting and patching. Approval does not waive right to later require removal and replacement of unsatisfactory work.

1.06 QUALITY ASSURANCE

A. Structural Elements: Do not cut and patch structural elements in a manner that could change their load-carrying capacity or load-deflection ratio.

B. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety.

C. Miscellaneous Elements: Do not cut and patch miscellaneous elements or related components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety.

D. Visual Requirements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.
   1. Cutting and Patching Conference: Before proceeding, meet at Project site with parties involved in cutting and patching, including mechanical and electrical
trades. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

1.07 WARRANTY
A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during cutting and patching operations, by methods and with materials so as not to void existing warranties.

PART 2 - PRODUCTS
2.01 MATERIALS
A. General: Comply with requirements specified in other Sections.
B. In-Place Materials: Use materials identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible. 1. If identical materials are unavailable or cannot be used, use materials that, when installed, will match the visual and functional performance of in-place materials.

PART 3 - EXECUTION
3.01 EXAMINATION
A. Examine surfaces to be cut and patched and conditions under which cutting and patching are to be performed. 1. Compatibility: Before patching, verify compatibility with and suitability of substrates, including compatibility with in-place finishes or primers. 2. Proceed with installation only after unsafe or unsatisfactory conditions have been corrected.

3.02 PREPARATION
A. Temporary Support: Provide temporary support of Work to be cut.
B. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
C. Adjoining Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.
D. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to minimize interruption to occupied areas.

3.03 PERFORMANCE
A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay. 1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
B. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.

2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.

3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.

4. Excavating and Backfilling: Comply with requirements in applicable Division 31 Sections where required by cutting and patching operations.

5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.

6. Proceed with patching after construction operations requiring cutting are complete.

C. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections.

1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.

2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
   a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
   b. Restore damaged pipe covering to its original condition.

3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
   a. Where patching occurs in a painted surface, apply primer and intermediate paint coats over the patch and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.

4. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.

5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition.

D. Cleaning: Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar materials.

END OF SECTION
SECTION 01 74 19
CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

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

1.02 SUMMARY
   A. This Section includes administrative and procedural requirements for the following:
      1. Salvaging nonhazardous demolition and construction waste.
      2. Recycling nonhazardous demolition and construction waste.
      3. Disposing of nonhazardous demolition and construction waste.
   B. Related Sections include the following:
      1. Division 01 Section "Sustainable Design Requirements" for additional LEED requirements.
      2. Division 01 Section "Temporary Facilities and Controls" for environmental-protection measures during construction.
      3. Division 02 Section "Demolition" for disposition of waste resulting from demolition of site improvements.
      4. Division 04 Section "Unit Masonry" for disposal requirements for masonry waste.
      5. Division 31 Section "Site Clearing" for disposition of waste resulting from site clearing and removal of above- and below-grade improvements.

1.03 DEFINITIONS
   A. Co-Mingled: Several types of construction waste that are combined in a single container. Co-mingling of recycling waste must be approved by the identified recycling facility.
   B. Construction Waste: Building and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.
   C. Demolition Waste: Building and site improvement materials resulting from demolition or selective demolition operations.
   D. Disposal: Removal off-site of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.
   E. Hazardous Waste: Any substance whose handling and/or disposal is regulated as hazardous waste by local, state, or federal authorities.
   F. Non-Recyclable Waste: All waste materials that are not able to be recycled, due to contamination, lack of recycling facilities or salvage options, or high cost.
   G. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.
   H. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.
   I. Source Separated: Materials that are separated on-site by category.
1.04 PERFORMANCE REQUIREMENTS

A. General: Develop waste management plan that results in end-of-Project rates for salvage/recycling of 75 percent by weight of total waste generated by the Work.

B. Salvage/Recycle Requirements: Owner's goal is to salvage and recycle as much nonhazardous demolition and construction waste as possible including the following materials:

1. Concrete, Masonry, and Other Inert Fill Material: Concrete, brick, rock, broken up asphalt pavement, clay, and other inert (non-organic) materials.

2. Metals: Metal scrap including iron, steel, copper, brass, and aluminum; includes beverage containers, packaging materials (such as metal banding), fencing, reinforcing bar, wiring, plumbing, etc.

3. Untreated Wood: Unpainted, untreated dimensional lumber, wood edging, wood shipping pallets, etc. Does not include pressure treated or creosote treated wood.


5. Gypsum Wallboard: Excess drywall construction materials including cuttings, other scrap, and excess materials.

6. Cardboard: Clean, corrugated cardboard such as used for packaging, etc.

7. Paper Goods:
   a. Office paper: includes any paper, such as manufacturer instruction, specification sheets, files, correspondence, packaging, stiffeners, etc.
   b. Newsprint: shredded or whole newspaper goods.

8. Plastic: Beverage containers, packaging materials (such as polystyrene "peanuts" and expanded polystyrene), containers (other than those used for hazardous materials), vinyl products, etc.


10. Insulation: Rigid foam, batt, and loose fill insulation materials.


12. Paints: Unused portions of paints and coatings applied on-site.


14. Rubber: Uncontaminated rubber scraps, including but not limited to recycled-content rubber flooring, rubber edging, tires that are no longer serviceable, etc.

15. Other: Any additional materials identified on-site to be valued for salvage, reuse, or recycling by the Contractor, Owner, Construction Manager, or Architect.

1.05 SUBMITTALS

A. Waste Management Plan: Submit 2 copies of plan within 30 days of date established for the Notice to Proceed.

B. Waste Reduction Progress Reports: Concurrent with each Application for Payment, submit 2 copies of report. Include the following information:

1. Material category.
2. Generation point of waste.
3. Total quantity of waste in tons.
4. Quantity of waste salvaged, both estimated and actual in tons.
5. Quantity of waste recycled, both estimated and actual in tons.
6. Total quantity of waste recovered (salvaged plus recycled) in tons.
7. Total quantity of waste recovered (salvaged plus recycled) as a percentage of total waste.

C. Waste Reduction Calculations: Before request for Substantial Completion, submit 2 copies of calculated end-of-Project rates for salvage, recycling, and disposal as a percentage of total waste generated by the Work.
D. Records of Donations: Indicate receipt and acceptance of salvageable waste donated to individuals and organizations. Indicate whether organization is tax exempt.

E. Records of Sales: Indicate receipt and acceptance of salvageable waste sold to individuals and organizations. Indicate whether organization is tax exempt.

F. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

G. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

H. LEED Submittal: LEED letter template for Credit MR 2.1 and 2.2, signed by Contractor, tabulating total waste material, quantities diverted and means by which it is diverted, and statement that requirements for the credit have been met.

1.06 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Waste Management Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." Review methods and procedures related to waste management including, but not limited to, the following:
   1. Review and discuss waste management plan including responsibilities of Waste Management Coordinator.
   2. Review requirements for documenting quantities of each type of waste and its disposition.
   3. Review and finalize procedures for materials separation and verify availability of containers and bins needed to avoid delays.
   4. Review procedures for periodic waste collection and transportation to recycling and disposal facilities.
   5. Review waste management requirements for each trade.
   6. Plan Revision: Make any revisions to the Construction Waste Management Plan agreed upon during the meeting and incorporate resolutions agreed to be made subsequent to the meeting. Submit the revised plan to the Architect for approval.

C. Implementation:
   1. Designate an on-site party responsible for instructing workers and implementing the Construction Waste Management Plan.
   2. Distribute copies of the Construction Waste Management Plan to the job site foreman and each subcontractor.
   3. Include waste management and recycling in worker orientation.
   4. Provide on-site instruction on appropriate separation, handling, recycling, and salvaging methods to be used by all parties at the appropriate stages of the work at the site.
   5. Prominently display Waste Management Plan and clearly mark all containers and areas on site dedicated to source separation.
   6. Include waste management and recycling discussion in pre-fabrication meetings with subcontractors and fabricators.
   7. Include discussion of waste management and recycling in regular job meetings and job safety meetings conducted during the course of work at the site.
1.07 WASTE MANAGEMENT PLAN

A. General: Develop plan consisting of waste identification, waste reduction work plan, and cost/revenue analysis. Indicate quantities by weight or volume, but use same units of measure throughout waste management plan.
   1. Show compliance with applicable state and local ordinances and regulations.
   2. Indicate any instances where compliance with requirements of this Section does not appear to be possible and request resolution from the Architect.

B. Waste Identification: Indicate anticipated types and quantities of demolition, site-clearing, and construction waste generated by the Work. Include estimated quantities and assumptions for estimates.

C. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.
   1. Salvaged Materials for Reuse: For materials that will be salvaged and reused in this Project, describe methods for preparing salvaged materials before incorporation into the Work.
   2. Salvaged Materials for Sale: For materials that will be sold to individuals and organizations, include list of their names, addresses, and telephone numbers.
   3. Salvaged Materials for Donation: For materials that will be donated to individuals and organizations, include list of their names, addresses, and telephone numbers.
   4. Recycled Materials: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.
   5. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.
      a. Identify materials that are not recyclable or otherwise conservable that must be disposed of in landfill or other means acceptable under governing State and local regulations.
         1) Provide documentation to justify decision to dispose of rather than recycle particular materials.
   6. Handling and Transportation Procedures: Include method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location on Project site where materials separation will be located.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 PLAN IMPLEMENTATION

A. General: Implement waste management plan as approved by Owner. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.
   1. Comply with Division 01 Section "Temporary Facilities and Controls" for operation, termination, and removal requirements.

B. Waste Management Coordinator: Engage a waste management coordinator to be responsible for implementing, monitoring, and reporting status of waste management work plan. Coordinator shall be present at Project site full time for duration of Project.
C. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work occurring at Project site.
   1. Distribute waste management plan to everyone concerned within three days of submittal return.
   2. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.

D. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
   1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged, recycled, reused, donated, and sold.
      a. Replace loaded containers with empty ones as demand requires but not less than weekly.
   2. Comply with Division 01 Section "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.

3.02 SALVAGING DEMOLITION WASTE
A. Salvaged Items for Reuse in the Work:
   1. Clean salvaged items.
   2. Pack or crate items after cleaning. Identify contents of containers.
   3. Store items in a secure area until installation.
   4. Protect items from damage during transport and storage.
   5. Install salvaged items to comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make items functional for use indicated.

B. Salvaged Items for Sale and Donation: Not permitted on Project site.

C. Salvaged Items for Owner's Use:
   1. Clean salvaged items.
   2. Pack or crate items after cleaning. Identify contents of containers.
   3. Store items in a secure area until delivery to Owner.
   4. Transport items to Owner's storage area.
   5. Protect items from damage during transport and storage.

D. Doors and Hardware: Brace open end of door frames. Except for removing door closers, leave door hardware attached to doors.

3.03 RECYCLING DEMOLITION AND CONSTRUCTION WASTE, GENERAL
A. General: Recycle paper and beverage containers used by on-site workers.

B. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall accrue to Contractor.

C. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical.
   1. Provide appropriately marked containers or bins for controlling recyclable waste until they are removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.
      a. Inspect containers and bins for contamination and remove contaminated materials if found.
   2. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
3. Stockpile materials away from construction area. Do not store within drip line of remaining trees.

4. Store components off the ground and protect from the weather.

5. Remove recyclable waste off Owner's property and transport to recycling receiver or processor.

D. Asphaltic Concrete Paving: Grind asphalt to maximum 4-inch size.
   1. Crush asphaltic concrete paving and screen to comply with requirements in Division 31 Section "Earth Moving" for use as general fill.

E. Asphaltic Concrete Paving: Break up and transport paving to asphalt-recycling facility.

F. Concrete: Remove reinforcement and other metals from concrete and sort with other metals.
   1. Pulverize concrete to maximum 4-inch size.
   2. Crush concrete and screen to comply with requirements in Division 31 Section "Earth Moving" for use as satisfactory soil for fill or subbase.

G. Masonry: Remove metal reinforcement, anchors, and ties from masonry and sort with other metals.
   1. Pulverize masonry to maximum 4-inch size.
      a. Crush masonry and screen to comply with requirements in Division 31 Section "Earth Moving" for use as general fill or subbase.
      b. Crush masonry and screen to comply with requirements in Division 32 Section "Plants" for use as mineral mulch.
   2. Clean and stack undamaged, whole masonry units on wood pallets.

H. Wood Materials: Sort and stack members according to size, type, and length. Separate lumber, engineered wood products, panel products, and treated wood materials.

I. Metals: Separate metals by type.
   1. Structural Steel: Stack members according to size, type of member, and length.
   2. Remove and dispose of bolts, nuts, washers, and other rough hardware.

J. Gypsum Board: Stack large clean pieces on wood pallets and store in a dry location. Remove edge trim and sort with other metals. Remove and dispose of fasteners.

K. Acoustical Ceiling Panels and Tile: Stack large clean pieces on wood pallets and store in a dry location.
   1. Separate suspension system, trim, and other metals from panels and tile and sort with other metals.

L. Carpet and Pad: Roll large pieces tightly after removing debris, trash, adhesive, and tack strips.
   1. Store clean, dry carpet and pad in a closed container or trailer provided by Carpet Reclamation Agency or carpet recycler.

M. Equipment: Drain tanks, piping, and fixtures. Seal openings with caps or plugs. Protect equipment from exposure to weather.

N. Plumbing Fixtures: Separate by type and size.

O. Piping: Reduce piping to straight lengths and store by type and size. Separate supports, hangers, valves, sprinklers, and other components by type and size.

P. Lighting Fixtures: Separate lamps by type and protect from breakage.

Q. Electrical Devices: Separate switches, receptacles, switchgear, transformers, meters, panelboards, circuit breakers, and other devices by type.

R. Conduit: Reduce conduit to straight lengths and store by type and size.
3.04 RECYCLING CONSTRUCTION WASTE

A. Packaging:
1. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.
3. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site, break down pallets into component wood pieces and comply with requirements for recycling wood.
4. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.

B. Site-Clearing Wastes: Chip brush, branches, and trees on-site.
1. Comply with requirements in Division 32 Section "Plants" for use of chipped organic waste as organic mulch.

C. Wood Materials:
1. Clean Cut-Offs of Lumber: Grind or chip into small pieces.
2. Clean Sawdust: Bag sawdust that does not contain painted or treated wood.
   a. Comply with requirements in Division 32 Section "Plants" for use of clean sawdust as organic mulch.

D. Gypsum Board: Stack large clean pieces on wood pallets and store in a dry location.
1. Clean Gypsum Board: Grind scraps of clean gypsum board using small mobile chipper or hammer mill. Screen out paper after grinding.
   a. Comply with requirements in Division 32 Section "Plants" for use of clean ground gypsum board as inorganic soil amendment.

3.05 DISPOSAL OF WASTE

A. General: Except for items or materials to be salvaged, recycled, or otherwise reused, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.
1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. Burning: Do not burn waste materials.

C. Disposal: Transport waste materials and dispose of at designated spoil areas on Owner's property.

D. Disposal: Transport waste materials off Owner’s property and legally dispose of them.

END OF SECTION
SECTION 01 77 00
CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.01 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.

1.02 SUMMARY
A. This Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
   1. Inspection procedures.
   2. Warranties.
   3. Final cleaning.
B. Related Sections include the following:
   1. Division 01 Section "Payment Procedures" for requirements for Applications for Payment for Completion and Final Completion.
   2. Division 01 Section "Photographic Documentation" for submitting Final Completion construction photographs and negatives.
   3. Division 01 Section "Execution" for progress cleaning of Project site.
   4. Division 01 Section "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
   5. Division 01 Section "Operation and Maintenance Data" for operation and maintenance manual requirements.
   6. Division 01 Section "Demonstration and Training" for requirements for instructing Owner's personnel.
   7. Divisions 02 through 49 Sections for specific closeout and special cleaning requirements for the Work in those Sections.

1.03 COMPLETION
A. Preliminary Procedures: Before requesting inspection for determining date of Completion, complete the following. List items below that are incomplete in request.
   1. Prepare a list of items to be completed and corrected, the value of items on the list, and reasons why the Work is not complete.
   2. Advise Owner of pending insurance changeover requirements.
   3. Submit specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
   4. Obtain and submit releases permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
   5. Deliver tools, spare parts, extra materials, and similar items to location designated by Owner. Label with manufacturer's name and model number where applicable.
   6. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
   7. Complete startup testing of systems.
   8. Submit test/adjust/balance records.
   9. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
   10. Advise Owner of changeover in heat and other utilities.
11. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
12. Complete final cleaning requirements, including touchup painting.
13. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.

B. Inspection: Submit a written request for inspection for Completion. Within ten (10) days after receipt of the Contractor's written notice that the work or designated portion thereof is complete, the Architect, Owner, and Contractor shall make an inspection of the Work to determine whether the Work has been completed in accordance with the Contract Documents, and to prepare a Punch List.
1. If the Work has not been completed to the required stage, the parties shall cease the inspection and an appropriate Amendment or Change Order shall be issued deducting from the payments then or thereafter due the Contractor, all costs associated with such premature inspection, including compensation for the Architect's additional services.
2. If the Work has been completed to the required stage, a Punch List shall be prepared by the Architect in concert with the Owner and Construction Manager in sufficient detail to fully outline to the Contractor:
   a. Work to be completed, if any.
   b. Work not in compliance with the drawings and specifications, if any.
   c. Unsatisfactory work for any reason, if any.
   d. Date for completion of the items listed, if any.

C. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
1. Results of completed inspection will form the basis of requirements for Final Completion.
   a. The failure to include any items on such list shall not alter the responsibility of the Contractor to complete all Work in accordance with the Contract Documents.
   b. When the Architect, on the basis of observations and inspections, determines that the Work or designated portion thereof is complete (and less than 10 items remain on the punch list) and the Building Inspection Record (State of Colorado Buildings Programs form SBP-B.I.R.) has been fully signed off, the Architect will prepare a Notice of Completion Letter, including the Contract Close-out Punch List (State of Colorado Buildings Programs form SBP-06), and the Close-out Checklist (State of Colorado Buildings Programs form SBP-05) and, if applicable, Approval of Beneficial Occupancy (State of Colorado Buildings Programs form SBP-01) which shall establish the Date of Completion of the Work, i.e. substantial completion, shall state the responsibilities of the Owner and the Contractor for security, maintenance, heat, utilities, property insurance premiums and damage to the Work.
2. The Owner shall have the right to take possession of and to use any completed or partially completed portions of the Work, even if the time for Completion of the Work or such portions of the Work has not expired and even if the Work has not been finally accepted. Such possession and use shall not constitute an acceptance of such portions of the Work.
   a. If the Owner elects to take possession of and to use any completed or partially completed portions of the Work prior to the time for Completion of the Work or portion thereof, prior to any such possession or use, an inspection shall be made by the Architect, the Owner and the Contractor. Any and all areas so occupied will be subject to a final inspection.
1.04 FINAL COMPLETION
A. Preliminary Procedures: Before requesting final inspection for determining date of Final Completion, complete the following:
1. Submit a final Application for Payment according to Division 01 Section "Payment Procedures."
2. Submit certified copy of Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
3. Submit evidence of final, continuing insurance coverage complying with insurance requirements.
4. Submit pest-control final inspection report and warranty.
5. Instruct Owner’s personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training videotapes.

B. Inspection: Submit a written request for final inspection for acceptance. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.
1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.05 LIST OF INCOMPLETE ITEMS
A. Preparation: Submit 2 copies of list. Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.
1. Organize list of spaces in sequential order.
2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
3. Include the following information at the top of each page:
   a. Project name.
   b. Date.
   c. Name of Architect.
   d. Name of Contractor.
   e. Page number.

1.06 WARRANTIES
A. Submittal Time:
1. General: Warranties shall on the date of Completion.
   a. Submit written warranties on request of Architect for designated portions of the Work where commencement of warranties other than date of Completion is indicated.

B. Partial Occupancy: Submit properly executed warranties within 15 days of completion of designated portions of the Work that are completed and occupied or used by Owner during construction period by separate agreement with Contractor.

C. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.
1. Bind warranties and bonds in heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.
2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.

3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.

D. Provide additional copies of each warranty to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 - EXECUTION

3.01 FINAL CLEANING

A. General: Provide final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.

B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.

1. Complete the following cleaning operations before requesting inspection for certification of Completion for entire Project or for a portion of Project:

   a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.

   b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.

   c. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.

   d. Remove tools, construction equipment, machinery, and surplus material from Project site.

   e. Remove snow and ice to provide safe access to building.

   f. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.

   g. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.

   h. Sweep concrete floors broom clean in unoccupied spaces.

   i. Vacuum carpet and similar soft surfaces, removing debris and excess nap; shampoo if visible soil or stains remain.

   j. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.

   k. Remove labels that are not permanent.
I. Touch up and otherwise repair and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration.
   1) Do not paint over "UL" and similar labels, including mechanical and electrical nameplates.

m. Wipe surfaces of mechanical and electrical equipment, elevator equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.

n. Replace parts subject to unusual operating conditions.

o. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.

p. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.

q. Clean ducts, blowers, and coils if units were operated without filters during construction.

r. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs, and those noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.

s. Leave Project clean and ready for occupancy.

C. Pest Control: Engage an experienced, licensed exterminator to make a final inspection and rid Project of rodents, insects, and other pests.

D. Comply with safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on Owner's property. Do not discharge volatile, harmful, or dangerous materials into drainage systems. Remove waste materials from Project site and dispose of lawfully.

END OF SECTION
PART 1 - GENERAL

1.01 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.

1.02 SUMMARY
A. This Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
   1. Operation and maintenance documentation directory.
   2. Emergency manuals.
   3. Operation manuals for systems, subsystems, and equipment.
   4. Maintenance manuals for the care and maintenance of products, materials, finishes, systems and equipment.
B. Related Sections include the following:
   1. Division 01 Section "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.
   2. Division 01 Section "Closeout Procedures" for submitting operation and maintenance manuals.
   3. Division 01 Section "Project Record Documents" for preparing Record Drawings for operation and maintenance manuals.
   4. Divisions 02 through 49 Sections for specific operation and maintenance manual requirements for the Work in those Sections.

1.03 DEFINITIONS
A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.
B. Subsystem: A portion of a system with characteristics similar to a system.

1.04 SUBMITTALS
A. Submit one copy of each manual in final form at least 15 days before final inspection. Architect will return copy with comments within 15 days after final inspection.
   1. Correct or modify each manual to comply with Architect's comments. Submit 3 copies of each corrected manual within 15 days of receipt of Architect's comments.

1.05 COORDINATION
A. Where operation and maintenance documentation includes information on installations by more than one factory-authorized service representative, assemble and coordinate information furnished by representatives and prepare manuals.

PART 2 - PRODUCTS

2.01 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY
A. Organization: Include a section in the directory for each of the following:
1. List of documents.
2. List of systems.
3. List of equipment.
4. Table of contents.

B. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.

C. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list.

D. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.

E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

2.02 MANUALS, GENERAL

A. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:
   1. Title page.
   2. Table of contents.

B. Title Page: Enclose title page in transparent plastic sleeve. Include the following information:
   1. Subject matter included in manual.
   2. Name and address of Project.
   3. Name and address of Owner.
   4. Date of submittal.
   5. Name, address, and telephone number of Contractor.
   6. Name and address of Architect.
   7. Cross-reference to related systems in other operation and maintenance manuals.

C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
   1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.

D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
   1. Binders: Heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
      a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
         1) Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or
name, and subject matter of contents. Indicate volume number for multiple-volume sets.

b. Dividers: Heavy-paper dividers with plastic-covered tabs for each section. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.

c. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software diskettes for computerized electronic equipment.

d. Supplementary Text: Prepared on 8-1/2-by-11-inch white bond paper.

e. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
   1) If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
   2) If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

2.03 EMERGENCY MANUALS

A. Content: Organize manual into a separate section for each of the following:
   1. Type of emergency.
   2. Emergency instructions.
   3. Emergency procedures.

B. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:
   1. Fire.
   2. Flood.
   5. Power failure.
   7. System, subsystem, or equipment failure.
   8. Chemical release or spill.

C. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.

D. Emergency Procedures: Include the following, as applicable:
   1. Instructions on stopping.
   2. Shutdown instructions for each type of emergency.
   3. Operating instructions for conditions outside normal operating limits.
   4. Required sequences for electric or electronic systems.
   5. Special operating instructions and procedures.

2.04 OPERATION MANUALS

A. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:
   1. System, subsystem, and equipment descriptions.
   2. Performance and design criteria if Contractor is delegated design responsibility.
   3. Operating standards.
4. Operating procedures.
5. Operating logs.
6. Wiring diagrams.
7. Control diagrams.
8. Piped system diagrams.
9. Precautions against improper use.
10. License requirements including inspection and renewal dates.

B. Descriptions: Include the following:
1. Product name and model number.
2. Manufacturer's name.
3. Equipment identification with serial number of each component.
4. Equipment function.
5. Operating characteristics.
6. Limiting conditions.
7. Performance curves.
8. Engineering data and tests.
9. Complete nomenclature and number of replacement parts.

C. Operating Procedures: Include the following, as applicable:
1. Startup procedures.
2. Equipment or system break-in procedures.
3. Routine and normal operating instructions.
4. Regulation and control procedures.
5. Instructions on stopping.
7. Seasonal and weekend operating instructions.
8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures.

D. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

E. Piped Systems: Diagram piping as installed, and identify color-coding where required for identification.

2.05 PRODUCT MAINTENANCE MANUAL

A. Content: Organize manual into a separate section for each product, material, and finish.
Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.

B. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.

C. Product Information: Include the following, as applicable:
1. Product name and model number.
2. Manufacturer’s name.
3. Color, pattern, and texture.
5. Reordering information for specially manufactured products.

D. Maintenance Procedures: Include manufacturer's written recommendations and the following:
1. Inspection procedures.
2. Types of cleaning agents to be used and methods of cleaning.
3. List of cleaning agents and methods of cleaning detrimental to product.
4. Schedule for routine cleaning and maintenance.
5. Repair instructions.

E. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.

F. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
   1. Include procedures to follow and required notifications for warranty claims.

2.06 SYSTEMS AND EQUIPMENT MAINTENANCE MANUAL

A. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.

B. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.

C. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:
   1. Standard printed maintenance instructions and bulletins.
   2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
   3. Identification and nomenclature of parts and components.
   4. List of items recommended to be stocked as spare parts.

D. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
   1. Test and inspection instructions.
   2. Troubleshooting guide.
   3. Precautions against improper maintenance.
   4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
   5. Aligning, adjusting, and checking instructions.
   6. Demonstration and training videotape, if available.

E. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
   1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
   2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.

F. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.

G. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.

H. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
   1. Include procedures to follow and required notifications for warranty claims.
PART 3 - EXECUTION

3.01 MANUAL PREPARATION

A. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals.

B. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.

C. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.

D. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.
   1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
   2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.

E. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
   1. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.

F. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in Record Drawings to ensure correct illustration of completed installation.
   1. Do not use original Project Record Documents as part of operation and maintenance manuals.
   2. Comply with requirements of newly prepared Record Drawings in Division 01 Section "Project Record Documents."

G. Comply with Division 01 Section "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

END OF SECTION
SECTION 01 78 39

PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.01 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.

1.02 SUMMARY

A. This Section includes administrative and procedural requirements for Project Record
   Documents, including the following:
   1. Record Drawings.
   2. Record Specifications.
   3. Record Product Data.

B. Related Sections include the following:
   1. Division 01 Section "Closeout Procedures" for general closeout procedures.
   2. Division 01 Section "Operation and Maintenance Data" for operation and
      maintenance manual requirements.
   3. Divisions 02 through 49 Sections for specific requirements for Project Record
      Documents of the Work in those Sections.

1.03 SUBMITTALS

A. Record Drawings: Comply with the following:
   1. Number of Copies: Submit one set(s) of marked-up Record Prints.

B. Record Specifications: Submit one copy of Project's Specifications, including addenda
   and contract modifications.

C. Record Product Data: Submit one copy of each Product Data submittal.
   1. Where Record Product Data is required as part of operation and maintenance
      manuals, submit marked-up Product Data as an insert in manual instead of
      submittal as Record Product Data.

PART 2 - PRODUCTS

2.01 RECORD DRAWINGS

A. Record Prints: Maintain one set of blue- or black-line white prints of the Contract
   Drawings and Shop Drawings.
   1. Preparation: Mark Record Prints to show the actual installation where installation
      varies from that shown originally. Require individual or entity who obtained
      record data, whether individual or entity is Installer, subcontractor, or similar
      entity, to prepare the marked-up Record Prints.
      a. Give particular attention to information on concealed elements that would
         be difficult to identify or measure and record later.
      b. Accurately record information in an understandable drawing technique.
      c. Record data as soon as possible after obtaining it. Record and check
         the markup before enclosing concealed installations.
   2. Content: Types of items requiring marking include, but are not limited to, the
      following:
a. Dimensional changes to Drawings.
b. Revisions to details shown on Drawings.
c. Depths of foundations below first floor.
d. Locations and depths of underground utilities.
e. Revisions to routing of piping and conduits.
f. Revisions to electrical circuitry.
g. Actual equipment locations.
h. Duct size and routing.
i. Locations of concealed internal utilities.
j. Changes made by Change Order.
k. Changes made following Architect's written orders.
l. Details not on the original Contract Drawings.
m. Field records for variable and concealed conditions.
n. Record information on the Work that is shown only schematically.

3. Mark the Contract Drawings or Shop Drawings, whichever is most capable of showing actual physical conditions, completely and accurately. If Shop Drawings are marked, show cross-reference on the Contract Drawings.

4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.

5. Mark important additional information that was either shown schematically or omitted from original Drawings.

6. Note alternate numbers, Change Order numbers, and similar identification, where applicable.

B. Format: Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.

1. Record Prints: Organize Record Prints and newly prepared Record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.

2. Identification: As follows:
   a. Project name.
   b. Date.
   c. Designation "PROJECT RECORD DRAWINGS."
   d. Name of Architect.
   e. Name of Contractor.

2.02 RECORD SPECIFICATIONS

A. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.

2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.

3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.

4. For each principal product, indicate whether Record Product Data has been submitted in operation and maintenance manuals instead of submitted as Record Product Data.

5. Note related Change Orders, Record Product Data, and Record Drawings where applicable.
2.03 RECORD PRODUCT DATA

A. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.
   1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
   2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
   3. Note related Change Orders, Record Specifications, and Record Drawings where applicable.

2.04 MISCELLANEOUS RECORD SUBMITTALS

A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

PART 3 - EXECUTION

3.01 RECORDING AND MAINTENANCE

A. Recording: Maintain one copy of each submittal during the construction period for Project Record Document purposes. Post changes and modifications to Project Record Documents as they occur; do not wait until the end of Project.

B. Maintenance of Record Documents and Samples: Store Record Documents and Samples in the field office apart from the Contract Documents used for construction. Do not use Project Record Documents for construction purposes. Maintain Record Documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to Project Record Documents for Architect's reference during normal working hours.

END OF SECTION
PART 1 - GENERAL

1.01 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.

1.02 SUMMARY

A. This Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:
   1. Demonstration of operation of systems, subsystems, and equipment.
   2. Training in operation and maintenance of systems, subsystems, and equipment.
   3. Demonstration and training videotapes.

B. Related Sections include the following:
   1. Divisions 02 through 49 Sections for specific requirements for demonstration and training for products in those Sections.

1.03 SUBMITTALS

A. Instruction Program: Submit two copies of outline of instructional program for demonstration and training, including a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.
   1. At completion of training, submit one complete training manual(s) for Owner's use.
      a. Attendance Record: For each training module, submit list of participants and length of instruction time.
      b. Demonstration and Training Videotapes: Submit two copies within seven days of end of each training module.
   2. Identification: On each copy, provide an applied label with the following information:
      a. Name of Project.
      b. Name and address of photographer.
      c. Name of Architect.
      d. Name of Contractor.
      e. Date videotape was recorded.
      f. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.

1.04 QUALITY ASSURANCE

A. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.

B. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Division 01 Section "Quality Requirements," experienced in operation and maintenance procedures and training.
C. Photographer Qualifications: A professional photographer who is experienced photographing construction projects.

1.05 COORDINATION
A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations.
B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.
C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by Architect.

PART 2 - PRODUCTS

2.01 INSTRUCTION PROGRAM
A. Program Structure: Develop an instruction program that includes individual training modules for each system and equipment not part of a system, as required by individual Specification Sections, and as follows:
1. Motorized doors, including overhead coiling doors and automatic entrance doors.
2. Equipment, including projection screens and laboratory fume hoods.
3. Fire-protection systems, including fire alarm, fire pumps, and fire-extinguishing systems.
4. Conveying systems, including elevators.
5. Laboratory equipment, including laboratory air and vacuum equipment and piping.
6. Refrigeration systems, including chillers, cooling towers, pumps, and distribution piping.
7. HVAC systems, including air-handling equipment, air distribution systems, and terminal equipment and devices.
8. HVAC instrumentation and controls.
9. Electrical service and distribution, including transformers, switchboards, panelboards, and motor controls.
10. Lighting equipment and controls.
11. Communication systems, including voice and data equipment.
13. Lightning Protection system.
B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following:
1. Basis of System Design, Operational Requirements, and Criteria: Include the following:
   a. System, subsystem, and equipment descriptions.
   b. Performance and design criteria if Contractor is delegated design responsibility.
   c. Operating standards.
   d. Regulatory requirements.
   e. Equipment function.
   f. Operating characteristics.
   g. Limiting conditions.
   h. Performance curves.
2. Documentation: Review the following items in detail:
   a. Emergency manuals.
b. Operations manuals.
c. Maintenance manuals.
d. Project Record Documents.
e. Identification systems.
f. Warranties and bonds.
g. Maintenance service agreements and similar continuing commitments.

3. Emergencies: Include the following, as applicable:
   a. Instructions on meaning of warnings, trouble indications, and error messages.
   b. Instructions on stopping.
   c. Shutdown instructions for each type of emergency.
   d. Operating instructions for conditions outside of normal operating limits.
   e. Sequences for electric or electronic systems.
   f. Special operating instructions and procedures.

4. Operations: Include the following, as applicable:
   a. Startup procedures.
   b. Equipment or system break-in procedures.
   c. Routine and normal operating instructions.
   d. Regulation and control procedures.
   e. Control sequences.
   f. Safety procedures.
   g. Instructions on stopping.
   h. Normal shutdown instructions.
   i. Operating procedures for emergencies.
   j. Operating procedures for system, subsystem, or equipment failure.
   k. Seasonal and weekend operating instructions.
   l. Required sequences for electric or electronic systems.
   m. Special operating instructions and procedures.

5. Adjustments: Include the following:
   a. Alignments.
   b. Checking adjustments.
   c. Noise and vibration adjustments.
   d. Economy and efficiency adjustments.

6. Troubleshooting: Include the following:
   a. Diagnostic instructions.
   b. Test and inspection procedures.

7. Maintenance: Include the following:
   a. Inspection procedures.
   b. Types of cleaning agents to be used and methods of cleaning.
   c. List of cleaning agents and methods of cleaning detrimental to product.
   d. Procedures for routine cleaning
   e. Procedures for preventive maintenance.
   f. Procedures for routine maintenance.
   g. Instruction on use of special tools.

8. Repairs: Include the following:
   a. Diagnosis instructions.
   b. Repair instructions.
   c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
   d. Instructions for identifying parts and components.
   e. Review of spare parts needed for operation and maintenance.
PART 3 - EXECUTION

3.01 PREPARATION

A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a combined training manual.

B. Set up instructional equipment at instruction location.

3.02 INSTRUCTION

A. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Owner for number of participants, instruction times, and location.

B. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.

1. Owner will furnish Contractor with names and positions of participants.
   a. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.

2. Schedule training with Owner with at least seven days' advance notice.
   a. Cleanup: Collect used and leftover educational materials and give to Owner. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

3.03 DEMONSTRATION AND TRAINING VIDEOTAPES

A. General: Engage a qualified commercial photographer to record demonstration and training videotapes. Record each training module separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice.

1. At beginning of each training module, record each chart containing learning objective and lesson outline.
   a. Videotape Format: Provide high-quality VHS color videotape or digital video disk.
   b. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to show area of demonstration and training. Display continuous running time.
   c. Narration: Describe scenes on videotape by audio narration by microphone while videotape is recorded. Include description of items being viewed. Describe vantage point, indicating location, direction (by compass point), and elevation or story of 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 other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY
A. Section includes general requirements and procedures for compliance with certain USGBC LEED prerequisites and credits needed for Project to obtain LEED Silver or better certification based on LEED-NC, Version 2.2, including, but not limited to the following:
   1. Documentation of percentages and amounts of materials using Contractor's Schedule of Values and LEED submittal letters.
   2. Submittals and documentation of material data, location of manufacture, construction waste, recycled content data and VOC compliance.
   3. Certification of submitted data and documentation.
   4. Salvaging and recycling requirements.
   5. Salvaging and recycling procedures.
B. This Project has been designed with the intent of attaining LEED Certification upon completion of the construction and commissioning process.
   1. Other LEED prerequisites and credits needed to obtain LEED certification depend on material selections and may not be specifically identified as LEED requirements. Compliance with requirements needed to obtain LEED prerequisites and credits may be used as one criterion to evaluate substitution requests and comparable product requests.
   2. Additional LEED prerequisites and credits needed to obtain the indicated LEED certification depend on Architect's design and other aspects of Project that are not part of the Work of the Contract.
   3. A copy of the LEED Project checklist is attached at the end of this Section for information only.
C. Related Sections:
   1. Division 01 Section "Indoor Air Quality Management."
   2. Division 01 Section "Construction Waste Management" for LEED requirements specific to salvaging and recycling construction waste.
   3. Division 01 Section "General Commissioning Requirements" for LEED requirements specific to building commissioning.
   4. Division 26 Section "Commissioning of HVAC Systems."
   5. Divisions 01 through 33 Sections for LEED requirements specific to the work of each of these Sections. Requirements may or may not include reference to LEED.

1.03 DEFINITIONS
A. Chain-of-Custody Certificates: Certificates signed by manufacturers certifying that wood used to make products was obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship." Certificates shall include evidence that manufacturer is certified for chain of custody by an FSC-FSC-accredited certification body.
B. LEED: Leadership in Energy & Environmental Design.

C. Regionally Extracted, Harvested, or Recovered and Manufactured Materials: Materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site. If only a fraction of a product or material is extracted/harvested/recovered and manufactured locally, then only that percentage (by weight) shall contribute to the regional value.

D. Recycled Content: The recycled content value of a material assembly shall be determined by weight. The recycled fraction of the assembly is then multiplied by the cost of assembly to determine the recycled content value.
   1. "Post-consumer" material is defined as waste material generated by households or by commercial, industrial, and institutional facilities in their role as end users of the product, which can no longer be used for its intended purpose.

E. Recycled Content: The percentage by weight of constituents that have been recovered or otherwise diverted from the solid waste stream, either during the manufacturing process (pre-consumer), or after consumer use (post-consumer).
   1. Spills and scraps from the original manufacturing process that are combined with other constituents after a minimal amount of reprocessing for use in further production of the same product are not recycled materials.

F. VOC Content: Volatile Organic Compound Content, calculated in grams/liter according to 40 CFR 59, Subpart D (EPA method 24.)

1.04 PERFORMANCE REQUIREMENTS

A. Credit MR 2.2 - Construction Waste Management: Owner's goal is to salvage and recycle as much non-hazardous construction waste as possible and has established minimum goal of 75 percent of overall project construction waste to be salvaged and recycled. See Division 1 Section "Construction Waste Management" for specific requirements.

B. Credit MR 5.2 - Regionally Extracted, Harvested, or Recovered and Manufactured Materials: Owner's requirement is that 20 percent of materials, by cost, used in the construction shall be manufactured and harvested locally. Subject to compliance with specification requirements, Contractor may select which materials make up the 20 percent.

1.05 SUBMITTALS

A. General: Submit additional LEED submittals required by other Specification Sections.

B. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.

C. Project Materials Cost Data: Provide statement indicating total cost for building materials used for Project.
   1. Costs exclude labor, overhead, and profit. Include breakout of costs for the following categories of items:
      a. Furniture.
      b. Plumbing.
      c. Mechanical.
SUSTAINABLE DESIGN REQUIREMENTS

1. Electrical.
2. Specialty items such as elevators and equipment.
3. Wood-based construction materials.

2. Schedule of Values: Schedule of values shall break out cost of materials apart from all other costs, including such other costs as overhead and profit.

3. Change Order Breakdown: Change orders, proposals and responses to Construction Change Directives shall include information matching Schedule of Values breakdown, indicating change in cost of material separately and technical specification sections affected.

D. LEED Action Plans: Provide preliminary submittals within 30 Insert number days of date established for commencement of the Work indicating how the following requirements will be met:

1. Credit MR 2.1 and Credit MR 2.2: Waste management plan complying with Division 01 Section "Construction Waste Management and Disposal."
2. Credit MR 3.1: List of proposed salvaged and refurbished materials.
   a. Identify each material that will be salvaged or refurbished, including its source, cost, and replacement cost if the item was to be purchased new.
3. Credit MR 4.1 and Credit MR 4.2: List of proposed materials with recycled content.
   a. Indicate cost, post-consumer recycled content, and pre-consumer recycled content for each product having recycled content.
4. Credit MR 5.1 and Credit MR 5.2: List of proposed regionally extracted, harvested, or recovered and manufactured materials.
   a. Identify each regionally extracted, harvested, or recovered and manufactured material, including its source and cost.
5. Credit MR 7: List of proposed certified wood products.
   a. Indicate each product containing certified wood, including its source and cost of certified wood products.
   b. Include statement indicating total cost for wood-based materials used for Project, including non-rented temporary construction.
6. Credit EQ 3.1: Construction indoor-air-quality management plan specified in Division 01 Section "Indoor Air Quality Management."

E. LEED Progress Reports: Concurrent with each Application for Payment, submit reports comparing actual construction and purchasing activities with LEED action plans for the following:

1. Credit MR 2.1 and Credit MR 2.2: Waste reduction progress reports complying with Division 01 Section "Construction Waste Management and Disposal."
2. Credit MR 3: Salvaged and refurbished materials.
3. Credit MR 3.1: Salvaged and refurbished materials.
5. Credit MR 5.1 and Credit MR 5.2: Regionally manufactured materials and regionally extracted and manufactured materials.
6. Credit MR 7: Certified wood products.

F. LEED Documentation Submittals:
1. Credit WE 3.1 and 3.2: Product Data for plumbing fixtures indicating water consumption.
2. Prerequisite EA 3: Product Data for new HVAC equipment indicating absence of CFC refrigerants.
3. Credit EA4: Product Data for new HVAC equipment indicating refrigerant type.
4. Credit EA 5: Product data and wiring diagrams for sensors and data collection system used to provide continuous metering of building energy-consumption.
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performance over [time] [a period of time of not less than one year of postconstruction occupancy].

5. Credit MR 2.1 and Credit MR 2.2: Comply with Division 01 Section "Construction Waste Management and Disposal."

6. Credit MR 3: Receipts for salvaged and refurbished materials used for Project, indicating sources and costs for salvaged and refurbished materials.

7. Credit MR 3.1: Receipts for salvaged and refurbished materials used for Project, indicating sources and costs for salvaged and refurbished materials.

8. Credit MR 4.1 and Credit MR 4.2: Product data and certification letter listing material name and manufacturer and indicating percentages by weight of post-consumer and pre-consumer recycled content for products having recycled content. Include statement indicating material costs for each product having recycled content.

9. Credit MR 5.1 and Credit MR 5.2: Product data for regionally extracted, harvested, or recovered and manufactured materials indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating cost for each regional material and the fraction by weight that is considered regional.

10. Credit MR 7:
   a. Product data and chain-of-custody certificates for products containing certified wood. Include statement indicating cost for each certified wood product.
   b. For all new permanently-installed wood products, both FSC-certified and not, vendor invoices must be compiled. A Vendor is defined as the company that sells wood products to building project contractors or subcontractors.
      1) Each vendor invoice must conform to the following requirements:
         a) Each wood product must be identified on a line-item basis;
         b) FSC products must be identified as such on a line-item basis and must be identified as "FSC Pure," "FSC Mixed Credit," or "FSC Mixed [NN] percent." Include percentage [NN] for FSC Mixed products.
         c) The $ value of each line item must be shown;
         d) The vendor's chain-of-custody (COC) number must be shown on any invoice that includes FSC products.
   c. For products that combine wood and other materials (i.e., assemblies), enter the percentage wood component by weight, volume or cost.
   d. Include statement indicating total cost for wood-based materials used for Project, including non-rented temporary construction.

11. Credit EQ 1: Product Data and Shop Drawings for carbon dioxide and airflow monitoring system.

12. Credit EQ 3.1 and 3.2: Reference Division 01 Section "Indoor Air Quality Management."
13. Credit EQ 4.1: Product data and MSDS for adhesives and sealants used inside the weatherproofing system indicating VOC content of each product used. Indicate VOC content in g/L calculated according to 40 CFR 59, Subpart D (EPA method 24).

14. Credit EQ 4.2: Product data and MSDS for paints and coatings used inside the weatherproofing system indicating chemical composition and VOC content of each product used. Indicate VOC content in g/L calculated according to 40 CFR 59, Subpart D (EPA method 24).

15. Credit EQ 4.3: Product Data for carpet systems as follows:
   a. Carpet: Provide statement indicating all carpet installed in the building interior meets the testing and product requirements of the Carpet and Rug Institute’s Green Label Plus program.
   b. Carpet Cushion: Provide statement indicating all carpet installed in the building interior meets the testing and product requirements of the Carpet and Rug Institute’s Green Label program.
   c. Carpet Adhesives: Provide statement as part of EQ Credit 4.1 indicating that all carpet adhesives meet VOC limit of 50 g/l.

16. Credit EQ 4.4:
   a. Product data for products containing composite wood or agrifiber products or wood glues used inside the weatherproofing system indicating that they do not contain urea-formaldehyde resin.
   b. Laminating adhesives used to fabricate on-site and shop-applied composite wood and agrifiber assemblies shall contain no added urea-formaldehyde resins.
      1) Include statement indicating adhesives and binders used for each product.

17. Credit EQ 5: Product Data for permanent walk-off mats and for filtration media showing MERV rating in accordance with ASHRAE 52.2.

18. Credit EQ 6.2: Product Data and Shop Drawings for sensors and control system used to provide individual airflow and temperature controls for minimum 50 percent of building occupants and for all shared multi-occupant spaces.

19. Credit EQ 7: Product Data and Shop Drawings for sensors and control system used to monitor and control room temperature and humidity.

1.06 QUALITY ASSURANCE

A. LEED Coordinator: Engage an experienced LEED-Accredited Professional to coordinate LEED requirements. LEED coordinator may also serve as waste management coordinator.

PART 2 - PRODUCTS

2.01 SALVAGED AND REFURBISHED MATERIALS

A. Credit MR 3.: Provide salvaged or refurbished materials for a minimum of 1 percent of building materials (by cost). The following materials may be salvaged or refurbished materials:
   1. <Insert list of materials>.

B. Credit MR 3.1: Provide salvaged or refurbished materials for a minimum of 5 percent of building materials (by cost). The following materials may be salvaged or refurbished materials:
   1. <Insert list of materials>. 
2.02 RECYCLED CONTENT OF MATERIALS
A. Credit MR 4.1 and Credit MR 4.2: Provide building materials with recycled content such that post-consumer recycled content plus one-half of pre-consumer recycled content constitutes a minimum of 20 percent of cost of materials used for Project.
   1. Cost of post-consumer recycled content of an item shall be determined by dividing weight of post-consumer recycled content in the item by total weight of the item and multiplying by cost of the item.
   2. Cost of pre-consumer recycled content of an item shall be determined by dividing weight of pre-consumer recycled content in the item by total weight of the item and multiplying by cost of the item.
   3. Recycled content shall be defined in accordance with the International Organization of Standards document, ISO 14021 "Environmental labels and declarations—Self-declared environmental claims (Type II environmental labeling)."
   4. Do not include furniture, plumbing, mechanical and electrical components, and specialty items such as elevators and equipment in the calculation.

2.03 REGIONALLY EXTRACTED, HARVESTED, OR RECOVERED AND MANUFACTURED MATERIALS
A. Credit MR 5.1 and Credit MR 5.2: Provide a minimum of 20 percent of building materials (by cost) that are regionally extracted, harvested, or recovered materials.
   1. 500 mile radius map of Project vicinity is attached at the end of this Section.

2.04 CERTIFIED WOOD
A. Credit MR 7: Use a minimum of 50 percent of wood-based materials and products, which are certified in accordance with the Forest Stewardship Council’s (FSC) Principles and Criteria, for wood building components. These components include, but are not limited to, structural framing and general dimensional framing, flooring, sub-flooring, wood doors and finishes.
   1. Wood-based materials include but are not limited to the following materials when made from made wood, engineered wood products, or wood-based panel products:
      a. Rough carpentry.
      b. Finish carpentry.
      c. Architectural woodwork.
      d. Wood flooring.
      e. Wood cabinets.
      f. Non-rented temporary construction, including bracing, concrete formwork, pedestrian barriers, and temporary protection.

2.05 LOW-EMITTING MATERIALS
A. Credit EQ 4.1: For field applications that are inside the weatherproofing system, use adhesives and sealants that comply with the South Coast Air Quality Management District (SCAQMD) Rule #1168 and for sealants and sealant primers, the Bay Area Air Quality Management District Regulation 8, Rule 51, summarized by the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA method 24):
   1. Wood Glues: 30 g/L.
   2. Metal to Metal Adhesives: 30 g/L.
   3. Adhesives for Porous Materials (Except Wood): 50 g/L.
   4. Subfloor Adhesives: 50 g/L.
   5. Plastic Foam Adhesives: 50 g/L.
   6. Carpet Adhesives: 50 g/L.
   7. Carpet Pad Adhesives: 50 g/L.
   8. VCT and Asphalt Tile Adhesives: 50 g/L.
9. Cove Base Adhesives: 50 g/L.
10. Gypsum Board and Panel Adhesives: 50 g/L.
11. Rubber Floor Adhesives: 60 g/L.
12. Ceramic Tile Adhesives: 65 g/L.
13. Multipurpose Construction Adhesives: 70 g/L.
14. Fiberglass Adhesives: 80 g/L.
15. Contact Adhesive: 80 g/L.
16. Structural Glazing Adhesives: 100 g/L.
17. Wood Flooring Adhesive: 100 g/L.
18. Structural Wood Member Adhesive: 140 g/L.
19. Special Purpose Contact Adhesive (contact adhesive that is used to bond melamine covered board, metal, unsupported vinyl, Teflon, ultra-high molecular weight polyethylene, rubber or wood veneer 1/16 inch or less in thickness to any surface): 250 g/L.
20. Top and Trim Adhesive: 250 g/L.
21. Plastic Cement Welding Compounds: 250 g/L.
22. ABS Welding Compounds: 325 g/L.
23. CPVC Welding Compounds: 490 g/L.
24. PVC Welding Compounds: 510 g/L.
25. Adhesive Primer for Plastic: 550 g/L.
27. ABS Welding Compounds: 400 g/L.
28. CPVC Welding Compounds: 490 g/L.
29. PVC Welding Compounds: 510 g/L.
30. Adhesive Primer for Plastic: 650 g/L.
31. Sheet Applied Rubber Lining Adhesive: 850 g/L.
32. Aerosol Adhesive, General Purpose Mist Spray: 65 percent by weight.
33. Aerosol Adhesive, General Purpose Web Spray: 55 percent by weight.
34. Special Purpose Aerosol Adhesive (All Types): 70 percent by weight.
35. Other Adhesives: 250 g/L.
36. Architectural Sealants: 250 g/L.
37. Nonmembrane Roof Sealants: 300 g/L.
38. Single-Ply Roof Membrane Sealants: 450 g/L.
39. Other Sealants: 420 g/L.
40. Sealant Primers for Nonporous Substrates: 250 g/L.
41. Sealant Primers for Porous Substrates: 775 g/L.
42. Modified Bituminous Sealant Primers: 500 g/L.
43. Other Sealant Primers: 750 g/L.

B. Credit EQ 4.2: For field applications that are inside the weatherproofing system, use paints and coatings that comply with Green Seal's Standard GS-11 and the following limits for VOC content when calculated according to 40 CFR 59, Subpart D and the following chemical restrictions:
1. Flat Paints, Coatings, and Primers: VOC not more than 50 g/L.
2. Nonflat Paints, Coatings, and Primers: VOC not more than 150 g/L.
3. Anticorrosive and Antirust Paints Applied to Ferrous Metals: VOC not more than 250 g/L.
4. Clear Wood Finishes, Varnishes: VOC not more than 350 g/L.
5. Clear Wood Finishes, Lacquers: VOC not more than 550 g/L.
6. Floor Coatings: VOC not more than 100 g/L.
7. Shellacs, Clear: VOC not more than 730 g/L.
8. Shellacs, Pigmented: VOC not more than 550 g/L.
9. Stains: VOC not more than 250 g/L.
10. Flat Interior Topcoat Paints: VOC not more than 50 g/L.
11. Nonflat Interior Topcoat Paints: VOC not more than 150 g/L.
12. Anticorrosive and Antirust Paints Applied to Ferrous Metals: VOC not more than 250 g/L.
13. Clear Wood Finishes, Varnishes and Sanding Sealers: VOC not more than 350 g/L.
14. Clear Wood Finishes, Lacquers: VOC not more than 550 g/L.
15. Floor Coatings: VOC not more than 100 g/L.
16. Shellacs, Clear: VOC not more than 730 g/L.
17. Shellacs, Pigmented: VOC not more than 550 g/L.
18. Stains: VOC not more than 250 g/L.
19. Primers, Sealers, and Undercoaters: VOC not more than 200 g/L.
20. Dry-Fog Coatings: VOC not more than 400 g/L.
22. Pretreatment Wash Primers: VOC not more than 420 g/L.
23. Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).
24. Restricted Components: Paints and coatings shall not contain any of the following:
   a. Acrolein.
   b. Acrylonitrile.
   c. Antimony.
   d. Benzene.
   e. Butyl benzyl phthalate.
   f. Cadmium.
   g. Di (2-ethylhexyl) phthalate.
   h. Di-n-butyl phthalate.
   i. Di-n-octyl phthalate.
   j. 1,2-dichlorobenzene.
   k. Diethyl phthalate.
   l. Dimethyl phthalate.
   m. Ethylenbenzene.
   n. Formaldehyde.
   o. Hexavalent chromium.
   p. Isophorone.
   q. Lead.
   r. Mercury.
   s. Methyl ethyl ketone.
   t. Methyl isobutyl ketone.
   u. Methylene chloride.
   v. Naphthalene.
   w. Toluene (methylbenzene).
   x. 1,1,1-trichloroethane.
   y. Vinyl chloride.

C. Credit EQ 4.3: For all carpet systems installed in the building interior, meet the requirements of the Carpet and Rug Institute’s Green Label Plus program for carpeting and Green Label program for cushion. All carpet adhesives shall meet VOC limit of 50 g/l.

D. Credit EQ 4.4:
1. Do not use composite wood or agrifiber products or adhesives that contain added urea-formaldehyde resins.
2. Laminating adhesives shall be free of urea-formaldehyde resins, (all other types of resins, such as phenol-formaldehyde are acceptable.)
PART 3 - EXECUTION

3.01 SITE DISTURBANCE
A. Credit SS 5.1: Comply with requirements of Division 01 Section "Summary."

3.02 MEASUREMENT AND VERIFICATION
A. Credit EA 5: Implement measurement and verification plan consistent with [Option B: Energy Conservation Measure Isolation] [Option D: Calibrated Simulation, Savings Estimation Method 2] in the EVO's "International Performance Measurement and Verification Protocol (IPMVP) Volume III: Concepts and Options for Determining Energy Savings in New Construction," and as further defined by the following:
   1. <Insert measurement and verification plan design team submitted for credit>.
B. If not already in place, install metering equipment to measure energy usage. Monitor, record, and trend log measurements.
C. Evaluate energy performance and efficiency by comparing actual to predicted performance.
D. Measurement and verification period shall cover at least one year of postconstruction occupancy.

3.03 CONSTRUCTION WASTE MANAGEMENT
A. Credit MR 2.1 and Credit MR 2.2: Comply with Division 01 Section "Construction Waste Management and Disposal."

3.04 CONSTRUCTION INDOOR-AIR-QUALITY MANAGEMENT
A. Credit EQ 3.1 and EQ 3.2: Comply with procedures specified in Division 01 Section "Indoor Air Quality Management.

END OF SECTION
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SUSTAINABLE DESIGN REQUIREMENTS

PART 1 - GENERAL

1.01 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.

1.02 SUMMARY
A. Section includes general requirements and procedures for compliance with certain USGBC LEED prerequisites and credits needed for Project to obtain LEED Silver or better certification based on LEED-NC, Version 2.2, including, but not limited to the following:
1. Documentation of percentages and amounts of materials using Contractor's Schedule of Values and LEED submittal letters.
2. Submittals and documentation of material data, location of manufacture, construction waste, recycled content data and VOC compliance.
3. Certification of submitted data and documentation.
4. Salvaging and recycling requirements.
5. Salvaging and recycling procedures.

B. This Project has been designed with the intent of attaining LEED Certification upon completion of the construction and commissioning process.
1. Other LEED prerequisites and credits needed to obtain LEED certification depend on material selections and may not be specifically identified as LEED requirements. Compliance with requirements needed to obtain LEED prerequisites and credits may be used as one criterion to evaluate substitution requests and comparable product requests.
2. Additional LEED prerequisites and credits needed to obtain the indicated LEED certification depend on Architect's design and other aspects of Project that are not part of the Work of the Contract.
3. A copy of the LEED Project checklist is attached at the end of this Section for information only.

C. Related Sections:
1. Division 01 Section "Construction Waste Management" for LEED requirements specific to salvaging and recycling construction waste.
2. Division 01 Section "General Commissioning Requirements" for LEED requirements specific to building commissioning.
3. Division 26 Section "Commissioning of HVAC Systems."
4. Divisions 01 through 33 Sections for LEED requirements specific to the work of each of these Sections. Requirements may or may not include reference to LEED.

1.03 DEFINITIONS
A. Chain-of-Custody Certificates: Certificates signed by manufacturers certifying that wood used to make products was obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship." Certificates shall include evidence that manufacturer is certified for chain of custody by an FSC-FSC-accredited certification body.

B. LEED: Leadership in Energy & Environmental Design.
C. Regionally Extracted, Harvested, or Recovered and Manufactured Materials: Materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site. If only a fraction of a product or material is extracted/harvested/recovered and manufactured locally, then only that percentage (by weight) shall contribute to the regional value.

D. Recycled Content: The recycled content value of a material assembly shall be determined by weight. The recycled fraction of the assembly is then multiplied by the cost of assembly to determine the recycled content value.
   1. "Post-consumer" material is defined as waste material generated by households or by commercial, industrial, and institutional facilities in their role as end users of the product, which can no longer be used for its intended purpose.
   2. "Pre-consumer" material is defined as material diverted from the waste stream during the manufacturing process. Excluded is reutilization of materials such as rework, regrind, or scrap generated in a process and capable of being reclaimed within the same process that generated it.

E. Recycled Content: The percentage by weight of constituents that have been recovered or otherwise diverted from the solid waste stream, either during the manufacturing process (pre-consumer), or after consumer use (post-consumer).
   1. Spills and scraps from the original manufacturing process that are combined with other constituents after a minimal amount of reprocessing for use in further production of the same product are not recycled materials.
   2. Discarded materials from one manufacturing process that are used as constituents in another manufacturing process are pre-consumer recycled materials.

F. VOC Content: Volatile Organic Compound Content, calculated in grams/liter according to 40 CFR 59, Subpart D (EPA method 24.)

1.04 PERFORMANCE REQUIREMENTS
A. Credit MR 2.2 - Construction Waste Management: Owner's goal is to salvage and recycle as much non-hazardous construction waste as possible and has established minimum goal of 75 percent of overall project construction waste to be salvaged and recycled. See Division 1 Section "Construction Waste Management" for specific requirements.

B. Credit MR 5.2 - Regionally Extracted, Harvested, or Recovered and Manufactured Materials: Owner's requirement is that 20 percent of materials, by cost, used in the construction shall be manufactured and harvested locally. Subject to compliance with specification requirements, Contractor may select which materials make up the 20 percent.

1.05 SUBMITTALS
A. General: Submit additional LEED submittals required by other Specification Sections.

B. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.

C. Project Materials Cost Data: Provide statement indicating total cost for building materials used for Project.
   1. Costs exclude labor, overhead, and profit. Include breakout of costs for the following categories of items:
      a. Furniture.
      b. Plumbing.
      c. Mechanical.
      d. Electrical.
      e. Specialty items such as elevators and equipment.
f. Wood-based construction materials.

2. Schedule of Values: Schedule of values shall break out cost of materials apart from all other costs, including such other costs as overhead and profit.

3. Change Order Breakdown: Change orders, proposals and responses to Construction Change Directives shall include information matching Schedule of Values breakdown, indicating change in cost of materials separately and technical specification sections affected.

D. LEED Action Plans: Provide preliminary submittals within 30 days of date established for commencement of the Work indicating how the following requirements will be met:
   1. Credit MR 2.1 and Credit MR 2.2: Waste management plan complying with Division 01 Section "Construction Waste Management and Disposal."
   2. Credit MR 3.1: List of proposed salvaged and refurbished materials.
      a. Identify each material that will be salvaged or refurbished, including its source, cost, and replacement cost if the item was to be purchased new.
   3. Credit MR 4.1 and Credit MR 4.2: List of proposed materials with recycled content.
      a. Indicate cost, post-consumer recycled content, and pre-consumer recycled content for each product having recycled content.
   4. Credit MR 5.1 and Credit MR 5.2: List of proposed regionally extracted, harvested, or recovered and manufactured materials.
      a. Identify each regionally extracted, harvested, or recovered and manufactured material, including its source and cost.
   5. Credit MR 7: List of proposed certified wood products.
      a. Indicate each product containing certified wood, including its source and cost of certified wood products.
      b. Include statement indicating total cost for wood-based materials used for Project, including non-rented temporary construction.

E. LEED Progress Reports: Concurrent with each Application for Payment, submit reports comparing actual construction and purchasing activities with LEED action plans for the following:
   1. Credit MR 2.1 and Credit MR 2.2: Waste reduction progress reports complying with Division 01 Section "Construction Waste Management and Disposal."
   2. Credit MR 3: Salvaged and refurbished materials.
   3. Credit MR 3.1: Salvaged and refurbished materials.
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F. LEED Documentation Submittals:
   1. Credit WE 3.1 and 3.2: Product Data for plumbing fixtures indicating water consumption.
   2. Prerequisite EA 3: Product Data for new HVAC equipment indicating absence of CFC refrigerants.
   3. Credit EA4: Product Data for new HVAC equipment indicating refrigerant type.
   4. Credit EA 5: Product data and wiring diagrams for sensors and data collection system used to provide continuous metering of building energy-consumption performance over [time] [a period of time of not less than one year of postconstruction occupancy].
   5. Credit MR 2.1 and Credit MR 2.2: Comply with Division 01 Section "Construction Waste Management and Disposal."
6. Credit MR 3: Receipts for salvaged and refurbished materials used for Project, indicating sources and costs for salvaged and refurbished materials.

7. Credit MR 3.1: Receipts for salvaged and refurbished materials used for Project, indicating sources and costs for salvaged and refurbished materials.

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9. Credit MR 5.1 and Credit MR 5.2: Product data for regionally extracted, harvested, or recovered and manufactured materials indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating cost for each regional material and the fraction by weight that is considered regional.

10. Credit MR 7:
   a. Product data and chain-of-custody certificates for products containing certified wood. Include statement indicating cost for each certified wood product.
   b. For all new permanently-installed wood products, both FSC-certified and not, vendor invoices must be compiled. A Vendor is defined as the company that sells wood products to building project contractors or subcontractors.
      1) Each vendor invoice must conform to the following requirements:
         a) Each wood product must be identified on a line-item basis;
         b) FSC products must be identified as such on a line-item basis and must be identified as “FSC Pure,” “FSC Mixed Credit,” or “FSC Mixed [NN] percent.” Include percentage [NN] for FSC Mixed products.
         c) The $ value of each line item must be shown;
         d) The vendor’s chain-of-custody (COC) number must be shown on any invoice that includes FSC products.
   c. For products that combine wood and other materials (i.e., assemblies), enter the percentage wood component by weight, volume or cost.
   d. Include statement indicating total cost for wood-based materials used for Project, including non-rented temporary construction.

11. Credit EQ 1: Product Data and Shop Drawings for carbon dioxide and airflow monitoring system.

12. Credit EQ 3.1:
   a. Construction Indoor Air Quality (IAQ) Management Plan developed following the recommended Design Approaches for the Sheet Metal and Air Conditioning National Contractors Association (SMACNA) IAQ Guidelines for Occupied Buildings under Construction, 1995, Chapter 3.
   b. Product Data for filtration media used on permanently installed air handlers operated during construction including filter manufacturer, filter model #, filter MERV rating, and location of installed filter. Confirm that each filter was replaced prior to occupancy.
   c. Construction Documentation: Six photographs at three different times during the construction period, along with a brief description of the SMACNA approach employed, documenting implementation of the indoor-air-quality management measures, such as protection of ducts and on-site stored or installed absorptive materials.
13. Credit EQ 3.2:
   a. Signed detailed narrative describing the project’s pre-occupancy (or pre-occupancy and post-occupancy) flush-out process including data regarding temperature, airflow, and duration of flush-out and any special considerations.
   b. Report from testing and inspecting agency indicating results of indoor-air-quality testing and documentation showing compliance with indoor-air-quality testing procedures and requirements.
   c. Data for filtration media used during occupancy, including MERV rating.

14. Credit EQ 4.1: Product data and MSDS for adhesives and sealants used inside the weatherproofing system indicating VOC content of each product used. Indicate VOC content in g/L calculated according to 40 CFR 59, Subpart D (EPA method 24).

15. Credit EQ 4.2: Product data and MSDS for paints and coatings used inside the weatherproofing system indicating chemical composition and VOC content of each product used. Indicate VOC content in g/L calculated according to 40 CFR 59, Subpart D (EPA method 24).

16. Credit EQ 4.3: Product Data for carpet systems as follows:
   a. Carpet: Provide statement indicating all carpet installed in the building interior meets the testing and product requirements of the Carpet and Rug Institute’s Green Label Plus program.
   b. Carpet Cushion: Provide statement indicating all carpet installed in the building interior meets the testing and product requirements of the Carpet and Rug Institute’s Green Label program.
   c. Carpet Adhesives: Provide statement as part of EQ Credit 4.1 indicating that all carpet adhesives meet VOC limit of 50 g/l.

17. Credit EQ 4.4:
   a. Product data for products containing composite wood or agrifiber products or wood glues used inside the weatherproofing system indicating that they do not contain urea-formaldehyde resin.
   b. Laminating adhesives used to fabricate on-site and shop-applied composite wood and agrifiber assemblies shall contain no added urea-formaldehyde resins.
      1) Include statement indicating adhesives and binders used for each product.

18. Credit EQ 5: Product Data for permanent walk-off mats and for filtration media showing MERV rating in accordance with ASHRAE 52.2.

19. Credit EQ 6.2: Product Data and Shop Drawings for sensors and control system used to provide individual airflow and temperature controls for minimum 50 percent of building occupants and for all shared multi-occupant spaces.

20. Credit EQ 7: Product Data and Shop Drawings for sensors and control system used to monitor and control room temperature and humidity.

1.06 QUALITY ASSURANCE
A. LEED Coordinator: Engage an experienced LEED-Accredited Professional to coordinate LEED requirements. LEED coordinator may also serve as waste management coordinator.
PART 2 - PRODUCTS

2.01 SALVAGED AND REFURBISHED MATERIALS
A. Credit MR 3.: Provide salvaged or refurbished materials for a minimum of 1 percent of building materials (by cost). The following materials may be salvaged or refurbished materials:
   1. <Insert list of materials>.
B. Credit MR 3.1: Provide salvaged or refurbished materials for a minimum of 5 percent of building materials (by cost). The following materials may be salvaged or refurbished materials:
   1. <Insert list of materials>.

2.02 RECYCLED CONTENT OF MATERIALS
A. Credit MR 4.1 and Credit MR 4.2: Provide building materials with recycled content such that post-consumer recycled content plus one-half of pre-consumer recycled content constitutes a minimum of 20 percent of cost of materials used for Project.
   1. Cost of post-consumer recycled content of an item shall be determined by dividing weight of post-consumer recycled content in the item by total weight of the item and multiplying by cost of the item.
   2. Cost of pre-consumer recycled content of an item shall be determined by dividing weight of pre-consumer recycled content in the item by total weight of the item and multiplying by cost of the item.
   3. Recycled content shall be defined in accordance with the International Organization of Standards document, ISO 14021 "Environmental labels and declarations—Self-declared environmental claims (Type II environmental labeling)."
   4. Do not include furniture, plumbing, mechanical and electrical components, and specialty items such as elevators and equipment in the calculation.

2.03 REGIONALLY EXTRACTED, HARVESTED, OR RECOVERED AND MANUFACTURED MATERIALS
A. Credit MR 5.1 and Credit MR 5.2: Provide a minimum of 20 percent of building materials (by cost) that are regionally extracted, harvested, or recovered materials.

2.04 CERTIFIED WOOD
A. Credit MR 7: Use a minimum of 50 percent of wood-based materials and products, which are certified in accordance with the Forest Stewardship Council’s (FSC) Principles and Criteria, for wood building components. These components include, but are not limited to, structural framing and general dimensional framing, flooring, sub-flooring, wood doors and finishes.
   1. Wood-based materials include but are not limited to the following materials when made from made wood, engineered wood products, or wood-based panel products:
      a. Rough carpentry.
      b. Finish carpentry.
      c. Architectural woodwork.
      d. Wood flooring.
      e. Wood cabinets.
      f. Non-rented temporary construction, including bracing, concrete formwork, pedestrian barriers, and temporary protection.
2.05 LOW-EMITTING MATERIALS

A. Credit EQ 4.1: For field applications that are inside the weatherproofing system, use adhesives and sealants that comply with the South Coast Air Quality Management District (SCAQMD) Rule #1168 and for sealants and sealant primers, the Bay Area Air Quality Management District Regulation 8, Rule 51, summarized by the following, limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA method 24):

1. Wood Glues: 30 g/L.
2. Metal to Metal Adhesives: 30 g/L.
3. Adhesives for Porous Materials (Except Wood): 50 g/L.
4. Subfloor Adhesives: 50 g/L.
5. Plastic Foam Adhesives: 50 g/L.
6. Carpet Adhesives: 50 g/L.
7. Carpet Pad Adhesives: 50 g/L.
8. VCT and Asphalt Tile Adhesives: 50 g/L.
9. Cove Base Adhesives: 50 g/L.
10. Gypsum Board and Panel Adhesives: 50 g/L.
11. Rubber Floor Adhesives: 60 g/L.
12. Ceramic Tile Adhesives: 65 g/L.
13. Multipurpose Construction Adhesives: 70 g/L.
14. Fiberglass Adhesives: 80 g/L.
15. Contact Adhesive: 80 g/L.
16. Structural Glazing Adhesives: 100 g/L.
17. Wood Flooring Adhesive: 100 g/L.
18. Structural Wood Member Adhesive: 140 g/L.
19. Special Purpose Contact Adhesive (contact adhesive that is used to bond melamine covered board, metal, unsupported vinyl, Teflon, ultra-high molecular weight polyethylene, rubber or wood veneer 1/16 inch or less in thickness to any surface): 250 g/L.
20. Top and Trim Adhesive: 250 g/L.
21. Plastic Cement Welding Compounds: 250 g/L.
22. ABS Welding Compounds: 325 g/L.
23. CPVC Welding Compounds: 490 g/L.
24. PVC Welding Compounds: 510 g/L.
25. Adhesive Primer for Plastic: 550 g/L.
27. ABS Welding Compounds: 400 g/L.
28. CPVC Welding Compounds: 490 g/L.
29. PVC Welding Compounds: 510 g/L.
30. Adhesive Primer for Plastic: 650 g/L.
31. Sheet Applied Rubber Lining Adhesive: 850 g/L.
32. Aerosol Adhesive, General Purpose Mist Spray: 65 percent by weight.
33. Aerosol Adhesive, General Purpose Web Spray: 55 percent by weight.
34. Special Purpose Aerosol Adhesive (All Types): 70 percent by weight.
35. Other Adhesives: 250 g/L.
36. Architectural Sealants: 250 g/L.
37. Nonmembrane Roof Sealants: 300 g/L.
38. Single-Ply Roof Membrane Sealants: 450 g/L.
39. Other Sealants: 420 g/L.
40. Sealant Primers for Nonporous Substrates: 250 g/L.
41. Sealant Primers for Porous Substrates: 775 g/L.
42. Modified Bituminous Sealant Primers: 500 g/L.
43. Other Sealant Primers: 750 g/L.
B. Credit EQ 4.2: For field applications that are inside the weatherproofing system, use paints and coatings that comply with Green Seal's Standard GS-11 and the following limits for VOC content when calculated according to 40 CFR 59, Subpart D and the following chemical restrictions:

1. Flat Paints, Coatings, and Primers: VOC not more than 50 g/L.
2. Nonflat Paints, Coatings, and Primers: VOC not more than 150 g/L.
3. Anticorrosive and Antirust Paints Applied to Ferrous Metals: VOC not more than 250 g/L.
4. Clear Wood Finishes, Varnishes: VOC not more than 350 g/L.
5. Clear Wood Finishes, Lacquers: VOC not more than 550 g/L.
6. Floor Coatings: VOC not more than 100 g/L.
7. Shellacs, Clear: VOC not more than 730 g/L.
8. Shellacs, Pigmented: VOC not more than 550 g/L.
9. Stains: VOC not more than 250 g/L.
10. Flat Interior Topcoat Paints: VOC not more than 50 g/L.
11. Nonflat Interior Topcoat Paints: VOC not more than 150 g/L.
12. Anticorrosive and Antirust Paints Applied to Ferrous Metals: VOC not more than 250 g/L.
13. Clear Wood Finishes, Varnishes and Sanding Sealers: VOC not more than 350 g/L.
14. Clear Wood Finishes, Lacquers: VOC not more than 550 g/L.
15. Floor Coatings: VOC not more than 100 g/L.
16. Shellacs, Clear: VOC not more than 730 g/L.
17. Shellacs, Pigmented: VOC not more than 550 g/L.
18. Stains: VOC not more than 250 g/L.
19. Primers, Sealers, and Undercoaters: VOC not more than 200 g/L.
20. Dry-Fog Coatings: VOC not more than 400 g/L.
22. Pretreatment Wash Primers: VOC not more than 420 g/L.
23. Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).
24. Restricted Components: Paints and coatings shall not contain any of the following:
   a. Acrolein.
   b. Acrylonitrile.
   c. Antimony.
   d. Benzene.
   e. Butyl benzyl phthalate.
   f. Cadmium.
   g. Di (2-ethylhexyl) phthalate.
   h. Di-n-butyl phthalate.
   i. Di-n-octyl phthalate.
   j. 1,2-dichlorobenzene.
   k. Diethyl phthalate.
   l. Dimethyl phthalate.
   m. Ethylbenzene.
   n. Formaldehyde.
   o. Hexavalent chromium.
   p. Isophorone.
   q. Lead.
   r. Mercury.
   s. Methyl ethyl ketone.
   t. Methyl isobutyl ketone.
   u. Methylene chloride.
v. Naphthalene.
w. Toluene (methylbenzene).
x. 1,1,1-trichloroethane.
y. Vinyl chloride.

C. Credit EQ 4.3: For all carpet systems installed in the building interior, meet the requirements of the Carpet and Rug Institute’s Green Label Plus program for carpeting and Green Label program for cushion. All carpet adhesives shall meet VOC limit of 50 g/l.

D. Credit EQ 4.4:
   1. Do not use composite wood or agrifiber products or adhesives that contain added urea-formaldehyde resins.
   2. Laminating adhesives shall be free of urea-formaldehyde resins, (all other types of resins, such as phenol-formaldehyde are acceptable.)

PART 3 - EXECUTION

3.01 SITE DISTURBANCE
   A. Credit SS 5.1: Comply with requirements of Division 01 Section "Summary."

3.02 MEASUREMENT AND VERIFICATION
   A. Credit EA 5: Implement measurement and verification plan consistent with [Option B: Energy Conservation Measure Isolation] [Option D: Calibrated Simulation, Savings Estimation Method 2] in the EVO's "International Performance Measurement and Verification Protocol (IPMVP) Volume III: Concepts and Options for Determining Energy Savings in New Construction," and as further defined by the following:
      1. <Insert measurement and verification plan design team submitted for credit>.
   B. If not already in place, install metering equipment to measure energy usage. Monitor, record, and trend log measurements.
   C. Evaluate energy performance and efficiency by comparing actual to predicted performance.
   D. Measurement and verification period shall cover at least one year of postconstruction occupancy.

3.03 CONSTRUCTION WASTE MANAGEMENT
   A. Credit MR 2.1 and Credit MR 2.2: Comply with Division 01 Section "Construction Waste Management and Disposal."

3.04 CONSTRUCTION INDOOR-AIR-QUALITY MANAGEMENT
   A. Credit EQ 3.1: Credit EQ 3.1: Develop and comply with Construction Indoor Air Quality (IAQ) Management Plan that follows the recommended Design Approaches for the Sheet Metal and Air Conditioning National Contractors Association (SMACNA) IAQ Guidelines for Occupied Buildings under Construction, 1995, Chapter 3.
      1. Protect stored onsite or installed absorptive materials from moisture damage.
      2. If Owner authorizes use of permanent heating, cooling, and ventilating systems during construction period as specified in Division 01 Section "Temporary Facilities and Controls," install filter media having a MERV 8 according to ASHRAE 52.2 at each return-air inlet for the air-handling system used during construction.
      3. Submit 18 on-site photographs (6 taken on three different occasions) are to be taken during construction highlighting compliance with the SMACNA IAQ Guidelines.
4. Replace all air filters immediately prior to occupancy.

B. Credit EQ 3.2: [Comply with one of the following requirements:]

1. After construction ends, prior to occupancy and with all interior finishes installed, perform a building flush-out by supplying a total volume of 14000 cu. ft. of outdoor air per sq. ft. of floor area while maintaining an internal temperature of at least 60 deg F and a relative humidity no higher than 60 percent.
   a. <Insert operating requirements>.

2. If occupancy is desired prior to flush-out completion, the space may be occupied following delivery of a minimum of 3500 cu. ft. of outdoor air per sq. ft. of floor area to the space. Once a space is occupied, it shall be ventilated at a minimum rate of 0.30 cfm per sq. ft. of outside air or the design minimum outside air rate determined in EQ Prerequisite 1, whichever is greater. During each day of the flush-out period, ventilation shall begin a minimum of three hours prior to occupancy and continue during occupancy. These conditions shall be maintained until a total of 14000 cu. ft./sq. ft. of outside air has been delivered to the space.
   a. <Insert operating requirements>.

3. Air-Quality Testing:
   a. Conduct baseline indoor-air-quality testing, after construction ends and prior to occupancy, using testing protocols consistent with the EPA's "Compendium of Methods for the Determination of Air Pollutants in Indoor Air," and as additionally detailed in the USGBC's "[LEED-NC] [LEED-CI]: Reference Guide."
   b. Demonstrate that the contaminant maximum concentrations listed below are not exceeded:
      1) Formaldehyde: 50 ppb.
      2) Particulates (PM10): 50 micrograms/cu. m.
      3) Total Volatile Organic Compounds (TVOC): 500 micrograms/cu. m.
      4) 4-Phenylcyclohexene (4-PH): 6.5 micrograms/cu. m.
      5) Carbon Monoxide: 9 ppm and no greater than 2 ppm above outdoor levels.

4. For each sampling point where the maximum concentration limits are exceeded, conduct additional flush-out with outside air and retest the specific parameter(s) exceeded to indicate the requirements are achieved. Repeat procedure until all requirements have been met. When retesting noncomplying building areas, take samples from same locations as in the first test.
   a. Air-sample testing shall be conducted as follows:
      1) All measurements shall be conducted prior to occupancy but during normal occupied hours, and with building ventilation system starting at the normal daily start time and operated at the minimum outside air flow rate for the occupied mode throughout the duration of the air testing.
      2) Building shall have all interior finishes installed including, but not limited to, millwork, doors, paint, carpet, and acoustic tiles. Nonfixed furnishings such as workstations and partitions are encouraged, but not required, to be in place for the testing.
      3) Number of sampling locations will vary depending on the size of building and number of ventilation systems. For each portion of building served by a separate ventilation system, the number of sampling points shall not be less than one per 25,000 sq. ft. or for each contiguous floor area, whichever is larger, and shall include areas with the least ventilation and greatest presumed source strength.
4) Air samples shall be collected between 3 and 6 feet from the floor to represent the breathing zone of occupants, and over a minimum four-hour period.

END OF SECTION
# LEED® - NC v2.2

## Sustainable Sites

<table>
<thead>
<tr>
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<th>Notes</th>
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</thead>
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<tr>
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<td>Site Selection</td>
</tr>
<tr>
<td>Credit 2</td>
<td>Development Density &amp; Community Connectivity</td>
</tr>
<tr>
<td>Credit 3</td>
<td>Brownfield Redevelopment</td>
</tr>
<tr>
<td>Credit 4.1</td>
<td>Alternative Transportation: Public Transportation Access</td>
</tr>
<tr>
<td>Credit 4.2</td>
<td>Alternative Transportation: Bicycle Storage &amp; Changing Rooms</td>
</tr>
<tr>
<td>Credit 4.3</td>
<td>Alternative Transportation: Low-Emitting &amp; Fuel Efficient Vehicles</td>
</tr>
<tr>
<td>Credit 4.4</td>
<td>Alternative Transportation: Parking Capacity</td>
</tr>
<tr>
<td>Credit 5.1</td>
<td>Site Development: Protect or Restore Habitat</td>
</tr>
<tr>
<td>Credit 5.2</td>
<td>Site Development: Maximize Open Space</td>
</tr>
<tr>
<td>Credit 6.1</td>
<td>Stormwater Design: Quantity Control</td>
</tr>
<tr>
<td>Credit 6.2</td>
<td>Stormwater Design: Quality Control</td>
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<tr>
<td>Credit 7.1</td>
<td>Heat Island Effect: Non-Roof white or gray concrete</td>
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<tr>
<td>Credit 7.2</td>
<td>Heat Island Effect: Roof</td>
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<tr>
<td>Credit 8</td>
<td>Light Pollution Reduction</td>
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**Total Credits Achieved:** 14 Possible

## Water Efficiency

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<th>Credit</th>
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<td>Credit 1.1</td>
<td>Water Efficient Landscaping: Reduce by 50%</td>
</tr>
<tr>
<td>Credit 1.2</td>
<td>Water Efficient Landscaping: No Potable Water Use or No Irrigation</td>
</tr>
<tr>
<td>Credit 2</td>
<td>Innovative Wastewater Technologies</td>
</tr>
<tr>
<td>Credit 3.1</td>
<td>Water Use Reduction: 20% Reduction</td>
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<tr>
<td>Credit 3.2</td>
<td>Water Use Reduction: 30% Reduction</td>
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**Total Credits Achieved:** 5 Possible

## Energy and Atmosphere

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<th>Notes</th>
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<tbody>
<tr>
<td>Prerequisite 1</td>
<td>Fundamental Commissioning of the Building Energy Systems</td>
</tr>
<tr>
<td>Prerequisite 2</td>
<td>Minimum Energy Performance</td>
</tr>
<tr>
<td>Prerequisite 3</td>
<td>Fundamental Refrigerant Management</td>
</tr>
<tr>
<td>Credit 1.1</td>
<td>Optimize Energy Performance, 10.5% new, 3.5% existing</td>
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<tr>
<td>Credit 1.2</td>
<td>Optimize Energy Performance, 14% new, 7% existing</td>
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<tr>
<td>Credit 1.3</td>
<td>Optimize Energy Performance, 17.51% New 10.5% Existing</td>
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<tr>
<td>Credit 1.4</td>
<td>Optimize Energy Performance, 21% New 14% Existing</td>
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<td>Credit 1.5</td>
<td>Optimize Energy Performance, 24.51% New 17.5% Existing</td>
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<td>Credit 1.6</td>
<td>Optimize Energy Performance, 28% New 21% Existing</td>
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<tr>
<td>Credit 1.7</td>
<td>Optimize Energy Performance, 31.5% New 24.5% Existing</td>
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<td>Credit 1.8</td>
<td>Optimize Energy Performance, 35% New 28% Existing</td>
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<td>Credit 1.9</td>
<td>Optimize Energy Performance, 38.5% New 31.5% Existing</td>
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<td>Credit 1.10</td>
<td>Optimize Energy Performance, 42% New 35% Existing</td>
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<td>Credit 2.1</td>
<td>On-Site Renewable Energy: 2.5%</td>
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<td>On-Site Renewable Energy: 7.5%</td>
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<td>On-Site Renewable Energy: 12.5%</td>
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<td>Credit 3</td>
<td>Enhanced Commissioning</td>
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<td>Credit 4</td>
<td>Enhanced Refrigerant Management</td>
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<tr>
<td>Credit 5</td>
<td>Measurement &amp; Verification</td>
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<td>Credit 6</td>
<td>Green Power: 35%</td>
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**Total Credits Achieved:** 17 Possible
### Materials and Resources

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<th>Description</th>
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<tr>
<td>X Credit 1.1</td>
<td>Building Reuse: Maintain 75% of Existing Walls, Floors &amp; Roof</td>
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<tr>
<td>X Credit 1.2</td>
<td>Building Reuse: Maintain 95% of Existing Walls, Floors &amp; Roof</td>
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<td>X Credit 1.3</td>
<td>Building Reuse: Maintain 50% of Interior Non-Structural Elements</td>
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<tr>
<td>X Credit 2.1</td>
<td>Construction Waste Management: Divert 50% From Disposal</td>
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<td>X Credit 2.2</td>
<td>Construction Waste Management: Divert 75% From Disposal</td>
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<td>X Credit 3.1</td>
<td>Materials Reuse: 5%</td>
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<td>X Credit 3.2</td>
<td>Materials Reuse: 10%</td>
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<td>X Credit 4.1</td>
<td>Recycled Content: 10% (post-consumer + 1/2 pre-consumer)</td>
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<tr>
<td>X Credit 4.2</td>
<td>Recycled Content: 20% (post-consumer + 1/2 pre-consumer)</td>
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<td>X Credit 5.1</td>
<td>Regional Materials: 10% Extracted, Processed &amp; Manufactured Locally</td>
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<td>Regional Materials: 20% Extracted, Processed &amp; Manufactured Locally</td>
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<td>X Credit 6</td>
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<td>X Credit 7</td>
<td>Certified Wood</td>
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**Total Possible:** 13

### Indoor Environmental Quality

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<tbody>
<tr>
<td>Y Prerequisite 1</td>
<td>Minimum IAQ Performance</td>
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<tr>
<td>Y Prerequisite 2</td>
<td>Environmental Tobacco Smoke (ETS) Control</td>
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<tr>
<td>X Credit 1</td>
<td>Outside Air Delivery Monitoring</td>
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<tr>
<td>X Credit 2</td>
<td>Increased Ventilation</td>
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<tr>
<td>X Credit 3.1</td>
<td>Construction IAQ Management Plan: During Construction</td>
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<tr>
<td>X Credit 3.2</td>
<td>Construction IAQ Management Plan: Before Occupancy</td>
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<td>X Credit 4.1</td>
<td>Low-Emitting Materials: Adhesives &amp; Sealants</td>
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<tr>
<td>X Credit 4.2</td>
<td>Low-Emitting Materials: Paints &amp; Coatings</td>
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<tr>
<td>X Credit 4.3</td>
<td>Low-Emitting Materials: Carpet Systems</td>
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<td>X Credit 4.4</td>
<td>Low-Emitting Materials: Composite Wood &amp; Agrifiber Products</td>
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<td>X Credit 5</td>
<td>Indoor Chemical &amp; Pollutant Source Control</td>
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<td>X Credit 6.1</td>
<td>Controllability of Systems: Lighting</td>
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<td>X Credit 6.2</td>
<td>Controllability of Systems: Thermal Comfort</td>
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<td>X Credit 7.1</td>
<td>Thermal Comfort: Design</td>
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<td>X Credit 7.2</td>
<td>Thermal Comfort: Verification</td>
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<td>X Credit 8.1</td>
<td>Daylight and Views: Daylight 75% of spaces</td>
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<tr>
<td>X Credit 8.2</td>
<td>Daylight and Views: Views for 90% of Spaces</td>
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**Total Possible:** 15

### Innovation & Design Process

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<th>Description</th>
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<tr>
<td>X Credit 1.1</td>
<td>Innovation in Design, As approved by USGBC</td>
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<tr>
<td>X Credit 1.2</td>
<td>Innovation in Design, As approved by USGBC</td>
</tr>
<tr>
<td>X Credit 1.3</td>
<td>Innovation in Design, As approved by USGBC</td>
</tr>
<tr>
<td>X Credit 1.4</td>
<td>Innovation in Design, As approved by USGBC</td>
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<tr>
<td>X Credit 2</td>
<td>LEED® Accredited Professional</td>
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**Total Possible:** 5

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**Project Points:** 47  
**Gold**
500 mile radius map.
LEED SUBMITTAL FORM

SUSTAINABLE SITES CREDIT 7.2

GENERAL

This Form is required as part of the submittal requirements and documentation procedures for compliance with certain U.S. Green Building Council’s (USGBC) Leadership in Energy and Environmental Design for New Construction and Major Renovations Version 2.2 (LEED-NC v2.2) prerequisites and credits needed for the Project to obtain LEED-NC v2.2 certification. For additional information, refer to Division 01 Specification Section “Sustainable Design Requirements.”

SUSTAINABLE SITES (SS) CREDIT 7.2
HEAT ISLAND EFFECT: ROOF

Submittals for this credit shall include all of the information required below, as applicable. Contractor shall include either the SRI value or the reflectance and emittance values. Submittals shall substantiate compliance with the following:

• Solar Reflectance Index (SRI) of each type of roofing membrane in accordance with ASTM E 1980.
• Reflectance of each type of roofing membrane measured in accordance with ASTM E 903, ASTM E1918 or ASTM C 1549.
• Emittance of each type of roofing membrane measured in accordance with ASTM C 1371.
• Roofing Manufacturer's technical product data to substantiate source(s) for Items 1, 2 and 3 above.

For SS Credit 7.2, list the following for each roofing product used for the field of the roof(s) as specified in Division 7:

Product No.: ________________________________________________________________________
Manufacturer: _______________________________________________________________________
Product Name/Model: __________________________________________________________________
Solar Reflectance Index (SRI): ___________________________ or Reflectance: ___________________________ and Emittance: ___________________________
Roof Slope: _________________________________________________________________________

Trade Contractor's signature and date:

_________________________  ________________________  __________________
Print Name  Print Company Name  Date

Manufacturer's signature and date:

_________________________  ________________________  __________________
Print Name  Print Company Name  Date
GENERAL

This Form is required as part of the submittal requirements and documentation procedures for compliance with certain U.S. Green Building Council’s (USGBC) Leadership in Energy and Environmental Design for New Construction and Major Renovations Version 2.2 (LEED-NC v2.2) prerequisites and credits needed for the Project to obtain LEED-NC v2.2 certification. For additional information, refer to Division 01 Specification Section “Sustainable Design Requirements.”

WATER EFFICIENCY (WE) CREDITS 3.1 & 3.2
WATER USE REDUCTION

For WE Credit 3.1, list the following for each type of water closet, urinal, lavatory faucet, shower and kitchen sink fixture used for project. As applicable for the specific fixture, list the "flush rate" or the "flow rate". Submit fixture manufacturer’s technical product data to substantiate information listed below for each fixture type.

Fixture Reference No.: ________________________________________________________________
Fixture Type: _______________________________________________________________________
Manufacturer: _______________________________________________________________________
Product Name/Model: ________________________________________________________________
Flush Rate: _________________________________________________________ (gallons per flush) or
Flow Rate: __________________________________________________________ (gallons per minute)

Trade Contractor’s signature and date:

_________________________  ________________________  __________________
Print Name  Print Company Name  Date

Manufacturer’s signature and date:

_________________________  ________________________  __________________
Print Name  Print Company Name  Date
LEED SUBMITTAL FORM

MATERIALS & RESOURCES CREDITS 4.1 and 4.2

GENERAL

This Form is required as part of the submittal requirements and documentation procedures for compliance with certain U.S. Green Building Council's (USGBC) Leadership in Energy and Environmental Design for New Construction and Major Renovations Version 2.2 (LEED-NC v2.2) prerequisites and credits needed for the Project to obtain LEED-NC v2.2 certification. For additional information, refer to Division 01 Specification Section "Sustainable Design Requirements."

MATERIALS & RESOURCES (MR) CREDITS 4.1 and 4.2

RECYCLED CONTENT

Post-Consumer material is defined as waste material generated by households or by commercial, industrial and institutional facilities in their role as end-users of the products, which can no longer be used for its intended purpose. Pre-Consumer material is defined as material diverted from the waste stream during the manufacturing process. Excluded is reutilization of materials such as rework, re-grind or scrap generated in a process and capable of being reclaimed within the same process that generated it.

Recycled content shall be defined in accordance with the International Organization for Standardization document, ISO 14021 - Environmental labels and declarations-Self-declared environmental claims (Type II environmental labeling).

Actual product/material costs shall exclude labor and equipment costs associated with installation.

For MR Credits 4.1 and 4.2, list the following for each product/material specified in Divisions 2 through 10 that has recycled content:

Product No.: ________________________________________________________________
Manufacturer: ________________________________________________________________
Product Name/Model: __________________________________________________________
Product/Material Cost: _________________________________________________________
Post-Consumer Recycled Content Percentage (by weight): __________________________
Pre-Consumer Recycled Content Percentage (by weight): ___________________________
Recycled Content Information Source: ____________________________________________

Trade Contractor's signature and date:

_________________________  ________________________  __________________
Print Name  Print Company Name  Date

Manufacturer's signature and date:

_________________________  ________________________  __________________
Print Name  Print Company Name  Date
LEED SUBMITTAL FORM

MATERIALS & RESOURCES CREDITS 5.1 and 5.2

GENERAL

This Form is required as part of the submittal requirements and documentation procedures for compliance with certain U.S. Green Building Council’s (USGBC) Leadership in Energy and Environmental Design for New Construction and Major Renovations Version 2.2 (LEED-NC v2.2) prerequisites and credits needed for the Project to obtain LEED-NC v2.2 certification. For additional information, refer to Division 01 Specification Section "Sustainable Design Requirements."

MATERIALS & RESOURCES (MR) CREDITS 5.1 and 5.2

REGIONAL MATERIALS

Refer to the "Definitions" Article in this Section for further definitions and additional information. Regional materials are those that are extracted, harvested or recovered; as well as manufactured within 500 miles of the project site. If only a fraction of a product or material is extracted, harvested, recovered; as well as manufactured locally, then only that percentage (by weight) shall contribute to the regional value.

Definitions:

Percent Compliant: Percent of product that meets both extraction and manufacture criteria (% by weight).

Harvest Distance: Distance between Project and extraction/harvest/recovery site (miles).

Manufacturer Distance: Distance between Project and final manufacturing location (miles).

For MR Credits 5.1 and 5.2 list the following for each regional product/material specified in Divisions 2 through 10:

Product No.: ______________________________________________________________________

Manufacturer: _____________________________________________________________________

Product Name/Model: ________________________________________________________________

Total Product/Material Cost: _________________________________________________________

Percent Compliant: __________________________________________________________________

Harvest Distance: ___________________________________________________________________

Manufacturing Distance: ______________________________________________________________

Harvest/Manufacture Location Information Source:_________________________________________

Trade Contractor's signature and date:

Print Name ___________________________  Print Company Name ___________________________  Date ___________________________

Manufacturer's signature and date:

Print Name ___________________________  Print Company Name ___________________________  Date ___________________________
LEED SUBMITTAL FORM

MATERIALS and RESOURCES CREDIT 7

GENERAL

This Form is required as part of the submittal requirements and documentation procedures for compliance with certain U.S. Green Building Council's (USGBC) Leadership in Energy and Environmental Design for New Construction and Major Renovations Version 2.2 (LEED-NC v2.2) prerequisites and credits needed for the Project to obtain LEED-NC v2.2 certification. For additional information, refer to Division 01 Specification Section "Sustainable Design Requirements."

MATERIALS & RESOURCES (MR) CREDIT 7

CERTIFIED WOOD

Refer to Division 01 Specification Section "Sustainable Design Requirements" for further definitions and additional information. Certified wood are wood-based materials and products that are certified in accordance with the Forest Stewardship Council's Principles and Criteria.

For MR Credit 7 list the following for each wood product/material in Divisions 2 through 10 containing certified wood:

Product No.: ________________________________________________________________
Manufacturer: ______________________________________________________________
Product Name/Model: _________________________________________________________
Product/Material Cost: _______________________________________________________
Wood Component Percentage: _________________________________________________
FSC Certified Wood Percentage of Wood Component: _____________________________
Forest Stewardship Council (FSC) Chain-of-Custody Certificate Number: ____________

Trade Contractor's signature and date: __________________________________________
Print Name ___________________________  Print Company Name ___________________  Date __________

Manufacturer's signature and date: _____________________________________________
Print Name ___________________________  Print Company Name ___________________  Date __________
SECTION 01 91 13

GENERAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.01 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.

B. OPR and BoD documentation prepared by Owner and Architect contains requirements that apply to this Section.

1.02 SUMMARY

A. This Section includes general requirements that apply to implementation of commissioning without regard to systems, subsystems, and equipment being commissioned.

B. Related Sections include the following:

1. Division 01 Section "Commissioning of HVAC" for specific requirements for commissioning HVAC systems.

1.03 DEFINITIONS

A. BoD: Basis of Design.

B. CxA: Commissioning Authority.

C. OPR: Owner's Project Requirements.

D. Systems, Subsystems, and Equipment: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, and equipment.

E. TAB: Testing, Adjusting, and Balancing.

1.04 COMMISSIONING TEAM

A. Members Appointed by Contractor: Individuals, each having authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated actions. The commissioning team shall consist of, but not be limited to, representatives of Contractor, including Project superintendent and subcontractors, installers, suppliers, and specialists deemed appropriate by the CxA.

B. Members Appointed by Owner:

1. CxA: The designated person, company, or entity that plans, schedules, and coordinates the commissioning team to implement the commissioning process. Owner will engage the CxA under a separate contract.

2. Representatives of the facility user and operation and maintenance personnel.

3. Architect and engineering design professionals.

1.05 OWNER'S RESPONSIBILITIES

A. Provide the OPR documentation to the CxA and Contractor for use in developing the commissioning plan; systems manual; operation and maintenance training plan; and testing plans and checklists.

B. Assign operation and maintenance personnel and schedule them to participate in commissioning team activities including, but not limited to, the following:
1. Coordination meetings.
2. Training in operation and maintenance of systems, subsystems, and equipment.
3. Testing meetings.
4. Demonstration of operation of systems, subsystems, and equipment.

C. Provide utility services required for the commissioning process.

D. Provide the BoD documents, prepared by Architect and approved by Owner, to the CxA and Contractor for use in developing the commissioning plan, systems manual, and operation and maintenance training plan.

1.06 CONTRACTOR'S RESPONSIBILITIES

A. Provide utility services required for the commissioning process.

B. Contractor shall assign representatives with expertise and authority to act on behalf of the Contractor and schedule them to participate in and perform commissioning team activities including, but not limited to, the following:
   1. Participate in design- and construction-phase coordination meetings.
   2. Participate in maintenance orientation and inspection.
   3. Participate in operation and maintenance training sessions.
   4. Participate in final review at acceptance meeting.
   5. Certify that Work is complete and systems are operational according to the Contract Documents, including calibration of instrumentation and controls.
   6. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.
   7. Review and approve final commissioning documentation.

C. Subcontractors shall assign representatives with expertise and authority to act on behalf of subcontractors and schedule them to participate in and perform commissioning team activities including, but not limited to, the following:
   1. Participate in design- and construction-phase coordination meetings.
   2. Participate in maintenance orientation and inspection.
   3. Participate in procedures meeting for testing.
   4. Participate in final review at acceptance meeting.
   5. Provide schedule for operation and maintenance data submittals, equipment startup, and testing to CxA for incorporation into the commissioning plan. Update schedule on a weekly basis throughout the construction period.
   6. Provide information to the CxA for developing construction-phase commissioning plan.
   7. Participate in training sessions for Owner's operation and maintenance personnel.
   8. Provide updated Project Record Documents to the CxA as requested.
   9. Gather and submit operation and maintenance data for systems, subsystems, and equipment to the CxA, as specified in Division 01 Section "Operation and Maintenance Data."
   10. Provide technicians who are familiar with the construction and operation of installed systems and who shall develop specific test procedures and participate in testing of installed systems, subsystems, and equipment.

1.07 CxA'S RESPONSIBILITIES

A. Organize and lead the commissioning team.

B. Prepare a construction-phase commissioning plan. Collaborate with Contractor and with subcontractors to develop test and inspection procedures. Include design changes and scheduled commissioning activities coordinated with overall Project schedule. Identify
commissioning team member responsibilities, by name, firm, and trade specialty, for performance of each commissioning task.

C. Review and comment on submittals from Contractor for compliance with the OPR, BoD, Contract Documents, and construction-phase commissioning plan. Review and comment on performance expectations of systems and equipment and interfaces between systems relating to the OPR and BoD.

D. Convene commissioning team meetings for the purpose of coordination, communication, and conflict resolution; discuss progress of the commissioning processes. Responsibilities include arranging for facilities, preparing agenda and attendance lists, and notifying participants. The CxA shall prepare and distribute minutes to commissioning team members and attendees within five workdays of the commissioning meeting.

E. At the beginning of the construction phase, conduct an initial construction-phase coordination meeting for the purpose of reviewing the commissioning activities and establishing tentative schedules for operation and maintenance submittals; operation and maintenance training sessions; TAB Work; and Project completion.

F. Observe and inspect construction and report progress and deficiencies. In addition to compliance with the OPR, BoD, and Contract Documents, inspect systems and equipment installation for adequate accessibility for maintenance and component replacement or repair.

G. Prepare Project-specific test and inspection procedures and checklists.

H. Schedule, direct, witness, and document tests, inspections, and systems startup.

I. Compile test data, inspection reports, and certificates and include them in the systems manual and commissioning report.

J. Certify date of acceptance and startup for each item of equipment for start of warranty periods.

K. Review Project Record Documents for accuracy. Request revisions from Contractor to achieve accuracy. Project Record Documents requirements are specified in Division 01 Section "Project Record Documents."

L. Review and comment on operation and maintenance documentation and systems manual outline for compliance with the OPR, BoD, and Contract Documents. Operation and maintenance documentation requirements are specified in Division 01 Section "Operation and Maintenance Data."

M. Prepare operation and maintenance training program and provide qualified instructors to conduct operation and maintenance training. Operation and maintenance training is specified in Division 01 Section "Demonstration and Training."

N. Prepare commissioning reports.

O. Assemble the final commissioning documentation, including the commissioning report and Project Record Documents.

1.08 COMMISSIONING DOCUMENTATION

A. Index of Commissioning Documents: CxA shall prepare an index to include storage location of each document.

B. OPR: A written document, prepared by Owner, that details the functional requirements of Project and expectations of how it will be used and operated. This document includes Project and design goals, measurable performance criteria, budgets, schedules, success criteria, and supporting information.
C. BoD Document: A document, prepared by Architect, that records concepts, calculations, decisions, and product selections used to meet the OPR and to satisfy applicable regulatory requirements, standards, and guidelines. The document includes both narrative descriptions and lists of individual items that support the design process.

D. Commissioning Plan: A document, prepared by CxA, that outlines the schedule, allocation of resources, and documentation requirements of the commissioning process, and shall include, but is not limited to the following:
1. Plan for delivery and review of submittals, systems manuals, and other documents and reports. Identification of the relationship of these documents to other functions and a detailed description of submittals that are required to support the commissioning processes. Submittal dates shall include the latest date approved submittals must be received without adversely affecting commissioning plan.
2. Description of the organization, layout, and content of commissioning documentation (including systems manual) and a detailed description of documents to be provided along with identification of responsible parties.
3. Identification of systems and equipment to be commissioned.
4. Description of schedules for testing procedures along with identification of parties involved in performing and verifying tests.
5. Identification of items that must be completed before the next operation can proceed.
6. Description of responsibilities of commissioning team members.
7. Description of observations to be made.
8. Description of requirements for operation and maintenance training, including required training materials.
9. Description of expected performance for systems, subsystems, equipment, and controls.
10. Schedule for commissioning activities with specific dates coordinated with overall construction schedule.
11. Identification of installed systems, subsystems, and equipment, including design changes that occurred during the construction phase.
13. Process and schedule for completing prestart and startup checklists for systems, subsystems, and equipment to be verified and tested.
14. Step-by-step procedures for testing systems, subsystems, and equipment with descriptions for methods of verifying relevant data, recording the results obtained, and listing parties involved in performing and verifying tests.

E. Test Checklists: CxA shall develop test checklists for each system, subsystem, or equipment including interfaces and interlocks, and include a separate entry, with space for comments, for each item to be tested. Prepare separate checklists for each mode of operation and provide space to indicate whether the mode under test responded as required. Provide space for testing personnel to sign off on each checklist. Specific checklist content requirements are specified in Division 01 Section "Commissioning of HVAC." Each checklist, regardless of system, subsystem, or equipment being tested, shall include, but not be limited to, the following:
1. Name and identification code of tested item.
2. Test number.
3. Time and date of test.
4. Indication of whether the record is for a first test or retest following correction of a problem or issue.
5. Dated signatures of the person performing test and of the witness, if applicable.
6. Individuals present for test.
7. Deficiencies.
8. Issue number, if any, generated as the result of test.
F. Certificate of Readiness: Certificate of Readiness shall be signed by Contractor, Subcontractor(s), Installer(s), and CxA certifying that systems, subsystems, equipment, and associated controls are ready for testing. Completed test checklists signed by the responsible parties shall accompany this certificate.

G. Test and Inspection Reports: CxA shall record test data, observations, and measurements on test checklists. Photographs, forms, and other means appropriate for the application shall be included with data. CxA shall compile test and inspection reports and test and inspection certificates and include them in systems manual and commissioning report.

H. Corrective Action Documents: CxA shall document corrective action taken for systems and equipment that fail tests. Include required modifications to systems and equipment and revisions to test procedures, if any. Retest systems and equipment requiring corrective action and document retest results.

I. Issues Log: CxA shall prepare and maintain an issues log that describes design, installation, and performance issues that are at variance with the OPR, BoD, and Contract Documents. Identify and track issues as they are encountered, documenting the status of unresolved and resolved issues.
   1. Creating an Issues Log Entry:
      a. Identify the issue with unique numeric or alphanumeric identifier by which the issue may be tracked.
   2. Assign a descriptive title of the issue.
      a. Identify date and time of the issue.
      b. Identify test number of test being performed at the time of the observation, if applicable, for cross-reference.
      c. Identify system, subsystem, and equipment to which the issue applies.
      d. Identify location of system, subsystem, and equipment.
      e. Include information that may be helpful in diagnosing or evaluating the issue.
      f. Note recommended corrective action.
      g. Identify commissioning team member responsible for corrective action.
      h. Identify expected date of correction.
      i. Identify person documenting the issue.
   3. Documenting Issue Resolution:
      a. Log date correction is completed or the issue is resolved.
      b. Describe corrective action or resolution taken. Include description of diagnostic steps taken to determine root cause of the issue, if any.
         1) Identify changes to the OPR, BoD, or Contract Documents that may require action.
         2) State that correction was completed and system, subsystem, and equipment is ready for retest, if applicable.
         3) Identify person(s) who corrected or resolved the issue.
         4) Identify person(s) documenting the issue.

J. Issues Log Report: On a periodic basis, but not less than for each commissioning team meeting, CxA shall prepare a written narrative for review of outstanding issues and a status update of the issues log. As a minimum, CxA shall include the following information in the issues log and expand it in the narrative:
   1. Issue number and title.
   2. Date of the identification of the issue.
   3. Name of the commissioning team member assigned responsibility for resolution.
   4. Expected date of correction.

K. Commissioning Report: CxA shall document results of the commissioning process including unresolved issues and performance of systems, subsystems, and equipment.
The commissioning report shall indicate whether systems, subsystems, and equipment have been completed and are performing according to the OPR, BoD, and Contract Documents. The commissioning report shall include, but is not limited to, the following:

1. Lists and explanations of substitutions; compromises; variances in the OPR, BoD, and Contract Documents; record of conditions; and, if appropriate, recommendations for resolution. This report shall be used to evaluate systems, subsystems, and equipment and shall serve as a future reference document during Owner occupancy and operation. It shall describe components and performance that exceed requirements of the OPR, BoD, and Contract Documents and those that do not meet requirements of the OPR, BoD, and Contract Documents. It may also include a recommendation for accepting or rejecting systems, subsystems, and equipment.

2. OPR and BoD documentation.

3. Commissioning plan.

4. Testing plans and reports.

5. Corrective modification documentation.

6. Issues log.

7. Completed test checklists.

8. Listing of off-season test(s) not performed and a schedule for their completion.

L. Systems Manual: CxA shall gather required information and compile systems manual. Systems manual shall include, but is not limited to, the following:

1. OPR and BoD, including system narratives, schematics, and changes made throughout the Project.

2. Project Record Documents as specified in Division 01 Section "Project Record Documents."

3. Final commissioning plan.


5. Operation and maintenance data as specified in Division 01 Section "Operation and Maintenance Data."

1.09 SUBMITTALS

A. Commissioning Plan Prefinal Submittal: CxA shall submit two hard copies of prefinal commissioning plan to Contractor, to Owner, and to Architect. Present submittal in sufficient detail to evaluate data collection and arrangement process. One copy, with review comments, will be returned to the CxA for preparation of the final construction-phase commissioning plan.

B. Commissioning Plan Final Submittal: CxA shall submit two hard copies and two sets of electronically formatted information of final commissioning plan. Deliver one hard copy and one set of discs to Owner, and one copy to Architect. The final submittal must address previous review comments. The final submittal shall include a copy of the prefinal submittal review comments along with a response to each item.

C. Test Checklists and Report Forms: CxA shall submit sample checklists and forms to Contractor quality-control manager and subcontractors for review and comment. Submit two copies of each checklist and report form.

D. Certificates of Readiness: CxA shall submit Certificates of Readiness.

E. Test and Inspection Reports: CxA shall submit test and inspection reports.

F. Corrective Action Documents: CxA shall submit corrective action documents.

1.10 QUALITY ASSURANCE

A. Instructor Qualifications: Factory-authorized service representatives, experienced in training, operation, and maintenance procedures for installed systems, subsystems, and equipment.
B. Test Equipment Calibration: Comply with test equipment manufacturer's calibration procedures and intervals. Recalibrate test instruments immediately whenever instruments have been repaired following damage or dropping. Affix calibration tags to test instruments. Instruments shall have been calibrated within six months prior to use.

1.11 COORDINATION

A. Coordinating Meetings: CxA shall conduct [weekly] [biweekly] [monthly] <Insert frequency> coordination meetings of the commissioning team to review progress on the commissioning plan, to discuss scheduling conflicts, and to discuss upcoming commissioning process activities.

B. Pretesting Meetings: CxA shall conduct pretest meetings of the commissioning team to review startup reports, pretest inspection results, testing procedures, testing personnel and instrumentation requirements, and manufacturers’ authorized service representative services for each system, subsystem, equipment, and component to be tested.

C. Testing Coordination: CxA shall coordinate sequence of testing activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
   1. Schedule times for tests, inspections, obtaining samples, and similar activities.

D. Manufacturers' Field Services: CxA shall coordinate services of manufacturers’ field services.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 OPERATION AND MAINTENANCE TRAINING REQUIREMENTS

A. Training Preparation Conference: Before operation and maintenance training, CxA shall convene a training preparation conference to include Owner's operation and maintenance personnel, Contractor, and subcontractors. In addition to requirements specified in Division 01 Section "Demonstration and Training," perform the following:
   1. Review the OPR and BoD.
   2. Review installed systems, subsystems, and equipment.
   3. Review instructor qualifications.
   4. Review instructional methods and procedures.
   5. Review training module outlines and contents.
   6. Review course materials (including operation and maintenance manuals).
   7. Inspect and discuss locations and other facilities required for instruction.
   8. Review and finalize training schedule and verify availability of educational materials, instructors, audiovisual equipment, and facilities needed to avoid delays.
   9. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

B. Training Modules: Develop an instruction program that includes individual training modules for each system, subsystem, and equipment as specified in Division 01 Section "Demonstration and Training."

END OF SECTION
SECTION 02 05 00

DEMOLITION

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included: Items of demolition and removal from site consisting of, but not necessarily limited to the following:
   1. Demolition of designated structures.
   2. Removal of foundations and floor slabs.
   5. Disconnection, capping, and identification of utilities.
   6. Final grade to elevations indicated or called for on the Drawings.

1.02 QUALITY ASSURANCE

A. CONTRACTOR’S Qualifications: Minimum of five (5) years experience on projects of similar size and cost.

1.03 SUBMITTALS

A. Submit demolition and removal procedures and schedule.

B. Submit record documents under provisions of Division 1 specifications.

1.04 JOB CONDITIONS

A. Protection:
   1. Conduct demolition to minimize interference with adjacent structure(s) and/or parking areas.
   2. Provide, erect, and maintain temporary barriers and security devices.
   3. Conduct operations with minimum interference to thoroughfares. Maintain egress and access at all times.
   4. Do not close or obstruct roadways or sidewalks without permission of OWNER.

B. The use of explosives is prohibited.

1.05 GUARANTEE

A. At completion of the Work and acceptance of the same by the OWNER, the CONTRACTOR shall issue his written guarantee covering the work performed under this section of the Specifications.

PART 2 - PRODUCTS

2.01 GENERAL

A. Materials and products used by the CONTRACTOR in the demolition process must be approved by the OWNER prior to use.
PART 3 - EXECUTION

3.01 PREPARATION

A. Prevent movement or settlement of adjacent structures, parking areas, etc. Provide shoring as required to provide safety to personnel and by governing authorities.

B. All shoring and bracing shall comply with the Special Conditions of the Specifications and local codes and authorities.

C. Provide protection for existing adjacent areas which are not to be demolished.

3.02 PERFORMANCE

A. Demolish and remove all items of demolition as indicated on the Drawings, in an orderly and careful manner. All metals, concrete, asphalt, and other debris materials shall be disposed of off-site and off of the OWNER’S property to a suitable disposal location in accordance with applicable disposal regulations.

B. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut length of existing pavement to remain in before removing existing pavement. Saw-cut faces vertically.

C. Keep work areas sprinkled with water to minimize dust. Provide trucks, hoses and water main or hydrant connections for this purpose.

D. As the Work progresses, remove demolished material from the Work site.

E. Maintain shoring and bracing in excavation during entire time excavations will be open.

F. Cease operations and immediately notify the OWNER if adjacent structures or areas appear to be endangered. Do not resume operations until corrective measures have been taken.

G. Where indicated on the Drawings or designated by the OWNER’S Construction Administrator, in a manner so as to prevent damage; remove, store, and protect all materials designated to be re-installed or retained.

H. Do not burn or bury materials on the work site.

I. Utilities:
   1. Disconnect, remove, and cap designated utility lines within demolition areas, as indicated on the Drawings, or as directed by the OWNER.
   2. Mark location of disconnected utilities. Identify utilities and indicate capping locations on the Record Documents.

J. Backfill areas excavated, open pits and holes resulting from the demolition operations. Comply with the requirements of Section 02 30 00.

K. Rough grade and compact areas affected by demolition so as to maintain site grades and contours.

L. Cover all openings in structures as directed by the OWNER.
M. Remove demolished materials from site and leave the Work site in a clean condition.

END OF SECTION 02 05 00
PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section specifies cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:
   1. Footings.
   2. Foundation walls.
   3. Slabs-on-grade.
   4. Concrete toppings.
   5. Building walls.

**ARCH**

B. Related Sections include the following:
   1. Division 03 Section "Concrete Topping" for emery- and iron-aggregate concrete floor toppings.
   2. Division 31 Section "Earth Moving" for drainage fill under slabs-on-grade.
   3. Division 31 Section Drilled Piers.

1.03 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.

1.04 SUBMITTALS

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

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. Submit substantiating data for each concrete mix design contemplated for use to the Architect/Engineer not less than four weeks prior to first concrete placement. Data for each mix shall, as a minimum, include the following:
      a. Mix identification designation (unique for each mix submitted).
      b. Statement of intended use for mix.
      c. Mixture proportions and descriptions.
      d. Wet and dry unit weight.
      e. Water/cementitious materials ratio.
      f. Total air content.
      g. Design slump.
      h. Intended method of placement in field.
C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. 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.
   1. Show all reinforcing, top and bottom profile of concrete element, supports below, and concrete walls, grade beams, joists, etc. framing into the element.
   2. Provide one continuous elevation at 1/4” scale for all beams, joists, or walls in a common line. Show pockets and openings in shear walls, structural slabs, beams, elevation at top of beams, walls, columns, sections through all beams, pilasters and columns, and placing sequence of reinforcing for items with more than one reinforcing layer.
   3. Show locations of approved construction joints, splices of reinforcing, type of splice used and splice location, grade of all reinforcement used and specifically identify all ASTM A706 and epoxy coated reinforcing.

D. Submit Data and installation instructions for void forms. Provide Manufacturer’s data on factory-made void pieces. Submit evidence void is of proper size and extent after concrete is placed. Submit evidence void form material has degraded as specified herein.

E. Samples: For waterstops and vapor retarder insert products.

F. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:
   1. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity. Submit test reports that no alkali reactivity is produced with the proposed aggregate-cement combinations when tested in accordance with ASTM C227.

G. Material Certificates: For each of the following, signed by manufacturers:
   1. Vapor retarders.

H. Floor surface flatness and levelness measurements to determine compliance with specified tolerances.

I. Minutes of preinstallation conference.

J. Placement notification: Advance notification of concrete placement, submit notification at least 24 hours in advance.

K. Proposed location of saw all construction joints and all proposed method statement to create secure joints without exceeding specified score depth cut joints

L. Proposed methods statement for creating polished and dyed exposed floors.

M. Curing compound data demonstrating specified moisture loss performance.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.

B. 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."

C. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.
   1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.
   2. 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.
   3. Concrete reinforcing steel shall be inspected by personnel experienced in concrete construction and acceptable to the Architect/Engineer. Personnel currently certified as an ACI Concrete Construction Inspector will be accepted.

D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from one source, and obtain admixtures through one source from a single manufacturer.

E. Welding: Qualify procedures and personnel according to AWS D1.4, "Structural Welding Code--Reinforcing Steel."

F. Formwork: Design and engineering of formwork shall be the responsibility of the Contractor. Design of formwork and preparation of formwork drawings shall be under the supervision of a professional engineer registered in the state of project.

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

H. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."
   1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
      a. Contractor's superintendent.
      b. Independent testing agency responsible for concrete design mixtures.
      c. Ready-mix concrete manufacturer.
      d. Concrete subcontractor.
      e. Owner's testing/inspection agency.

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2. 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, forms and form removal limitations, shoring, vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, floor and slab flatness and levelness measurement, trusses related to polished and dyed exposed concrete floors, concrete repair procedures, and concrete protection.
3. Minutes of the meeting shall be recorded, typed, and printed by the Contractor and distributed by him to all parties concerned within 5 days of the meeting. One copy of the minutes shall also be transmitted to the following for information purposes: Owner's Representative.

The minutes shall include a statement by the concrete contractor indicating that the proposed mix design, and placing, finishing and curing procedures can produce the concrete quality required by these specifications.

I. Record of Work: Maintain a record listing the time and date of placement of all concrete for the structure. Retain batch tickets for all concrete. Such record shall be kept until the completion of the project and shall be available to the Architect for examination at any time.

J. Pre-placement Inspection: Formwork installation, reinforcing steel placement, and installation of all items to be embedded or cast into concrete shall be verified by the Contractor prior to placement.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Avoid damaging coatings on steel reinforcement.

B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.

2.02 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
   1. Plywood, metal, or other approved panel materials.
   2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
      a. High-density overlay, Class 1 or better.
      b. Medium-density overlay, Class 1 or better; mill-release agent treated and edge sealed.
      c. Structural 1, B-B or better; mill oiled and edge sealed.
      d. B-B (Concrete Form), Class 1 or better; mill oiled and edge sealed.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

C. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that will produce surfaces with gradual or abrupt irregularities
not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.

D. Void Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads. Provide factory-made sections with curved, closed faces around drilled piers. Curved face radius shall match drilled pier radius. Stay-in-place void forms shall degrade within 3 months so the void form cannot impart upward load on the structure when the soil heaves.


F. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.

G. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

H. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
   1. Furnish units that will leave no corrodbale metal closer than 1-1/2 inch to the plane of exposed concrete surface.
   2. Furnish ties that, when removed, will leave holes no larger than 1 inch in diameter in concrete surface.
   3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

2.03 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

B. Low-Alloy-Steel Reinforcing Bars: where welding of reinforcement or field bending is noted on the drawings ASTM A 706/A 706M, deformed.

C. Epoxy-Coated Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed bars, ASTM A 775/A 775M or ASTM A 934/A 934M, epoxy coated, with less than 2 percent damaged coating in each 12-inch bar length.

D. Plain-Steel Welded Wire Reinforcement: ASTM A 185, plain, fabricated from as-drawn steel wire into flat sheets.

2.04 REINFORCEMENT ACCESSORIES

A. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A 775/A 775M.

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:
   1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.
2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.
3. For zinc-coated reinforcement, use galvanized wire or dielectric-polymer-coated wire bar supports.

2.05 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
1. Portland Cement: ASTM C 150, Type I/II, gray unless otherwise noted. Supplement with the following:
   a. Fly Ash: ASTM C 618, Class C or F.

B. Normal-Weight Aggregates: ASTM C 33, Class 3S coarse aggregate or better, graded. Provide aggregates from a single source with documented service record data of at least 10 years’ satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials.
1. Maximum Coarse-Aggregate Size: nominal. As noted on the drawings.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Water: ASTM C 94/C 94M.

2.06 ADMIXTURES


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.
7. Non-Chloride, Non-Corrosive Accelerating Admixture: The admixture shall conform to ASTM C494, Type C or E, and not contain more chloride ions than are present in municipal drinking water. The admixture manufacturer must have long-term non-corrosive test data from an independent testing laboratory (of at least a year’s duration) using an acceptable accelerated corrosion test method such as that using electrical potential measures.
8. Mid-range water reducing admixture shall be EUCON X15 or EUCON MR by The Euclid Chemical Company, DARACEM or Mira Series by W. R. Grace or POZZOLITH997 or Rheobuild 3000 by Master Builders and shall conform to ASTM C494 Type A.

2.07 FIBER REINFORCEMENT

A. Synthetic Fiber: Monofilament or fibrillated polypropylene fibers engineered and designed for use in concrete pavement, complying with ASTM C 1116, Type III, 1/2 to 1-1/2 inches long.
2.08 WATERSTOPs

**ARCH**

A. Flexible PVC Waterstops: CE CRD-C 572, with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.
   1. Profile: [Ribbed with center bulb.]
   2. Dimensions: [4 inches by 3/16 inch thick]; nontapered.

B. Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 by 1 inch.

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2.09 [VAPOR RETARDERS]

1. [Available Products:]
   a. [Fortifiber Corporation; Moistop Ultra A.]

2. [Available Products:]
   a. [Fortifiber Corporation; Moistop Ultra.]

3. [Available Products:]
   a. [Fortifiber Corporation; Moistop Plus.]

4. [Product: Meadows, W. R., Inc.; Premoulded Membrane Vapor Seal.]

2.10 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
   1. Available Products:
      a. Axim Concrete Technologies; Cimfilm.
      b. Burke by Edoco; BurkeFilm.
      c. ChemMasters; Spray-Film.
      d. Conspec Marketing & Manufacturing Co., Inc., a Dayton Superior Company; Aquafilm.
      e. Dayton Superior Corporation; Sure Film.
      f. Euclid Chemical Company (The); Eucobar.
      g. Kaufman Products, Inc.; Vapor Aid.
      h. Lambert Corporation; Lambco Skin.
      i. L&M Construction Chemicals, Inc.; E-Con.
      j. MBT Protection and Repair, Div. of ChemRex; Confilm.
      l. Metalcrete Industries; Waterhold.
      m. Nox-Crete Products Group, Kinsman Corporation; Monofilm.
      n. Sika Corporation, Inc.; SikaFilm.
      o. Symons Corporation, a Dayton Superior Company; Finishing Aid.
      p. Unitex; Pro-Film.
      q. US Mix Products Company; US Spec Monofilm ER.
      r. Vexcon Chemicals, Inc.; Certi-Vex EnvioAssist.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

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

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating. The film must chemically break down in a four to six week period. Provide data from an Independent Laboratory indicating a maximum moisture loss of 0.30 kg/m² at 72 hours when tested in accordance with ASTM C156.
   1. Available Products:
      a. [Anti-Hydro International, Inc.; AH Curing Compound #2 DR WB.]

F. Clear, Solvent-Borne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A. Have test data from an Independent Laboratory indicating a maximum moisture loss of 0.30 kg/m² at 72 hours when tested in accordance with ASTM C156.

G. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A. Have test data from an Independent Laboratory indicating a maximum moisture loss of 0.30 kg/m² at 72 hours when tested in accordance with ASTM C156.

2.11 RELATED MATERIALS


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B. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

C. Dovetail Anchor Slots: Hot-dip galvanized steel sheet, not less than 0.0336 inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

2.12 REPAIR MATERIALS

A. 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: Not less than 4100 psi at 28 days when tested according to ASTM C 109/C 109M.

B. Repair Overlayment: 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 topping 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 topping manufacturer.
4. Compressive Strength: Not less than 5000 psi at 28 days when tested according to ASTM C 109/C 109M.

2.13 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 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: 25 percent.

C. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 for reinforced concrete exposed to chlorides in service 0.30 for other reinforced concrete 1.00 for reinforced concrete that will be dry and protected from moisture in service percent by weight of cement.

D. Admixtures: Use admixtures according to manufacturer's written instructions.
   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.

E. Performance and Design Requirements
   1. Shrinkage: Shrinkage strain, determined and reported in accordance with ASTM C157 as amended and modified herein, shall not exceed the values below for each class of concrete listed.
      a. Amendments and Modifications to ASTM C157:
         1) Storage: After the initial 24-hour comparator reading, the specimens are placed back in the lime-saturated water until the age of 7 days. At this time another comparator reading is taken. This reading is used as the base reading, which is used to calculate percent shrinkage. The specimens are then stored in a 50% humidity room at 73 degrees.
         2) Test Reports: Report gage length (average of 3) after 4, 7, 14, 28, and 56 days. In addition to the information required by ASTM C157 Section 11, shrinkage test reports shall include the gage lengths (initial length measurements) used to determine the reported shrinkage strains.
      b. 28-day Shrinkage Strain: Shrinkage strains, determined as above after 28 days of storage, shall not exceed the following:
         1) Concrete for slabs-on-grade cast directly on a vapor retarder: 0.046%.
         2) Concrete for, walls: 0.054%.

2.14 CONCRETE MIXTURES FOR BUILDING ELEMENTS

A. Proportion structural normal weight concrete mixture as noted on the drawings.
2.15 FABRICATING REINFORCEMENT
   A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.16 CONCRETE MIXING
   A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to
      ASTM C 94/C 94M and ASTM C 1116, and furnish batch ticket information.

PART 3 - EXECUTION

3.01 FORMWORK
   A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support
      vertical, lateral, static, and dynamic loads, and construction loads that might be applied,
      until structure can support such loads.

   B. Construct formwork so concrete members and structures are of size, shape, alignment,
      elevation, and position indicated, within tolerance limits of ACI 117. Concrete adjacent to
      elevators shall be installed within the tolerances required by the elevator manufacturer.

   C. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as
      follows:
      1. Class B, 1/4 inch for smooth-formed finished surfaces.
      2. Class C, 1/2 inch for rough-formed finished surfaces.
      3. The permissible irregularity is a cumulative value due to all sources of error
         including, but not limited to, layout, plumbness, member sizes, formwork offsets,
         joints, and member levelness. The permissible irregularity shall also apply
         between adjacent concrete surfaces on opposite sides of a construction joint.

   D. Construct forms tight enough to prevent loss of concrete mortar.

   E. Fabricate forms for easy removal without hammering or prying against concrete surfaces.
      Provide crush or wrecking plates where stripping may damage cast concrete surfaces.
      Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
      1. Install keyways, reglets, recesses, and the like, for easy removal.
      2. Do not use rust-stained steel form-facing material.

   F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required
      elevations and slopes in finished concrete surfaces. Provide and secure units to support
      screed strips; use strike-off templates or compacting-type screeds.

   G. Provide temporary openings for cleanouts and inspection ports where interior area of
      formwork is inaccessible. Close openings with panels tightly fitted to forms and securely
      braced to prevent loss of concrete mortar. Locate temporary openings in forms at
      inconspicuous locations.

   H. Chamfer exterior corners and edges of permanently exposed concrete.

   I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and
      bulkheads required in the Work. Determine sizes and locations from trades providing
      such items.

   J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust,
      dirt, and other debris just before placing concrete.
K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

M. Protect void form materials from moisture at all times before concrete placement.

N. All formwork surfaces that will provide the finish surface of exposed concrete must be accepted by the Architect before depositing concrete.

O. Void Spaces: Provide void spaces of full size and extent shown on the drawings. Specified void form may be used at the Contractor's option. Where void forms are used below structural slabs-on-grade or for support of reinforcing, place 1/8-inch (minimum) thick masonite or plywood sheet on top of the void forms. Place in the largest pieces practical, secure in place and seal joints to prevent leakage of concrete into the void space. Seal joints between adjacent pieces of void form and between void form and drilled piers. Prevent concrete from entering void space. Void form installation shall conform to Manufacturer's recommendations.

3.02 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" and with the following additional requirements:
   a. Tolerance of embedded items: Comply with ACI 117 and the following additional requirements:
      1) Anchor Bolts:
         a) Plumbness: Within + 1/16" over the projecting height of the anchor bolt.
      2) Embedded Plates and Weldment:
         a) Location: +/-1" vertical, +/- 1" horizontal.
         b) Plumb and alignment: 1/4" in 12".

2. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.

3. Install dovetail anchor slots in concrete structures. Where masonry wall or veneer abuts concrete, provide one vertical dovetail slot for each 8” of masonry thickness. Where concrete serves as backup, space slots at 16 inches on center.

3.03 REMOVING AND REUSING FORMS

A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete, if concrete is hard enough to not be damaged by form-removal operations and curing and protection operations are maintained.

B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.
C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

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3.04 VAPOR RETARDERS
1. [[Place and compact a 1/2-inch-thick layer of fine-graded granular material over granular fill.]]

3.05 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder 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. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain concrete cover. Do not tack weld crossing reinforcing bars.

D. Size, length, number, and placing of supports shall be sufficient to hold reinforcing in the proper position within specified tolerances during construction traffic and concrete placement.

E. On vertical formwork, use approved bar chairs or spacers as required to maintain proper concrete cover and bar position. Do not staple or use any other metallic fastener to secure bolsters, chairs, etc. to formwork for concrete surfaces exposed to the exterior.
1. Weld reinforcing bars according to AWS D1.4, where indicated.

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

G. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least two mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

H. Epoxy-Coated Reinforcement: Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M. Use epoxy-coated steel wire ties to fasten epoxy-coated steel reinforcement.

3.06 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. Continue reinforcement across construction joints, unless otherwise indicated.
2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
3. 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.

4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.

5. Space vertical joints in walls as indicated. Locate joints beside pilasters integral with walls, near corners, and in concealed locations where possible, but locate at centerline of support or in middle third of span.

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 when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

3. Interior Slabs-on-Grade: Unless noted otherwise on the drawings, locate construction joints on column centerlines. Locate control joints where shown on the drawings. If not shown, provide control joints at column centerlines and at intervals not more than 10 feet each way.

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 or 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.

E. Joints in Slabs-on Metal Deck: Locate construction joints as noted on the drawings. For metal deck slabs with WWR, continue WWR through the construction joint and lap in the adjacent pour. For metal deck slabs without WWR provide #4x4'-0 at 12 inches on center staggered 1'-0 at construction joints. Do not provide control joints.

F. Topping Slabs Exposed to View: Locate control joints where shown on the drawings. If not shown, locate topping slab control joints at column centerlines, over girders, and at intervals not exceeding 10' each way.

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3.07 WATERSTOPS

A. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of the Work. Field fabricate joints in waterstops according to manufacturer's written instructions.

B. Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated, according to manufacturer's written instructions, adhesive bonding,
mechanically fastening, and firmly pressing into place. Install in longest lengths practicable.

3.08 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. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.
   1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

C. 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.

D. 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.

E. 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.

F. Hot-Weather Placement: Comply with ACI 301 and as follows:
   1. 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.

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3.09 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
   1. Apply to concrete surfaces not exposed to public view.

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
   1. Apply to concrete surfaces exposed to public view, to receive a rubbed finish, to be covered with a coating or covering material applied directly to concrete.

C. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

**ARCH**

3.10 FINISHING FLOORS AND SLABS

A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. 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 restraightening until surface is left with a uniform, smooth, granular texture.
   1. Apply float finish to surfaces indicated to receive trowel finish and to be covered with fluid-applied or sheet waterproofing, or membrane roofing.

C. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten 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 indicated and surfaces exposed to view or to be covered with resilient flooring, carpet, paint, or another thin-film-finish coating system and to floors that are to be polished and dyed.
   2. 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) 35; and of levelness, F(L) 25; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 17; for slabs-on-grade.
      b. Specified overall values of flatness, F(F) 30; with minimum local values of flatness, F(F) 24; for slabs on metal deck.
D. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces indicated and where ceramic or quarry tile is to be installed by either thickset or thin-set method. While concrete is still plastic, slightly scarify surface with a fine broom.
   1. Comply with flatness and levelness tolerances for trowel finished floor surfaces.

E. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, and 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.

3.11 MISCELLANEOUS CONCRETE ITEMS

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

D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel-finish concrete surfaces.

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3.12 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. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
   1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
a. Water.
b. Continuous water-fog spray.
c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape. Moisture-retaining cover shall be inspected each day by Contractor. Any areas which do not show condensation on the underside of the cover or any slab areas which are not wet shall be immediately rewetted and the cover reapplied to prevent moisture loss.

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

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period. Do not use without written permission of manufacture of products that are applied to the slab.

   a. 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.

4. 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. Recoat 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.

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.

C. 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 and that are unacceptable to the Architects. Allow Architect/Engineer to observe formed concrete surfaces immediately upon removal of forms and prior to repair of surface defects. Defects in structural concrete shall be brought to the attention of the Architect/Engineer. Repair tie holes and surface defects immediately after such observation. Where the concrete surface will be textured by sandblasting or bush-hammering, repair surface defects before texturing.

    1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension in solid concrete, but not less than 1 inch in
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depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.

2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.

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

D. 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. Submit proposed repair for acceptance prior to beginning this work.

1. Repair finished surfaces containing defects that are unacceptable to the Architect. 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. Submit proposed repair for acceptance prior to beginning this work.

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

7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to Architect's approval.
3.14 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Inspections:
1. Steel reinforcement placement embedments, and mechanical connectors.
2. Inspect reinforcing steel and embedments prior to placing concrete as follows:
   a. Inspect all reinforcing, verifying type of reinforcing, bar sizes, spacings, number of bars, concrete cover to bars, bar locations, splices including splice location and lap splice length or mechanical connector, in place condition of coated bars, and method of support of reinforcing.
   b. Inspect embedded bolts, plates, and steel shapes. Verify that size and number of bolts or anchors/rebar, embedment, anchorage, use of specified template and general embedment locations are as specified. Welds to embedments shall be tested as specified in Section 05 12 00.
   c. Welding of reinforcing steel, where permitted, shall be inspected as specified in Section 05 12 00.
   d. Inspect partially embedded reinforcement, which is field bent, or field straightened. Verify that procedures specified in ACI-301-99 Section 3.3.2.8 – “Field Bending or Straightening” are followed. Inspect all field bent bars not bent in accordance with ACI 301 using visual and magnetic particle methods after bending is complete.
   e. Test rebar anchored into hardened concrete as specified in Section 05120 for adhesive anchors.
3. Mechanical Connectors: Perform all special inspections as defined in the code approval report for mechanical connectors. As a minimum the following are required:
   a. Continuously observe the installation of the first two splices for each type of mechanical connector. Verify all aspects of installation are in accordance with Manufacturer’s instructions and code approval report.
   b. Visually inspect 100% of completed connections to verify installation is in accordance with Manufacturer’s instructions and ICC test report.
4. Steel reinforcement welding.
5. Headed bolts and studs.
6. Verification of use of required design mixture.
7. Concrete placement, including conveying and depositing. Inspect the first concrete placement of footings, drilled piers, stemwalls/gradebeams structural foundation walls, slab-on-grade, slab-on-metal floor deck, and slab-on-metal roof deck. Inspect each truck for correct mix design, addition of water to each truck and subsequent mixing, cleanliness of forms, concrete vibration, concrete finishing, and concrete curing.
8. Curing procedures and maintenance of curing temperature.
9. Verification of concrete strength before removal of shores and forms from beams and slabs.
10. Temperature of In-Place Concrete: Owner’s Testing Agency shall measure and report maximum/minimum temperature of in-place concrete during curing period when concreting in cold weather.

C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day. Obtain one sample for each 5000 square feet of shearwalls or slabs if this is less than the 100 cu. yd. Requirements.
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a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change. Determine slump of concrete for each truck (at beginning of load) prior to placing drilled piers.

3. Air Content: ASTM C 231, pressure method, for normal-weight concrete; one test for each composite sample at point of placement, but not less than one test for each day's pour of each concrete mixture.
   a. Where concrete will be exposed to deicing salts, air content tests will be made on samples from the first three batches in the placement and until three consecutive batches have air contents within the range specified, at which time every fifth batch will be tested. This test frequency will be maintained until a batch is not within the range specified, at which time testing of each batch will be resumed until three consecutive batches have air contents within the range specified. These air content tests may be taken on composite samples or on samples from the batch at any time after discharge of two cubic feet of concrete.

4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.

5. Unit Weight: One test for each composite sample, but not less than one test for each day's pour of each concrete mixture.

6. Compression Test Specimens: ASTM C 31/C 31M.
   a. Cast and laboratory cure four standard cylinder specimens for each composite sample.

7. Compressive-Strength Tests: ASTM C 39/C 39M; test one cylinder at 7 days and one set of two specimens at 28 days. Hold one cylinder and test at 56 days if 28-day strength is not achieved.
   a. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.

8. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

9. Test results shall be reported in writing to Architect, concrete manufacturer, Building Official and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests, concrete supplier & mix ID number. Also include amount of water added at site prior to sampling, ambient air temperature, and concrete wet unit weight. Include time concrete was batched and time when placement was finished.

10. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

11. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. Testing and inspecting agency may conduct tests to determine adequacy of
concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by Architect.

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

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

D. Measure floor and slab flatness and levelness according to ASTM E 1155 within 48 hours of finishing.

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. This Section includes polished concrete.
B. Related Sections include the following:
   1. Division 03 Section "Cast-in-Place Concrete."
   2. Division 07 Section "Joint Sealers."

1.03 SYSTEM DESCRIPTION
A. Performance Requirements: Provide polished flooring that has been selected, manufactured and installed to achieve the following:
   1. Abrasion Resistance: ASTM C779, Method A, high resistance, no more than 0.008 inch (0.20 mm) wear in 30 minutes.
   2. Reflectivity: Increase of 35 percent as determined by standard gloss meter.
   3. Waterproof Properties: Rilem Test Method 11.4, 70 percent or greater reduction in absorption.
B. Design Requirements:
   1. Hardened Concrete Properties:
      a. Minimum Concrete Compressive Strength: 3500 psi.
      b. Normal Weight Concrete: No lightweight aggregate.
      c. Non-air entrained.
   2. Placement Properties:
      a. Natural concrete slump of 4 1/2 inches - 5 inches. Admixtures may be used.
      b. Flatness Requirements:
         1) Overall FF 40.
         2) Local FF 20.
   3. Hard-Steel Troweled (3 passes) Concrete: No burn marks. Finish to ACI 302.1R, Class 5 floor.
   4. Curing Options:
      a. Membrane forming curing compounds (ASTM C309, Type 1, Class B, all resin, dissipating cure).
      b. Damp Curing: Seven day cure.

1.04 SUBMITTALS
A. Shop Drawings: Indicate information on shop drawings as follows:
   1. Typical layout including dimensions and floor grinding schedule.
   2. Plan view of floor and joint pattern layout.
B. Product Data: Submit product data for specified products.
   1. Preparation and concrete grinding procedures.
C. Operation and Maintenance Data: For inclusion in Operations and maintenance manuals: Submit operation and maintenance data for installed products in accordance with Division 01 Section "Closeout Submittals."

1. Manufacturer’s instructions on maintenance renewal of applied treatments.
2. Protocols and product specifications for joint filing, crack repair and/or surface repair.

1.05 QUALITY ASSURANCE

A. Qualifications:
1. Installer experienced in performing work of this section who has specialized in installation of work similar to that required for this project and who is acceptable to product manufacturer.
2. Manufacturer Qualifications: Manufacturer capable of providing field service representation during construction and approving application method.

B. Regulatory Requirements.
1. NFSI Test Method 101-A Phase Two Level High Traction Material.

C. Mockup:
1. Construct mockups in accordance with Division 01 Section "Quality Control."
2. Mockup Size: 100 s.f. sample panel at jobsite at location as directed under conditions similar to those which will exist during actual placement.
3. Mockup will be used to judge workmanship, concrete substrate preparation, operation of equipment, material application, color selection and shine.
4. Allow 7 days for inspection of mock-up before proceeding with work.
5. When accepted, mock-up will demonstrate minimum standard of quality required for this work. Remove mock-up and dispose of materials when no longer required and when directed by Architect.

D. Preinstallation Meetings: Conduct a preinstallation meeting to verify project requirements, manufacturer’s installation instructions and manufacturer’s warranty requirements. Review the following:
1. Environmental requirements.
2. Scheduling and phasing of work.
3. Coordinating with other work and personnel.
4. Protection of adjacent surfaces.
5. Surface preparation.
6. Repair of defects and defective work prior to installation.
7. Cleaning.
8. Installation of polished floor finishes.

1.06 DELIVERY, STORAGE & HANDLING

A. Deliver materials in manufacturer’s original packaging with identification labels and seals intact.

B. Storage and Protection:
1. Store materials protected from exposure to harmful weather conditions and at temperature conditions recommended by manufacturer.
2. Protect concrete slab.

C. Waste Management and Disposal:
1. Separate waste materials for reuse and recycling in accordance with Division 01 Section "Construction Waste Management and Disposal."
2. Remove from site and dispose of packaging materials at appropriate recycling facilities.
1.07 PROJECT CONDITIONS
   A. Comply with manufacturer’s instructions for substrate temperature and moisture content, ambient temperature and humidity, ventilation, and other conditions affecting topping performance.
   B. Close areas to traffic during and after floor application for time period recommended by manufacturer.

1.08 WARRANTY
   A. Manufacturer’s Warranty: Provide manufacturer’s standard warranty document executed by authorized company official. Manufacturer’s warranty is in addition to, and does not limit, other rights Owner may have under Contract Documents.

PART 2 - PRODUCTS

2.01 MANUFACTURERS
   A. Polished Concrete Finishing Products
      1. Advanced Floor Products.
      2. Bomanite Corporation.
      3. L & M Construction Chemicals, Inc.

2.02 PRODUCTS/SYSTEMS
   A. Hardener, Sealer, Densifier: Proprietary, water based, odorless liquid, VOC compliant, environmentally safe chemical hardening solution leaving no surface film.
   B. Joint Filler: Semi-rigid, 2-component, self-leveling, 100% solids, rapid curing, polyurea control joint and crack filler with Shore A 80 or higher hardness.
   C. Oil Repellent Sealer: Ready to use, silane, siloxane and fluoropolymers blended water based solution sealer, quick drying, low-odor, oil and water repellent, VOC compliant and compatible with chemically hardened floors.
   D. Cleaning Solution: Proprietary, mild, highly concentrated liquid concrete cleaner and conditioner containing wetting and emulsifying agents; biodegradable, environmentally safe and certified High Traction by National Floor Safety Institute (NFSI).
   E. Finish: Standard, or optional Medium gloss (MG-2), 800 grit.

PART 3 - EXECUTION

3.01 EXAMINATION
   A. Verify that concrete substrate conditions, which have been previously installed under other sections or contracts, are acceptable for product installation in accordance with manufacturer’s instructions prior to installation of concrete finishing materials.
   B. Verify Concrete Slab Performance Requirements:
      1. Verify concrete is cured to 28 day 3500 psi strength.
      2. Verify concrete surfaces received a hard steel-trowel finish (3 passes) during placement.

3.02 PREPARATION
   A. Ensure surfaces are clean and free of dirt and other foreign matter harmful to performance of concrete finishing materials.
   B. Examine surface to determine soundness of concrete for polishing.
C. Remove surface contamination.

3.03 MANUFACTURERS INSTRUCTIONS
A. Comply with manufacturer’s written data, including technical bulletins, and installation instructions.

3.04 INSTALLATION
A. Floor Surface Polishing and Treatment:
   1. Provide polished concrete floor treatment in entirety of slab indicated by drawings. Provide consistent finish in all contiguous areas.
   2. Apply floor finish prior to installation of fixtures and accessories.
   3. Diamond polish concrete floor surfaces with power disc machine recommended by floor finish manufacturer. Sequence with coarse to fine grit using dry method.
      a. Comply with manufacturer’s recommended polishing grits for each sequence to achieve desired finish level. Level of sheen shall match that of approved mock-up.
      b. Expose aggregate in concrete surface only as determined by approved mock-up.
      c. All concrete surfaces shall be as uniform in appearance as possible.
   4. Apply Hardener/Densifier as follows:
      a. First coat at 250 s.f./gal.
      b. Second coat at 350 s.f./gal.
      c. Follow manufacturer’s recommendations for drying time between successive coats.
   5. Remove defects and repolish defective areas.
   6. Finish edges of floor finish adjoining other materials in a clean and sharp manner.

3.05 ADJUSTMENTS
A. Polish to higher gloss those areas not meeting specified gloss levels per mock-up.
B. Fill joints flush to surface.

3.06 FINAL CLEANING
A. Mechanically scrub treated floors for seven days with soft to medium pads with approved cleaning solution.
B. Upon completion, remove surplus and excess materials, rubbish, tools and equipment.

3.07 PROTECTION
A. Protect installed product from damage during 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. This Section includes unit masonry assemblies consisting of the following:
     1. Concrete masonry units (CMUs).
     2. Face brick.
     3. Cast stone trim units.
     4. Mortar and grout.
     5. Reinforcing steel.
     7. Ties and anchors.
     8. Embedded flashing.
     9. Miscellaneous masonry accessories.
  B. Related Sections include the following:
     1. Division 07 Section "Water Repellents" for water repellents applied to unit masonry assemblies.
     2. Division 07 Section "Sheet Metal Flashing and Trim" for exposed sheet metal flashing.
     3. Division 07 Section "Penetration Firestopping" for firestopping at openings in masonry walls.
     4. Division 07 Section "Joint Sealants" for sealing control and expansion joints in unit masonry.
  C. Products furnished, but not installed, under this Section include the following:
     1. Anchor sections of adjustable masonry anchors for connecting to structural frame, installed under Division 05 Section "Structural Steel Framing."
  D. Products installed, but not furnished, under this Section include the following:
     1. Steel lintels and shelf angles for unit masonry, furnished under Division 05 Section "Metal Fabrications."
     2. Manufactured reglets in masonry joints for metal flashing, furnished under Division 07 Section "Sheet Metal Flashing and Trim."

1.03 DEFINITIONS
  A. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.04 PERFORMANCE REQUIREMENTS
  A. Provide structural unit masonry that develops indicated net-area compressive strengths \( f'_{m} \) at 28 days.
  B. Determine net-area compressive strength \( f'_{m} \) of masonry by testing masonry prisms according to ASTM C 1314.
1.05 SUBMITTALS

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

B. Shop Drawings: For the following:
   1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
   2. Stone Trim Units: Show sizes, profiles, and locations of each stone trim unit required.
   3. 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.
   4. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.

C. Samples: For each type and color of the following:
   1. Face brick, in the form of straps of five or more bricks.
   2. Special brick shapes.
   3. Pigmented mortar. Make Samples using same sand and mortar ingredients to be used on Project. Label Samples to indicate types and amounts of pigments used.
   4. Stone trim: 3 range samples, 12 by 12 by 1 inch.
   5. Accessories embedded in masonry: Submit samples of masonry veneer anchors with fasteners, dimensions, and finishes to be used.

D. LEED Submittals:
   1. Credit MR 4.1 and MR 4.2: Product Data indicating percentages by weight of postconsumer and preconsumer recycled content for products having recycled content.
      a. Include statement indicating costs for each product having recycled content.
   2. Credits MR 5.1 and 5.2: Regionally Extracted, Harvested, or Recovered and Manufactured Materials:
      a. Indicate location of manufacturing facility, including name, address, and distance between manufacturing facility and the project site. Provide manufacturer’s documentation indicating location where the base materials were extracted, mined, quarried, harvested, etc., and the distance between this location and the project site. Also include material costs, excluding cost of installation.

E. Material Certificates: Include statements of material properties indicating compliance with requirements including compliance with standards and type designations within standards. Provide for each type and size of the following:
   1. Masonry units.
      a. For bricks, include size-variation data verifying that actual range of sizes falls within specified tolerances.
      b. For exposed brick, include material test report for efflorescence according to ASTM C 67.
      c. For masonry units used in structural masonry, include data and calculations establishing average net-area compressive strength of units.
   2. Cementitious materials. Include brand, type, and name of manufacturer.
   3. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
   4. Reinforcing bars.
   5. Joint reinforcement.
   6. Anchors, ties, and metal accessories.

F. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
1. Include test reports, per ASTM C 780, for mortar mixes required to comply with property specification.

G. Cold-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with cold-weather requirements.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Minimum 5 years experience in masonry and successful completion of not less than 10 projects of size and complexity similar to this one.

B. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, through one source from a single manufacturer for each product required.

C. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from a single manufacturer for each cementitious component and from one source or producer for each aggregate.

D. Preconstruction Testing Service: Owner will engage a qualified independent testing agency to perform preconstruction testing indicated below. Payment for these services will be made by Owner. Retesting of materials that fail to meet specified requirements shall be done at Contractor's expense.
   1. Prism Test: For each type of construction required, per ASTM C 1314.

E. Fire-Resistance Ratings: Where indicated, provide materials and construction identical to those of assemblies with fire-resistance ratings determined per ASTM E 119 by a testing and inspecting agency, by equivalent concrete masonry thickness, or by other means, as acceptable to authorities having jurisdiction.

F. Mockups: Build mockups as specified in Division 01 Section "Quality Requirements."
   1. Build mockup of typical wall area as shown on Drawings.
      a. Demonstrate the following characteristics:
         1) Color, range, texture of masonry units.
         2) Bond, color, mortar joints, tooling, control joints, special patterns.
         3) Anchors, joint reinforcement, wall ties.
         4) Vapor barrier, moisture barrier, flashing sheathing, studs, weep holes, and insulation.
         5) Surrounding materials such as stone trim, precast concrete, etc.
         6) Special component features for contiguous work such as sealant joints, corner pieces or other special shapes.
         7) Cleaning and water repellent coating.
   2. Retain subparagraph and associated subparagraphs below for limited mockups.
   3. Approval of mockups is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; and aesthetic qualities of workmanship. The approved mockup, after cleaning, will be used as the standard of workmanship required for masonry work.
      a. Approval of mockups is also for other material and construction qualities specifically approved by Architect in writing.
      b. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless such deviations are specifically approved by Architect in writing.
      c. Masonry work shall not commence until mockup is approved by Architect.

G. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."
1.07 DELIVERY, STORAGE, AND HANDLING
   A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.
   B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
   C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
   D. Deliver preblended, dry mortar mix in moisture-resistant containers designed for lifting and emptying into dispensing silo. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in a metal dispensing silo with weatherproof cover.
   E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.08 PROJECT CONDITIONS
   A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
      1. Extend cover a minimum of 24 inches down both sides and hold cover securely in place.
   B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least 3 days after building masonry walls or columns.
   C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
      1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
      2. Protect sills, ledges, and projections from mortar droppings.
      3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
      4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.
   D. 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.
      1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and above and will remain so until masonry has dried, but not less than 7 days after completing cleaning.

PART 2 - PRODUCTS
2.01 MASONRY UNITS, GENERAL
   A. Recycled Content: Materials/products shall contain the maximum amount of recycled content allowed that retains material integrity.
   B. Regionally Extracted, Harvested, or Recovered and Manufactured Materials:
1. Preference shall be given to suppliers whose facilities are within a 500 mile radius of the project site.
2. Preference shall also be given to materials that are harvested, extracted, mined, quarried, etc. within a 500 mile radius of the project site.

C. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to exceed tolerances and to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects, including dimensions that vary from specified dimensions by more than stated tolerances, will be exposed in the completed Work or will impair the quality of completed masonry.

2.02 CONCRETE MASONRY UNITS (CMUs)

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

B. Concrete Masonry Units: ASTM C 90.
   1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 1900 psi.
   2. Weight Classification: Lightweight, unless otherwise indicated.
   3. Size (Width): Manufactured to dimensions 3/8 inch less than nominal dimensions.
   4. Recycled Content: 5 percent of mixture, by weight, shall be 100 percent postindustrial fly ash.

2.03 MASONRY LINTELS

A. Prefabricated or built-in-place masonry lintels made from bond beam concrete masonry units with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

2.04 BRICK

A. General: Provide shapes indicated and as follows:
   1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
   2. Provide special shapes for applications where stretcher units cannot accommodate special conditions, including those at corners, movement joints, bond beams, sashes, and lintels.
   3. Provide special shapes for applications requiring brick of size, form, color, and texture on exposed surfaces that cannot be produced by sawing.
   4. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.

B. Face Brick: ASTM C 216, Grade SW, Type FBX.
   1. Initial Rate of Absorption: Less than 30 g/30 sq. in. per minute when tested per ASTM C 67.
   3. Application: Use where brick is exposed, unless otherwise indicated.
   4. Products: Interstate Brick
      a. Field Brick:
         1) Canyon Rose, wire-cut, 60 percent
         2) Park Rose, wire cut, 20 percent.
         3) Manhattan, wire-cut, 20 percent.
b. **Recessed Brick**: Interstate Brick:
   1) Canyon Rose, vertical scratch.

### 2.05 STONE TRIM UNITS

**A. Limestone**: ASTM C 568, Classification II Medium-Density.
1. **Variety and Sources**: Indiana oolitic limestone quarried in Lawrence, Monroe, or Owen Counties, Indiana.
   a. **Grade and Color**: [Select, buff] [Select, gray] [Standard, buff] [Standard, gray] [Rustic, buff] [Rustic, gray] [Variegated], according to grade and color classification established by ILI.

**B. Finish**: Smooth.
1. **Finish for Tops of Sills**: Sand rubbed.

**C. Provide stone units accurately shaped, with exposed faces dressed true, and with beds and joints at right angles to faces.**
1. For limestone, comply with recommendations in ILI's "Indiana Limestone Handbook."

### 2.06 MORTAR AND GROUT MATERIALS

**A. Portland Cement**: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

**B. Fly Ash**: ASTM C618, Class F or C.

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

**D. Portland Cement-Lime Mix**: Packaged blend of portland cement complying with ASTM C 150, Type I or Type III, and hydrated lime complying with ASTM C 207, Type S.

**E. Mortar Pigments**: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes. Use only pigments with a record of satisfactory performance in masonry mortar.
1. **Products**:
   b. Davis Colors; True Tone Mortar Colors.
   c. Solomon Grind-Chem Services, Inc.; SGS Mortar Colors.

**F. Aggregate for Mortar**: ASTM C 144.
1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
2. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.

**G. Aggregate for Grout**: ASTM C 404.
1. Provide size 1 for fine aggregate.
2. Provide size 8 or 89 for course aggregate.

**H. Cold-Weather Admixture**: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.
1. **Products**:
   a. Addiment Incorporated; Mortar Kick.
   b. Euclid Chemical Company (The); Accelguard 80.
   d. Sonneborn, Div. of ChemRex; Trimix-NCA.
I. Water: Potable.

2.07 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.
   1. Interior Walls: Hot-dip galvanized, carbon steel.
   2. Exterior Walls: Hot-dip galvanized, carbon steel.
   3. Wire Size for Side Rods: W1.7 or 0.148-inch diameter.
   4. Wire Size for Cross Rods: W1.7 or 0.148-inch diameter.
   5. Wire Size for Veneer Ties: W1.7 or 0.148-inch diameter.
   6. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.
   7. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units.

2.08 TIES AND ANCHORS

A. Materials: Provide ties and anchors specified in subsequent paragraphs that are made from materials that comply with subparagraphs below, unless otherwise indicated.
   2. Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, hot-dip galvanized after fabrication to comply with ASTM A 153/A 153M.
   3. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Wire Ties, General: Unless otherwise indicated, size wire ties to extend at least halfway through veneer but with at least 5/8-inch cover on outside face. Outer ends of wires are bent 90 degrees and extend 2 inches parallel to face of veneer.

C. Individual Wire Ties: Rectangular units with closed ends and not less than 4 inches wide.
   1. Wire: Fabricate from 1/4-inch-diameter, hot-dip galvanized steel wire. Mill-galvanized wire ties may be used in interior walls, unless otherwise indicated.

D. Adjustable Anchors for Connecting to Structure: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
   1. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch-diameter, hot-dip galvanized steel wire. Mill-galvanized wire may be used at interior walls, unless otherwise indicated.
   2. Tie Section: Triangular-shaped wire tie, sized to extend within 1 inch of masonry face, made from 0.25-inch-diameter, hot-dip galvanized steel wire. Mill-galvanized wire may be used at interior walls, unless otherwise indicated.
   3. Anchor Section for Concrete or CMU: Use Adjustable Masonry-Veneer Anchor specified below, except use fasteners designed for attachment to concrete.
   4. Connector Section for Concrete: Dovetail tabs for inserting into dovetail slots in concrete and attached to tie section; formed from 0.053-inch-thick, steel sheet, galvanized after fabrication. 0.064-inch-thick, galvanized sheet may be used at interior walls, unless otherwise indicated.

E. Adjustable Masonry-Veneer Anchors
   1. General: Provide anchors that allow vertical adjustment but resist tension and compression forces perpendicular to plane of wall, for attachment over sheathing to wood or metal studs, and as follows:
      a. Structural Performance Characteristics: Capable of withstanding a 100-lbf load in both tension and compression without deforming or developing play in excess of 0.05 inch.
2. Screw-Attached, Masonry-Veneer Anchors: Units consisting of a wire tie and a metal anchor section.
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) Dur-O-Wal, a Dayton Superior Company; D/A 210X with D/A 7000.
      2) Heckmann Building Products Inc.; Pos-I-Tie with 316.
      3) Hohmann & Barnard, Inc.; X-Seal.
      4) Wire-Bond; Type IIIx.
   b. Anchor Section: Sheet metal plate, 1-1/4 inches wide by 6 inches long, with screw holes top and bottom; top and bottom ends bent to form pronged legs of length to match thickness of insulation or sheathing; and raised rib-stiffened strap, 5/8 inch wide by 6 inches long, stamped into center to provide a slot between strap and plate for inserting wire tie.
   c. Anchor Section: Zinc-alloy barrel section with flanged head with eye and corrosion-resistant, self-drilling screw. Eye designed to receive wire tie and to serve as head for drilling fastener into framing. Barrel length to suit sheathing thickness, allowing screw to seat directly against framing with flanged head covering hole in sheathing.
   d. Fabricate sheet metal anchor sections and other sheet metal parts from 0.067-inch-thick, steel sheet, galvanized after fabrication.
   e. Wire Ties: Triangular-, rectangular-, or T-shaped wire ties fabricated from 0.25-inch-diameter, hot-dip galvanized steel wire.

3. Polymer-Coated, Steel Drill Screws for Steel Studs: ASTM C 954 except manufactured with hex washer head and neoprene washer, No. 10 diameter by length required to penetrate steel stud flange with not less than 3 exposed threads, and with organic polymer coating with salt-spray resistance to red rust of more than 800 hours per ASTM B 117.
   a. Products:
      1) ITW Buildex; Teks Maxiseal with Climaseal finish.
      2) Textron Inc., Textron Fastening Systems; Elco Dril-Flex with Stalgard finish.

2.09 MISCELLANEOUS ANCHORS
A. Dovetail Slots in Concrete: Furnish dovetail slots with filler strips, of slot size indicated, fabricated from 0.034-inch, galvanized steel sheet.
B. Anchor Bolts: Headed steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153/A 153M, Class C; of dimensions indicated.

2.10 EMBEDDED FLASHING MATERIALS
A. Flexible Flashing: For flashing not exposed to the exterior, use[ one of] the following, unless otherwise indicated:
   1. Elastomeric Thermoplastic Flashing: Composite flashing product consisting of a polyester-reinforced ethylene interpolymer alloy as follows:
      a. Monolithic Sheet: Elastomeric thermoplastic flashing, 0.040 inch thick.
      b. Self-Adhesive Sheet: Elastomeric thermoplastic flashing, 0.025 inch thick, with a 0.015-inch-thick coating of rubberized-asphalt adhesive.
      c. Accessories: Provide preformed corners, end dams, other special shapes, and seaming materials produced by flashing manufacturer.
      d. Products:
         1) Hyload, Inc.; Hyload Cloaked Flashing System.
B. 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.

2.11 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene urethane or PVC.

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

C. Weep Products: Use the following, unless otherwise indicated:
   1. Wicking Material: Absorbent rope, made from cotton or UV-resistant synthetic fiber, 1/4 to 3/8 inch in diameter, in length required to produce 2-inch exposure on exterior and 18 inches in cavity between wythes. Use only for weeps.

D. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.
   1. Provide one of the following configurations:
      a. Strips, full-depth of cavity and 10 inches wide, with dovetail shaped notches 7 inches deep that prevent mesh from being clogged with mortar droppings.
      b. Strips, not less than 1-1/2 inches thick and 10 inches wide, with dimpled surface designed to catch mortar droppings and prevent weep holes from being clogged with mortar.

   2. Products:
      a. Advanced Building Products Inc.; Mortar Break II.
      b. Archovations, Inc.; CavClear Masonry Mat.
      c. Dayton Superior Corporation, Dur-O-Wal Division; Polytite MortarStop.
      d. Mortar Net USA, Ltd.; Mortar Net.

2.12 CAVITY-WALL INSULATION

A. As specified in Division 07 Section "Thermal Insulation."

2.13 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:
      a. Diedrich Technologies, Inc.
      b. EaCo Chem, Inc.
      c. ProSoCo, Inc.

2.14 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. 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 or needed to provide required compressive strength of masonry.
1. For masonry below grade or in contact with earth, use Type N.
2. For reinforced masonry, use Type N.
3. 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.
4. For interior non-load-bearing partitions, Type O may be used instead of Type N.

D. Pigmented Mortar: Use colored cement product or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products.
1. Pigments shall not exceed 10 percent of portland cement by weight.
2. Mix to match Architect's sample.

E. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.
1. Color as selected by Architect.

F. 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.
a. Fly ash (Type F or C) in proportions not greater than 25 percent of the total cementitious materials may be used. Provide slump of 9 inches, +/- 1 inch. Minimum 28-day compressive strength of 2000 psi required.
b. Fine Grout: Proportion by volume. One part Portland cement, with not more than one-tenth part hydrated lime or lime putty added, and two and one-fourth to three parts sand.
c. Coarse Grout: Proportioned by volume. One part Portland cement with not more than one-tenth part hydrated lime or lime putty added, two to three parts sand and not more than two parts gravel.
2. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143/C 143M.

2.15 SOURCE QUALITY CONTROL
A. Owner will engage a qualified independent testing agency to perform source quality-control testing indicated below:
1. Payment for these services will be made by Owner.
2. Retesting of materials failing to comply with specified requirements shall be done at Contractor's expense.

B. Clay Masonry Unit Test: For each type of unit furnished, per ASTM C 67.

C. Concrete Masonry Unit Test: For each type of unit furnished, per ASTM C 140.

PART 3 - EXECUTION

3.01 EXAMINATION
A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
1. Verify that foundations are within tolerances specified.
2. Verify that reinforcing dowels are properly placed.

B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION, GENERAL

A. Thickness: Build cavity walls and other masonry construction to full thickness shown.

B. Build chases and recesses to accommodate items specified in this and other Sections.

C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.

D. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut 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.

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

    1. Mix units from several pallets or cubes as they are placed.

F. 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.

G. Comply with construction tolerances in ACI 530.1/ASCE 6/TMS 602 and with the following:

    1. 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, 1/4 inch in 20 feet, or 1/2 inch maximum.

    2. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet, or 1/2 inch maximum.

    3. 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, 1/4 inch in 20 feet, or 1/2 inch maximum.

    4. For exposed bed joints, do not vary from thickness indicated by more than plus or minus 1/16 inch, with a maximum thickness limited to 7/16 inch. Do not vary from bed-joint thickness of adjacent courses by more than 1/16 inch.

    5. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/16 inch. Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/16 inch.

    6. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch except due to warpage of masonry units within tolerances specified for warpage of units.

    7. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch from one masonry unit to the next.

3.03 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 and bond pattern indicated on Drawings; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

C. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, install units without cores or frogs and with exposed surfaces finished.

D. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.

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

F. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below and rod mortar or grout into core.

G. Fill cores in hollow concrete masonry units with grout 24 inches under bearing plates, beams, lintels, posts, and similar items, unless otherwise indicated.

H. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above, unless otherwise indicated.
   1. Leave clearance between top of partition and underside of structure above as shown on Drawings.
   2. Fasten partition top anchors to structure above as detailed.
   3. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Division 07 Section "Fire-Resistive Joint Systems."

3.04 MORTAR BEDDING AND JOINTING

A. Lay hollow brick and concrete masonry units 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 completely filled 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. Set cast-stone trim units in full bed of mortar with full vertical joints. Fill dowel, anchor, and similar holes.
   1. Clean soiled surfaces with fiber brush and soap powder and rinse thoroughly with clear water.
   2. Wet joint surfaces thoroughly before applying mortar.

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.

3.05 CAVITY WALLS

A. Bond wythes of cavity walls together using one of the following methods:
1. Individual Metal Ties: Provide ties as shown installed in horizontal joints, but not less than one metal tie for 2.67 sq. ft. of wall area spaced not to exceed 24 inches o.c. horizontally and 16 inches o.c. vertically. Stagger ties in alternate courses. Provide additional ties within 12 inches of openings and space not more than 36 inches apart around perimeter of openings. At intersecting and abutting walls, provide ties at no more than 24 inches o.c. vertically.
   a. Where bed joints of wythes do not align, use adjustable (two-piece) type ties.
   b. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable (two-piece) type ties to allow for differential movement regardless of whether bed joints align.

2. Masonry Joint Reinforcement: Installed in horizontal mortar joints for both veneer and non-veneer masonry.
   a. Where bed joints of both wythes align, use ladder-type reinforcement extending across both wythes or tab-type reinforcement.
   b. Where bed joints of wythes do not align, use adjustable (two-piece) type reinforcement.
   c. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable (two-piece) type reinforcement with continuous horizontal wire in facing wythe attached to ties to allow for differential movement regardless of whether bed joints align.


B. Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Do not attempt to trowel or remove mortar fins protruding into cavity.

C. Installing Cavity-Wall Insulation: Place small dabs of adhesive, spaced approximately 12 inches o.c. both ways, on inside face of insulation boards, or attach with plastic fasteners designed for this purpose. Fit courses of insulation between wall ties and other confining obstructions in cavity, with edges butted tightly both ways. Press units firmly against inside wythe of masonry or other construction as shown.
   1. Fill cracks and open gaps in insulation with spray foam insulation specified in Division 07 Section "Therman Insulation."

3.06 MASONRY JOINT REINFORCEMENT

A. General:
   1. Install in both veneer and non-veneer masonry.
   2. Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.
      a. Space reinforcement not more than 16 inches o.c.
      b. Space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.
      c. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings.
         1) Reinforcement above is in addition to continuous reinforcement.

B. Interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

E. Cut and bend reinforcing units as directed by manufacturer for continuity at corners, returns, offsets, column fireproofing, pipe enclosures, and other special conditions.
3.07 ANCHORING MASONRY TO STRUCTURAL MEMBERS

A. Anchor masonry to structural members where masonry abuts or faces structural members to comply with the following:
   1. Provide an open space not less than 1 inch in width between masonry and structural member, unless otherwise indicated. Keep open space free of mortar and other rigid materials.
   2. Anchor masonry to structural members with anchors embedded in masonry joints and attached to structure.
   3. Space anchors as indicated, but not more than 24 inches o.c. vertically and 16 inches o.c. horizontally.

3.08 ANCHORING MASONRY VENEERS

A. Anchor masonry veneers to wall framing with masonry-veneer anchors to comply with the following requirements:
   1. Fasten screw-attached anchors through sheathing to wall framing with metal fasteners of type indicated. Use two fasteners unless anchor design only uses one fastener.
   2. Insert slip-in anchors in metal studs as sheathing is installed. Provide one anchor at each stud in each horizontal joint between sheathing boards.
   3. Embed tie sections in masonry joints. Provide air space between back of masonry veneer and face of insulation to be not less than that shown on Drawings.
   4. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
   5. Space anchors as indicated, but not more than 18 inches o.c. vertically and 24 inches o.c. horizontally, with not less than 1 anchor for each 2 sq. ft. of wall area. Install additional anchors within 12 inches of openings and at intervals, not exceeding 8 inches, around perimeter.

3.09 CONTROL AND EXPANSION JOINTS

A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.

B. Form control joints in concrete masonry using one of the following methods:
   1. Fit bond-breaker strips into hollow contour in ends of concrete masonry units on one side of control joint. Fill resultant core with grout and rake out joints in exposed faces for application of sealant.
   2. Install preformed control-joint gaskets designed to fit standard sash block.
   3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar or rake out joint for application of sealant.
   4. Install temporary foam-plastic filler in head joints and remove filler when unit masonry is complete for application of sealant.

C. Form expansion joints in brick as follows:
   1. Build in compressible joint fillers where indicated.

D. Provide horizontal, pressure-relieving joints by either leaving an air space or inserting a compressible filler of width required for installing sealant and backer rod specified in Division 07 Section "Joint Sealants," but not less than 3/8 inch.
   1. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry.
3.10 LINTELS
A. Install steel lintels where indicated.
B. Provide masonry lintels where shown and where openings of more than 12 inches for brick-size units and 24 inches for block-size units are shown without structural steel or other supporting lintels.
C. Provide minimum bearing of 8 inches at each jamb, unless otherwise indicated.

3.11 FLASHING, WEEP HOLES, CAVITY DRAINAGE, AND VENTS
A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated. Install vents at tops of walls, and shelf angles, ledges, and other obstructions to upward flow of air in cavities, and where indicated.
B. Install flashing as follows, unless otherwise indicated:
   1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
   2. At multiwythe masonry walls, including cavity walls, extend flashing through outer wythe, turned up a minimum of 8 inches, and through inner wythe to within 1/2 inch of the interior face of wall in exposed masonry. Where interior face of wall is to receive furring or framing, carry flashing completely through inner wythe and turn flashing up approximately 2 inches on interior face.
   3. At masonry-veneer walls, extend flashing through veneer, across air space behind veneer, and up face of sheathing at least 8 inches; with upper edge tuck under building paper or building wrap, lapping at least 4 inches.
   4. At lintels and shelf angles, extend flashing a minimum of 6 inches into masonry at each end. At heads and sills, extend flashing 6 inches at ends and turn up not less than 2 inches to form end dams.
   5. Cut flexible flashing off flush with face of wall after masonry wall construction is completed.
C. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.
D. Install weep holes in head joints in exterior wythes of first course of masonry immediately above embedded flashing and as follows:
   1. Use specified weep/vent products to form weep holes.
   2. Use weep/vent material to form weep holes above flashing and at the top of brick veneer walls to form vents.
   3. Space weep holes 24 inches o.c., unless otherwise indicated.
E. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in Part 2 "Miscellaneous Masonry Accessories" Article.

3.12 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 temporary 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.

3.13 FIELD QUALITY CONTROL

A. Inspectors: Owner will engage qualified independent inspectors to perform inspections and prepare reports. Allow inspectors access to scaffolding and work areas, as needed to perform inspections.
   1. Place grout only after inspectors have verified compliance of grout spaces and grades, sizes, and locations of reinforcement.

B. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections indicated below and prepare test reports:
   1. Payment for these services will be made by Owner.
   2. Retesting of materials failing to comply with specified requirements shall be done at Contractor's expense.

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

D. Clay Masonry Unit Test: For each type of unit provided, per ASTM C 67.

E. Concrete Masonry Unit Test: For each type of unit provided, per ASTM C 140.

F. Grout Test (Compressive Strength): For each mix provided, per ASTM C 1019.

G. Prism Test: For each type of construction provided, per ASTM C 1314 at 7 days and 2 at 28 days. Make and test 3 grouted and 3 non-grouted prisms.

H. Veneer Anchor attached to Steel Stud Backup: Test 3 anchors to 200 pounds. Record load and slip in tension and compression.

I. Veneer Anchor attached to Concrete Backup: Test 3 anchors to 200 pounds. Record load and slip in tension and compression.

3.14 REPAIRING, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

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

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
   1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.

3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.

4. 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.

3.15 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

B. 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. Crush masonry waste to less than 4 inches in each dimension.
2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. Fill material is specified in Division 31 Section "Earth Moving."
3. Do not dispose of masonry waste as fill within 18 inches of finished grade.

C. 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 05 12 00
STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

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

1.02 SUMMARY
A. This Section includes the following:
   1. Structural steel.
   2. Architecturally exposed structural steel.
B. Related Sections include the following:
   1. Division 01 Section "Quality Requirements" for independent testing agency procedures and administrative requirements.
   2. Division 05 Section “Architecturally Exposed Structural Steel”.
   3. Division 05 Section "Steel Decking" for field installation of shear connectors.
   4. Division 05 Section "Metal Fabrications" for steel lintels or shelf angles not attached to structural-steel frame miscellaneous steel fabrications and other metal items not defined as structural steel.
   **ARCH**
   5. [Division 09 painting Sections] [and] [Division 09 Section "High-Performance Coatings"] for surface preparation and priming requirements.

1.03 DEFINITIONS
A. Structural Steel: Elements of structural-steel frame, as classified by AISC's "Code of Standard Practice for Steel Buildings and Bridges," that support design loads.
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B. Architecturally Exposed Structural Steel: Structural steel designated as architecturally exposed structural steel in the Contract Documents.

1.04 PERFORMANCE REQUIREMENTS
A. Connections
   1. Provide connections as shown or noted on drawings. The design of connections not shown or noted shall be provided by the Structural Engineer-of-Record upon request.
   2. Alternate connections designed by the Contractor's Engineer may be submitted with one set of stamped calculations for record. Alternate connection concepts shall be pre-approved during bidding. All alternate connections shall be designed for the value noted on plan. The Contractor shall compensate the Structural Engineer-of-Record for time spent reviewing alternate connection designs and revising Contract Documents.
1.05 SUBMITTALS

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

B. Shop Drawings: Show fabrication of structural-steel components.
   1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
   2. Include embedment drawings.
   3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.
   4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical high-strength bolted connections.

C. Erection Drawings:
   1. Submit erection drawings defining location of each assembly or piece within the structure. Provide sufficient details to describe all field welding. Clearly identify all high strength bolts not required to be tensioned ("snug tight" as defined by AISC). If drawings are submitted in multiple packages, each submittal shall be complete with all erection drawings, details and piece drawings. Subsequent submittals of erection drawings which modify or add to earlier versions will be clearly marked.
   2. Submit setting drawings for bolts and plates installed by others.

D. Welding certificates.

E. Qualification Data: For Installer and fabricator.

F. Mill Test Reports: Signed by manufacturers certifying that the following products comply with requirements:

1.06 QUALITY ASSURANCE

A. Fabricator Qualifications: A qualified fabricator who participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category Std

B. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel."

C. Fabrication and erection shall comply with applicable provisions of the following specifications and documents
      a. Section 3.1: Revise the second paragraph to read: "The Contract Documents shall clearly show the work that is to be performed and shall give the following information with sufficient dimensions to accurately convey the quantity and nature of the structural steel to be fabricated".
      b. Section 3.2: Replace the entire section with the following: "Requirements for structural steel including dimensions, arrangement, and details shall be shown in the overall contract document package. Fabricator shall be responsible for incorporating all such information from structural, architectural, mechanical, electrical drawings, as well as those of other disciplines".
      c. Section 3.5: Delete all text after the first sentence
      d. Section 3.6: Page 19, Replace the text of the entire section with the following: "When the fast-track project delivery system is selected,
release of structural drawings shall constitute release for construction only, if specifically noted on the drawing. Drawings that indicate "not for construction" shall not be used for detailing.”

Section 4.2: Page 21, 2nd Paragraph; Eliminate the following: “When requested to do so by the Owner's Designated Representative for Design”

Section 4.4: Page 23; Revise 2nd sentence to read the following: “These drawings shall be returned in accordance with the schedule defined in Division 1 of the project specification. In the absence of this requirement, the Owner's Designated Representative for Design shall return submittals within 14 days of receipt from the Owner's Designated Representative for Design for Construction”.

Section 6.4.4: Page 33; Revise statement “For the purpose of inspection, camber shall be measured in the fabricator’s shop in the unstressed condition”, to read “camber specified on the drawings is intended to be camber at the time of erection with decking placed prior to placing concrete. Owner’s Designated Representative for Construction shall submit methods for controlling deflections on beams with inadequate camber prior to placing concrete on deck”.

Section 6.5.3: Page 38; Revise definition to read “two mils”.

Section 7.10.3, Page 47 - Refer to the design criteria in the general notes on the drawings for definition of the complete lateral load resisting system for the steel frame. The Contractor shall notify the Erector in accordance with Section 7.10 of the AISC Code of Standard Practice for Steel Buildings and Bridges of all bracing requirements beyond those required to support the bare steel frame.

3. AISC's "Specification for Structural Steel Buildings."
4. AISC's "Specification for the Design of Steel Hollow Structural Sections."
5. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

D. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.07 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from erosion and deterioration.
1. Store fasteners in a protected place. Clean and relubricate bolts and nuts that become dry or rusty before use.
2. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

1.08 COORDINATION

A. Furnish anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.
PART 2 - PRODUCTS

2.01 STRUCTURAL-STEEL MATERIALS

A. W-Shapes: ASTM A 992/A 992M

B. Channels, and Angles-Shapes: ASTM A 36/A 36M

C. Plate and Bar: ASTM A 36/A 36M unless noted otherwise.

D. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade B, structural tubing.

E. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B.
   1. Weight Class: As noted.
   2. Finish: Black, except where indicated to be galvanized.

F. Welding Electrodes: Comply with AWS requirements, 70 Series.

2.02 BOLTS, CONNECTORS, AND ANCHORS

A. Use Tension control bolts whenever possible.

B. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy hex steel structural bolts; ASTM A 563 heavy hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers.
   1. Finish: Plain, except use for fasteners expose to weather.

C. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, heavy hex or round head steel structural bolts with splined ends; ASTM A 563 heavy hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers.
   1. Finish: Plain, expect for all fasteners exposed to weather. Mechanically deposited zinc coating, ASTM B 695, Class 50.

D. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1, Type B.

E. Headed Anchor Rods: ASTM F 1554, Grade 55, grade as noted on the drawings weldable, straight.
   4. Finish: Plain, expect use where exposed to weather.

F. Threaded Rods: ASTM A 36/A 36M.
   3. Finish: Plain, except use where exposed to weather.


I. Rebar: Rebar used for welding shall meet the requirements of ASTM A-706. Rebar bends shall meet the minimum bend diameters listed in the ACI 318, latest edition.

   1. Interior Use: For use in conditioned environments free from potential moisture, provide carbon steel anchors conforming to ASTM A307 with zinc plating in accordance with FS 22-Z-235.
   2. Exterior or Exposed Use: In exposed or potentially wet environments, and for attachment of exterior cladding materials, provide stainless steel anchors. Stainless steel anchors shall be Series 300 stainless steel bolts with Series 300 or Type 18-8 stainless steel nuts and washers.

   1. Exterior or Exposed Use: In exposed or potentially wet environments and for attachment of exterior cladding materials, provide stainless steel anchors. Stainless steel anchors shall be Series 300 stainless steel threaded rods with Series 300 or Type 18-8 stainless steel nuts and washers.

2.03 PRIMER

A. Primer: Non-required.

B. Galvanizing Repair Paint: ASTM A 780.

C. Where steel is to be field painted, provide shop coat of paint compatible with paint finish system specified in Division 9.

2.04 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time. 6000 psi.

2.05 FABRICATION

   1. Camber structural-steel members where indicated.
   2. Identify high-strength structural steel according to ASTM A 6/ A 6M and maintain markings until structural steel has been erected.
   3. Mark and match-mark materials for field assembly.

B. Architecturally Exposed Structural Steel: Comply with fabrication requirements, including tolerance limits, of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for structural steel identified as architecturally exposed structural steel.
1. Fabricate with exposed surfaces smooth, square, and free of surface blemishes including pitting, rust, scale, seam marks, roller marks, rolled trade names, and roughness.
2. Remove blemishes by filling or grinding or by welding and grinding, before cleaning, treating, and shop priming.

C. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
   1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1.
   2. Beam Copes and Weld Access Holes: Thermally cut surfaces in material exceeding 1-1/2” thickness in rolled and built up shapes shall be ground to bright metal in accordance with Section J.18 of the AISC specification.

D. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.

E. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

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F. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 3, "Power Tool Cleaning."

G. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer's written instructions.

H. Holes: Provide holes required for securing other work to structural steel and for passage of other work through steel framing members.
   1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
   2. Base-Plate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.

I. Splices: Splicing of members to obtain the required lengths will not be permitted without prior acceptance of the Architect unless shown on the drawings.

J. Substitutions: Where exact sizes and weights called for are not readily available, secure the Architect's acceptance of suitable sizes in time to prevent delay due to such substitutions.

2.06 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
   1. Joint Type: As noted on drawings.

B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.

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1. Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable
tolerances. Prevent weld show-through on exposed steel surfaces. Remove backing bars and run-off tabs, and grind steel smooth.
  a. Grind butt welds flush.
  b. Grind or fill exposed fillet welds to smooth profile. Dress exposed welds.

2.07 SHOP PRIMING

A. Shop prime steel surfaces except the following:
  1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
  2. Surfaces to be field welded.
  3. Surfaces to be high-strength bolted with slip-critical connections.
  4. Surfaces to receive sprayed fire-resistive materials.
  5. Galvanized surfaces.
  6. Surfaces not exposed to weather and not exposed to public view.

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B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:

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C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a dry film thickness of not less than 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
  1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
  2. Apply two coats of shop paint to inaccessible surfaces after assembly or erection. Change color of second coat to distinguish it from first.

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D. Painting: Apply a 1-coat, nonasphaltic primer complying with SSPC-PS Guide 7.00, "Painting System Guide 7.00: Guide for Selecting One-Coat Shop Painting Systems," to provide a dry film thickness of not less than 1.5 mils.

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2.08 GALVANIZING

A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/ A 123M.
  1. Fill vent holes and grind smooth after galvanizing.
  2. Galvanize lintels and shelf angles attached to structural-steel frame and located in exterior walls.

2.09 SOURCE QUALITY CONTROL

A. Owner will engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports.
  1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.
B. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

C. Bolted Connections: Shop-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

D. Welded Connections: In addition to 100% visual inspection, shop-welded connections will be tested and inspected according to AWS D1.1 and the following inspection procedures.
   1. All full or partial penetration groove welded connections and splices: 100% ultrasonic.
   2. All other welds: 10% magnetic particle.

E. In addition to visual 100% inspection, shop-welded headed anchors shear connections and deframed anchor studs shall be tested and inspected according to requirements in AWS D1.1 for stud welding and as follows:
   1. Bend tests will be performed if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
   2. Tests will be conducted on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1.

F. Shop inspection by the Testing Agency for all columns and 20% of beams and girders shall include examination of steel for straightness and alignment, conformance to length and camber tolerances, fissures, mill scale and other defects and deformities, as described in ASTM A6 and examination of aforementioned fabricated pieces for conformity with approved shop drawings. Testing of welding will be performed as required.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments, with steel erector present, for compliance with requirements.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place, unless otherwise indicated.
   1. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.
   2. Contractor shall coordinate installation of all non-structural steel items which will load the non-self supporting structural steel frame. The structural steel frame temporary supports shall resist all loads from these non-structural steel items.
   3. Field Modification: Obtain written acceptance from the Architect before the use of flame cutting for field modification or refabrication of structural steel. The Structural Steel Fabricator shall be responsible for errors in fabrication and for correct fit in the field.
   4. Support of Other Work: No permanent loading other than the weight of supported metal deck and concrete slabs shall be imposed on composite beams and girders without prior approval by the Architect until the concrete in such slabs has
achieved 75 percent of its design strength. Contractor shall submit calculations prepared by an Engineer registered verifying the adequacy of the non-composite members to support the anticipated loading prior to developing composite strength. All costs associated with the accommodation of such loading, including review of submittals and modification of structural members and/or details, shall be borne by the Contractor.

3.03 ERECTION


   1. Set base and bearing plates for structural members on wedges, shims, or setting nuts as required.
   2. Weld plate washers to top of base plate.
   3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of base or bearing plate before packing with grout.
   4. Promptly pack grout solidly between bearing surfaces and base or bearing plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts. Clean and moisten surfaces to be grouted. Remove all free water immediately prior to placing grout. Mix and install grout in accordance with Manufacturer's instructions. Completely fill all spaces to be grouted. After grout has acquired its initial set, trim to lower edge of bearing plate and remove excess material. Consolidate exposed edges to a dense uniform surface.

C. Maintain erection tolerances of structural steel and architecturally exposed structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges." Except as follows:
   1. Cambered Steel Beams: Fabrication camber shall be adjusted to compensate for conditions of shipping, handling and erection. Maximum deviation of vertical camber at mid span of beam after erection, prior to placing deck +1/2"; -1/2" maximum.
   2. Leveling and Plumbing: Base leveling and plumbing on a mean temperature of 70 degrees F. Compensate for difference in temperature at time of erection.

D. Align and adjust various members forming part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
   1. Level and plumb individual members of structure.
   2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.

E. Splice members only where indicated.

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F. Remove erection bolts on welded, architecturally exposed structural steel; fill holes with plug welds; and grind smooth at exposed surfaces.
G. Do not use thermal cutting during erection unless approved by Architect. Finish thermally cut sections within smoothness limits in AWS D1.1.

H. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

I. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer's written instructions.

J. Compression Splices: Fasten splices in compression after bearing surfaces have been brought into contact. Clean bearing surfaces before assembling. Close all gaps 1/32” wide or greater by driving non-tapered mild steel shims full depth of the bearing surface along the full length of the gap.

3.04 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
   1. Joint Type: As noted on the drawings.

B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.
   2. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.

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3. Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable tolerances. Prevent weld show-through on exposed steel surfaces.
   a. Grind butt welds flush.
   b. Grind or fill exposed fillet welds to smooth profile. Dress exposed welds.
   c. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.

C. Drilled-In Inserts: Install in accordance with Manufacturer’s recommendations in accurately drilled holes of required diameter and depth. Where adhesive inserts are used, thoroughly clean hole of all debris and drill dust by wire brushing and compressed air prior to installation of insert and adhesive system. Do not drill holes in concrete or masonry until material has achieved full design strength.

3.05 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to inspect field welds, high-strength bolted connections and drilled-in inserts.

B. Bolted Connections: Shop-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
1. Visually inspect all bolted connections to ascertain that all bolts, nuts and required washers have been installed and are of proper type and that all faying surfaces have been brought into snug contact. Verify the specified surface preparation of the faying surface has been correctly prepared.

2. Tensioned High Strength Bolts:
   a. Standard Bolts:
      1) Inspect the bolt tightness of 10% of the bolts (minimum of 2), selected at random in each high strength bolted connection. If rejectable bolts are found in any connection, all remaining bolts in that connection shall be inspected for tightness. Inspection procedure shall be in accordance with “Specification for Structural Joints Using ASTM A325 or A490 Bolts” approved by Research Council on Riveted and Bolted Structural Joints of the Engineering Foundation (Research Council on Structural Connections, latest edition.
   
   b. Twist Off (Self-Indicating) Bolts
      1) Perform a visual inspection of all high strength bolted connections to assure that all torque-off splines have been sheared.
      2) When splines are not sheared, the Testing Agency shall determine that proper bolt tension has been achieved by the application of a properly calibrated testing torque or the Contractor may, at his option, remove and replace all bolts with unsheared splines. All cost of additional inspection required by this paragraph shall be borne by the Contractor.

C. Welded Connections: Field welds shall be tested according to AWS D1.1 and the following inspection procedures:
   1. Ascertainment that electrodes used for manual shielded metal-arc welding and the electrodes and flux used for submerged are welding conform to the requirements herein.
   2. Ascertainment that the welding is performed only by welding operators and welders who are properly certified. The Testing Agency shall witness such qualification testing of welding operator and welders, as may be required.
   3. Ascertainment that the fit-up, joint preparation, size, contour, extent of reinforcement, and length and location of welds conform to specified requirements and the Contract Drawings, and that no specified welds are omitted or unspecified welds added without approval of the Architect.

D. The Testing Agency shall test field welds as follows:
   1. All welds including curtain wall and shoring connections: 100% visual.
   2. All full or partial penetration groove welds: 100% ultrasonic.
   3. All other welds, including curtain wall and shoring connections: 10% magnetic particle.
   4. Stud connectors on composite beams shall be tested as follows:
      a. In addition to 100% visual inspection and the requirements on AWS D1.1 for stud welding, all studs shall be acoustically inspected. Studs which do not ring when struck with a hammer shall be bent 15 degrees. If the bent stud does not fracture, stud is acceptable and may be left bent.
      b. In addition to the above, not less than one of each 100 studs shall be tested by bending 15 degrees. If no fracture occurs, stud is considered acceptable and left bent.

5. If defective welds are discovered, the remaining uninspected welds shall receive such ultrasonic or magnetic particle inspection as may be required by the Architect. All cost of additional inspection required by this paragraph shall be borne by the Contractor.
6. The welding inspector will have the authority to reject weldments. Such rejection may be based on visual inspection where in his opinion the weldment would not pass a more detailed investigation.

7. Reports by the Testing Agency's Inspector will contain, as a minimum, an adequate description of each weld tested, the identifying mark of the welder responsible for the weld, critique of any defects noted by visual inspection or testing, and a statement regarding the acceptability of the weld tested, as judged by current A.W.S. standards. Reports shall be distributed as early as possible but not later than one workweek after the tests have been performed. The Architect shall be notified by phone if, in the judgment of the Inspector, test results require immediate comment.

8. Radiographic testing may be substituted for ultrasonic.

E. In addition to visual inspection, test and inspect field-welded shear connectors according to requirements in AWS D1.1 for stud welding and as follows:
   1. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
   2. Conduct tests on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1.

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

G. Drilled-in Anchors and Drilled-in Rebar:
   1. Self-Expanding Anchors: The Testing Agency shall inspect self-expanding Drilled-in Anchors shown on the structural drawings as follows:
      a. Prior to installation, the Testing Agency shall determine that the installing contractor has the proper materials and equipment for drilling holes in the receiving surface of required diameter and length.
      b. All anchors shall be visually inspected after installation to ensure that they have been installed perpendicular to the receiving surface and to proper depth.
      c. Pull test the first 3 and 1% of all remaining anchors for a tension load of 100% of the Manufacturer's recommended allowable working loads in tension.
   2. Adhesive-Bonded Anchors/Rebar: The Testing Agency shall inspect adhesive-bonded, drilled-in anchors as follows:
      a. The Testing Agency shall be present at the site to observe the installation of the first anchors/rebar placed. Such observation shall be to ensure that drilled holes are of required diameter and depth, holes are properly cleaned prior to installation of the anchors, and that holes are completely filled with properly mixed adhesive after installation.
      b. All anchors/rebar shall be visually inspected after installation to ensure that the anchor has been installed perpendicular to the receiving surface and to proper depth.
      c. Pull test the first 3 and 1% of all remaining anchors for a tension load of 100% of the Manufacturer's recommended allowable working loads in tension.

H. Verification of Erection Tolerances:
   1. The contractor shall survey the structure after erection and prior to placing deck.
      a. Submit report to the Architect and Owner within 24 hours after recording the data. Report shall identify all deviations of member locations and/or elevations in excess of allowable tolerance specified.
**ARCH**

3.06 REPAIRS AND PROTECTION

A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Touchup Painting: After installation, promptly clean, prepare, and prime or repriime field connections, rust spots, and abraded surfaces of prime-painted joists and accessories, bearing plates, and abutting structural steel.
   1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
   2. Apply a compatible primer of same type as shop primer used on adjacent surfaces.

C. Touchup Painting: Cleaning and touchup painting are specified in Division 09 painting Sections.

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. This Section includes the following:
   1. Roof deck.
   2. Composite floor deck.

B. Related Sections include the following:
   1. Division 03 Section "Cast-in-Place Concrete" for concrete fill.
   2. Division 05 Section "Structural Steel Framing" for shop- and field-welded shear connectors.
   3. Division 05 Section "Metal Fabrications" for framing deck openings with miscellaneous steel shapes.
   4. Division 09 painting Sections for repair painting of primed deck.

1.03 SUBMITTALS

A. Product Data: For each type of deck, accessory, and product indicated.

B. Shop Drawings: Show layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

C. Product Certificates: For each type of steel deck, signed by product manufacturer.

D. Welding certificates.

E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that each of the following complies with requirements:
   1. Power-actuated mechanical fasteners.
   2. Acoustical roof deck.

F. Research/Evaluation Reports: For steel deck.

1.04 QUALITY ASSURANCE

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

B. Welding: Qualify procedures and personnel according to AWS D1.3, "Structural Welding Code - Sheet Steel."
C. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."

**ARCH**


1.05 DELIVERY, STORAGE, AND HANDLING

A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Steel Deck:
      a. ASC Profiles, Inc.
      c. Consolidated Systems, Inc.
      d. DACS, Inc.
      e. D-Mac Industries Inc.
      f. Epic Metals Corporation.
      g. Marlyn Steel Decks, Inc.
      h. New Millennium Building Systems, LLC.
      i. Nucor Corp.; Vulcraft Division.
      j. Roof Deck, Inc.
      k. United Steel Deck, Inc.
      l. Valley Joist; Division of EBSCO Industries, Inc.
      m. Verco Manufacturing Co.
      n. Wheeling Corrugating Company; Div. of Wheeling-Pittsburgh Steel Corporation.

2.02 ROOF DECK

A. Steel Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 31, and with the following:
   1. Galvanized Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33, G60 zinc coating. Use at exterior locations not exposed to view.

**ARCH**

2. Galvanized and Shop-Primed Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33, G60 zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer. Use at exterior locations exposed to view.

**ARCH**

3. Color: Manufacturer's standard

Deck Profile: As indicated.
4. Profile Depth: As indicated.
5. Design Uncoated-Steel Thickness: As indicated.
6. Span Condition: Triple span or more.
7. Side Laps: Overlapped.

2.03 COMPOSITE FLOOR DECK

A. Composite Steel Floor Deck: Fabricate panels, with integrally embossed or raised pattern ribs and interlocking side laps, to comply with "SDI Specifications and Commentary for Composite Steel Floor Deck," in SDI Publication No. 31, with the minimum section properties indicated, and with the following:
   1. Galvanized Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 40, G90 zinc coating where exposed to moisture.
   2. Profile Depth: As indicated.
   3. Design Uncoated-Steel Thickness: As indicated
   4. Span Condition: Triple span or more.

2.04 NONCOMPOSITE FORM DECK

A. Noncomposite Steel Form Deck: Fabricate ribbed-steel sheet noncomposite form-deck panels to comply with "SDI Specifications and Commentary for Noncomposite Steel Form Deck," in SDI Publication No. 31, with the minimum section properties indicated, and with the following:
   1. Prime-Painted Steel Sheet: ASTM A 1008/A 1008M, Structural Steel (SS), Grade 33, minimum, with top and underside surface shop primed with manufacturer's standard baked-on, rust-inhibitive primer.
   2. Galvanized Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33, zinc coating. Use G90 minimum zinc coating where exposed to moisture.
   3. Profile Depth: As indicated
   4. Design Uncoated-Steel Thickness: As indicated
   5. Span Condition: Triple span or more.

2.05 ACCESSORIES

A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.

B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.

C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 minimum diameter.

D. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

E. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi, of same material and finish as deck, and of thickness and profile required by SDI Publication No. 31 for overhang and slab depth.

F. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck, unless otherwise indicated.
G. Weld Washers: Uncoated steel sheet, shaped to fit deck rib, 0.0747 inch thick, with factory-punched hole of 3/8-inch minimum diameter.

H. Galvanizing Repair Paint: ASTM A 780 with dry film containing a minimum of 94 percent zinc dust by weight.

I. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

B. When stud shear connectors are to be welded through metal deck and/or corrugated metal forming, the top flange of beams to receive such studs shall be unpainted and free of debris prior to installation of the deck and/or forming.

3.02 INSTALLATION, GENERAL

A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 31, manufacturer's written instructions, and requirements in this Section.

B. Install temporary shoring before placing deck panels, if required to meet deflection limitations.

C. Locate deck bundles to prevent overloading of supporting members.

D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.

E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.

F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.

G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.

1. All openings through metal deck shown on the drawings, and other openings greater than 10” in any direction, shall be reinforced.

2. Miscellaneous openings not shown on the drawings such as those required for vents, risers, conduits, etc., shall be cut and reinforced if necessary, by the trade requiring the opening.

H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.
3.03 ROOF-DECK INSTALLATION

A. Fasten roof-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter that is not less than 1-1/2 inches long.
   1. Weld Diameter: As indicated.
   2. Weld Spacing: Weld edge and interior ribs of deck units with a minimum of two welds per deck unit at each support. Space welds as indicated.
   3. Weld Washers: Install weld washers at each weld location when the minimum uncoated steel thickness is less than 0.028 inch.
   4. Self Drilling Screws: Size as indicated.

B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports: As indicated.

C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches, with end joints as follows:
   1. End Joints: Lapped 2 inches minimum or butted at Contractor's option.

D. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Mechanically fasten to substrate to provide a complete deck installation.
   1. Weld cover plates at changes in direction of roof-deck panels, unless otherwise indicated.

E. Fasten floor-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated and as follows:
   2. Weld Spacing: Weld edge ribs of panels at each support. Space additional welds an average of 12 inches apart, but not more than 18 inches apart.
   3. Weld Washers: Install weld washers at each weld location when the minimum uncoated steel thickness is less than 0.028 inch.
   4. Where welded studs are field applied through deck, such studs may be substituted for a deck connection on a one for one basis.

F. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of half of the span or 36 inches, and as follows:
   1. Mechanically fasten with self-drilling, No. 10 diameter or larger, carbon-steel screws, or
   2. Mechanically clinch or button punch, or
   3. Fasten with a minimum of 1-1/2-inch-long welds.

G. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches, with end joints as follows:
   1. End Joints: Butted.

H. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure according to SDI recommendations, unless otherwise indicated.

I. Floor-Deck Closures: Weld steel sheet column closures, cell closures, and Z-closures to deck, according to SDI recommendations, to provide tight-fitting closures at open ends of ribs and sides of deck.
J. Fastening Corrugated Metal Forming: Secure to supporting member with 1/2" minimum diameter fusion welds made through 14 gauge welding washers. Minimum weld requirements are as follows:
1. End Laps: In valley of side laps and at center of sheet.
2. Intermediate Supports: In valley of side lap on every other support and in valley of center corrugation on the remaining supports (to form an X pattern).
3. Exterior Edges: 12" on center.
4. Minimum Number of Welds Per 100 square foot of Deck Area:
   a. 27 gauge and thinner – 25
   b. All heavier gauges – 15

K. Studs shall be field welded to the structural members only after all steel framing, deck and/or forms are in place and shored when required. Deck shall be installed so that the bottom rib plate is in continuous contact with the surface to receive the studs.

L. Stud Shear Connector Capacity: Number of shear connectors indicated on the drawings is based on 100 percent of the allowable capacity for shear connectors in normal weight or light weight concrete as listed in AISC Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings. Actual shear connector capacities shall be determined by tests on each type of deck supplied and the number of shear connectors required in each rib. If additional shear connectors are required due to decreases in the capacity of shear connectors for the type of deck and stud placement supplied, such additional shear connectors shall be provided at no additional cost to the Owner.

M. Installation:
1. Install shear connectors in accordance with Manufacturer’s instructions. Use only personnel and equipment authorized by the Manufacturer.
2. Use through-deck shear connector welding where deck material thickness permits proper weld fusion to develop required connector capacity. Provide adequate test results to verify the feasibility of through-deck welding for the particular connector sizes and deck thicknesses involved.
3. If through-deck shear connector welding is not feasible, install shear connectors through prepunched holes in the deck. Provide prepunched holes only for the shear connectors involved and keep hole oversize to the minimum required to develop a proper weld.
4. At the beginning of each shift of work, and after each time welding equipment has been moved, two test studs shall be installed and bent to 45 degrees. If failure occurs, adjust equipment and repeat test. Two consecutive test studs shall be welded and found satisfactory before production for that shift begins or is resumed.

3.04 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. The Testing Agency shall visually inspect all metal deck to observe that the deck is the proper type, depth, finish, is not damaged or rusted, and has been properly installed. Verify the overlapping edges of panels are in close contact at sidetaps.

C. The Testing Agency shall visually inspect all deck welds and fasteners prior to being covered by other work. Verify weld and fastener size, spacing, and quality of attachment. Verify that screw threads are not stripped. Verify that stand-off of powder actuated fasteners are within Manufacturer’s recommendations.
D. Verification of proper size, number and location of stud shear connectors installed directly to steel and through metal deck.

E. Weld testing of shear stud connectors installed through metal deck shall be tested as specified in Section 05120 Structural Steel.

F. Field welds will be subject to inspection.

G. Testing agency will report inspection results promptly and in writing to Contractor and Architect.

H. Remove and replace work that does not comply with specified requirements.

I. Additional inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

3.05 REPAIRS AND PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Repair Painting: Wire brush and clean rust spots, welds, and abraded areas on both surfaces of prime-painted deck immediately after installation, and apply repair paint.

C. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Substantial Completion.
   1. Do not use deck units for storage or as a working platform until permanently secured in position.
   2. The General Contractor shall assure that completed deck is not damaged by use as a runaway, storage of materials or subsequent work. He is to assure that construction loads are not allowed which exceed the safe carrying capacity of the deck.

END OF SECTION
SECTION 05 40 00
COLD-FORMED METAL FRAMING

PART 1 - GENERAL

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

1.02 SUMMARY
A. This Section includes the following:
   1. Exterior non-load-bearing and soffit wall framing.
   2. Delegated design of exterior non-load-bearing wall and soffit framing.

B. Related Sections include the following:
   1. Division 05 Section "Metal Fabrications" for masonry shelf angles and connections.
   2. Division 09 Section "Non-Structural Metal Framing" for interior non-load-bearing, metal-stud framing and ceiling-suspension assemblies.
   3. Division 09 Section "Gypsum Board Shaft Wall Assemblies" for interior non-load-bearing, metal-stud-framed, shaft-wall assemblies.

1.03 PERFORMANCE REQUIREMENTS
A. Structural Performance: Design and provide cold-formed metal framing capable of withstanding design loads within limits and under conditions indicated.
   1. Design Loads: As indicated. Do not reduce specified loads for deflection design.
   2. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:
      a. Typical except use 1/600 of the wall height for walls with masonry veneer.
      b. Exterior Non-Load-Bearing Framing: Horizontal deflection of 1/360 of the wall height.
   3. Design framing systems to provide for movement of framing members without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F.
   4. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure as follows:
      a. Upward and downward movement of. L/300 for floors and L/200 for roofs.

B. Cold-Formed Steel Framing, General: Design according to AISI's "Standard for Cold-Formed Steel Framing - General Provisions."
   1. Headers: Design according to AISI's "Standard for Cold-Formed Steel Framing - Header Design."
   2. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.
1.04 SUBMITTALS

A. Product Data: For each type of cold-formed metal framing product and accessory indicated.

B. Shop Drawings: Show layout, spacings, sizes, thicknesses, and types of cold-formed metal framing; fabrication; and fastening and anchorage details, including mechanical fasteners. Show reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.
   1. For cold-formed metal framing indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Welding certificates.

D. Qualification Data: For professional engineer.

E. Product Test Reports: From a qualified testing agency, unless otherwise stated, indicating that each of the following complies with requirements, based on evaluation of comprehensive tests for current products:
   1. Vertical deflection clips.
   2. Horizontal drift deflection clips
   3. Stiff Clips

1.05 QUALITY ASSURANCE

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

B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of cold-formed metal framing that are similar to those indicated for this Project in material, design, and extent.

C. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM E 329 to conduct the testing indicated.

D. Product Tests: Data from a qualified independent testing agency, or in-house testing with calibrated test equipment indicating deflection clips, drift clips, and stiff clips conform to the strength and stiffness requirements herein with the designated fasteners/welds.


F. AISI Specifications and Standards: Comply with AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members" and its "Standard for Cold-Formed Steel Framing - General Provisions."
   1. Comply with AISI's "Standard for Cold-Formed Steel Framing - Header Design."

G. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."
1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect cold-formed metal framing from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Store cold-formed metal framing, protect with a waterproof covering, and ventilate to avoid condensation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering cold-formed metal framing that may be incorporated into the Work include, but are not limited to, the following:

1. Allied Studco.
2. AllSteel Products, Inc.
4. Clark Steel Framing.
5. Consolidated Fabricators Corp.; Building Products Division.
6. Craco Metals Manufacturing, LLC.
7. Custom Stud, Inc.
8. Dale/Incor.
10. Dietrich Metal Framing; a Worthington Industries Company.
11. Formetal Co. Inc. (The).
12. Innovative Steel Systems.
13. MarinoWare; a division of Ware Industries.
15. SCAFCO Corporation.
18. Steeler, Inc.
20. United Metal Products, Inc.

2.02 MATERIALS

A. Steel Sheet: ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of grade and coating weight as follows:

1. Grade: Not less than 33 ksi for studs 18 gauge and lighter, 50 kips for studs 16 gage and heavier.
2. Coating: G60, or equivalent.

B. Steel Sheet for Vertical Deflection Clips, Stiff Clips, and Drift Clips: ASTM A 653/A 653M, structural steel, zinc coated, of grade and coating as follows:

1. Grade: As required by structural performance.
2. Coating: G90.

2.03 EXTERIOR NON-LOAD-BEARING WALL FRAMING

A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: As indicated.
2. Minimum Flange Width: 1-5/8 inches
3. Section Properties: As required, but not less than the minimum indicated on the drawings.

B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:
   1. Minimum Base-Metal Thickness: Matching steel studs.

C. Vertical Deflection Clips: Manufacturer's standard bypass and head clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web. Maximum deflection of the clip/stud assembly under design load shall be 1/16" and shall be 1/8" under the lesser of the design or the elastic limit load.
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Dietrich Metal Framing; a Worthington Industries Company.
      b. MarinoWare, a division of Ware Industries.
      c. SCAFCO Corporation
      d. The Steel Network, Inc.

D. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal and lateral loads and transfer them to the primary structure, and as follows: Maximum track lateral deflection under design load shall be 1/16" and shall be 1/8" under the lesser of the design or the elastic limit load.
   1. Minimum Base-Metal Thickness: 0.0451 inch.
   2. Flange Width: 1 inch plus the design gap for 1-story structures and 1 inch plus twice the design gap for other applications.

E. Double Deflection Tracks: Manufacturer's double, deep-leg, U-shaped steel tracks, consisting of nested inner and outer tracks; unpunched, with unstiffened flanges. Maximum track lateral deflection under design load shall not exceed 1/8" or the elastic limit load.
   1. Outer Track: Of web depth to allow free vertical movement of inner track, with flanges designed to support horizontal and lateral loads and transfer them to the primary structure, and as follows:
      a. Minimum Base-Metal Thickness: As required.
      b. Flange Width: 1 inch plus twice the design gap for other applications.
   2. Inner Track: Of web depth indicated, and as follows:
      a. Minimum Base-Metal Thickness: As Required.
      b. Flange Width: Sum of outer deflection track flange width plus 1 inch.

F. Drift Clips: Manufacturer's standard bypass or head clips, capable of isolating wall stud from upward and downward vertical displacement and lateral drift of primary structure. Maximum lateral deflection of the drift cup/stud assembly under design loads shall be the smaller of 1/8" or the elastic limit load.

G. Stiff Clips: Clip capable of supporting design loads indicated through positive mechanical attachment to the stud web. Maximum deflection of the clip/stud assembly under the applied load shall be 1/16" and shall be 1/8" under the lesser of the design or the elastic limit load.
2.04 EXTERIOR SOFFIT JOIST FRAMING

A. Steel Soffit Joists: Manufacturer's standard C-shaped steel sections, of web depths indicated, with stiffened flanges, and as follows:
   1. Minimum Base-Metal Thickness: 0.0428 inch.
   3. Section Properties: As required.

2.05 FRAMING ACCESSORIES

A. Fabricate steel-framing accessories from steel sheet, ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of same grade and coating weight used for framing members.

B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:
   1. Supplementary framing.
   2. Bracing, bridging, and solid blocking.
   3. Web stiffeners.
   4. Anchor clips.
   5. End clips.
   6. Foundation clips.
   7. Stud kickers, knee braces, and girts.
   8. Joist hangers and end closures.

2.06 ANCHORS, CLIPS, AND FASTENERS

A. Steel Shapes and Clips: ASTM A 36/A 36M, zinc coated by hot-dip process according to ASTM A 123/A 123M.

B. Anchor Bolts: ASTM F 1554, Grade 36, threaded carbon-steel hex-headed bolts and carbon-steel nuts; and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A 153/A 153M, Class C.

C. Expansion Anchors: Fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 5 times design load, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.

D. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 10 times design load, as determined by testing per ASTM E 1190 conducted by a qualified independent testing agency.

E. Mechanical Fasteners: ASTM C 1513, corrosion-resistant-coated, self-drilling, self-tapping steel drill screws.
   1. Head Type: Low-profile head beneath sheathing, manufacturer's standard elsewhere.

F. Welding Electrodes: Comply with AWS standards.

2.07 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: SSPC-Paint 20 or DOD-P-21035.
B. Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to match width of bottom track or rim track members.

2.08 FABRICATION

A. Fabricate cold-formed metal framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.
   1. Fabricate framing assemblies using jigs or templates.
   2. Cut framing members by sawing or shearing; do not torch cut.
   3. Fasten cold-formed metal framing members by welding, screw fastening, clinch fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.
      a. Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
      b. Locate mechanical fasteners and install according to Shop Drawings, with screw penetrating joined members by not less than three exposed screw threads.
   4. Fasten other materials to cold-formed metal framing by welding, bolting, or screw fastening, according to Shop Drawings.

B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies to prevent damage or permanent distortion.

C. Fabrication Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:
   1. Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
   2. Squareness: Fabricate each cold-formed metal framing assembly to a maximum out-of-square tolerance of 1/8 inch.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine supporting substrates and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.

B. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed framing without reducing thickness of fire-resistive materials below that are required to obtain fire-resistance rating indicated. Protect remaining fire-resistive materials from damage.
C. Install sealer gaskets to isolate the underside of wall bottom track or rim track and the top of foundation wall or slab at stud or joist locations.

3.03 INSTALLATION, GENERAL

A. Cold-formed metal framing may be shop or field fabricated for installation, or it may be field assembled.

B. Install cold-formed metal framing according to AISI's "Standard for Cold-Formed Steel Framing - General Provisions" and to manufacturer's written instructions unless more stringent requirements are indicated.

C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.
   1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch.

D. Install cold-formed metal framing and accessories plumb, square, and true to line, and with connections securely fastened.
   1. Cut framing members by sawing or shearing; do not torch cut.
   2. Fasten cold-formed metal framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.
      a. Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
      b. Locate mechanical fasteners and install according to Shop Drawings, and complying with requirements for spacing, edge distances, and screw penetration.

E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.

F. Install temporary bracing and supports to secure framing and support loads comparable in intensity to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.

G. Do not bridge building expansion and control joints with cold-formed metal framing. Independently frame both sides of joints.

H. Install insulation, specified in Division 07 Section "Thermal Insulation," in built-up exterior framing members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.

I. Fasten hole reinforcing plate over web penetrations that exceed size of manufacturer's standard punched openings.

J. Erection Tolerances: Install cold-formed metal framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:
   1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
3.04 EXTERIOR NON-LOAD-BEARING WALL INSTALLATION

A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure as indicated.

B. Fasten both flanges of studs to top and bottom track, unless otherwise indicated. Space studs as follows:
   1. Maximum Stud Spacing: 16 inches.

C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.

D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.
   1. Install single-leg deflection tracks and anchor to building structure.
   2. Install double deep-leg deflection tracks and anchor outer track to building structure.
   3. Connect vertical deflection clips to bypassing and/or infill studs and anchor to building structure.
   4. Connect drift clips to cold formed metal framing and anchor to building structure.

E. Install horizontal bridging in wall studs, spaced in rows indicated on Shop Drawings but not more than 48 inches apart. Fasten at each stud intersection.
   1. Top Bridging for Single Deflection Track: Install row of horizontal bridging within 12 inches of single deflection track. Install a combination of flat, taut, steel sheet straps of width and thickness indicated and stud or stud-track solid blocking of width and thickness matching studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
   2. Bridging: Cold-rolled steel channel welded or mechanically fastened to webs of punched studs.

F. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, fasteners, and stud girts, to provide a complete and stable wall-framing system.

3.05 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.

B. All Fasteners and all welds will be subject to testing and inspecting. Visual inspect 100% of all fasteners for correct size, number, edge/end distance. Inspect all proprietary clips for installation in accordance with contract documents, approved submittals, and manufacturer’s installation instructions.

C. Testing agency will report test results promptly and in writing to Contractor and Architect.

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

E. Additional testing and inspecting, at Contractor’s expense, will be performed to determine compliance of replaced or additional work with specified requirements.
3.06 REPAIRS AND PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed metal framing with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer that ensure that cold-formed metal framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION
SECTION 05 50 00
METAL FABRICATIONS

PART 1 - GENERAL

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

1.02 SUMMARY
   A. This Section is general in nature. Fabrications specified may or may not be required for this Project.
   B. This Section includes the following:
      1. Steel framing and supports for mechanical and electrical equipment.
      2. Steel framing and supports for applications where framing and supports are not specified in other Sections.
      3. Crane davit for window-washing equipment.
      4. Elevator hoist beams.
      5. Shelf angles.
      7. Steel weld plates and angles for casting into concrete not specified in other Sections.
      8. Miscellaneous steel trim including loading-dock edge angles.
      9. Metal ladders.
     10. Metal ships' ladders.
     11. Metal bollards.
   C. Products furnished, but not installed, under this Section include the following:
      1. Loose steel lintels.
      2. Anchor bolts, steel pipe sleeves, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
   D. Related Sections include the following:
      1. Division 03 Section "Cast-in-Place Concrete" for installing anchor bolts, steel pipe sleeves, wedge-type inserts and other items indicated to be cast into concrete.
      2. Division 04 Section "Unit Masonry" for installing loose lintels, anchor bolts, and other items indicated to be built into unit masonry.
      3. Division 05 Section "Structural Steel Framing."
      4. Division 05 Section "Metal Stairs."
      5. Division 05 Section "Pipe Tube and Bar Railings."
      6. Division 05 Section "Decorative Metal."
      7. Division 05 Section "Decorative Metal Railings."
      8. Division 14 Section "Machine Roomless Elevators" for support angles for elevator door sills.

1.03 PERFORMANCE REQUIREMENTS
   A. Structural Performance of Ladders: Provide ladders capable of withstanding the effects of loads and stresses within limits and under conditions specified in ANSI A14.3.
B. Thermal Movements: Provide exterior metal fabrications that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

1.04 SUBMITTALS

A. Product Data: For the following:
   1. Nonslip aggregates and nonslip-aggregate surface finishes.
   2. Metal nosings and treads.
   3. Paint products.

B. Shop Drawings: Show fabrication and installation details for metal fabrications.
   1. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.
   2. Provide templates for anchors and bolts specified for installation under other Sections.
   3. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. LEED Submittals:
   1. Credit MR 4.1 and MR 4.2: Product Data indicating percentages by weight of postconsumer and preconsumer recycled content for products having recycled content.
      a. Include statement indicating costs for each product having recycled content.
   2. Credits MR 5.1 and MR 5.2: Regionally Extracted, Harvested, or Recovered and Manufactured Materials:
      a. Indicate location of manufacturing facility, including name, address, and distance between manufacturing facility and the project site. Provide manufacturer's documentation indicating location where the base materials were extracted, mined, quarried, harvested, etc., and the distance between this location and the project site. Also include material costs, excluding cost of installation.

D. Welding certificates.

1.05 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to the following:
   1. AWS D1.1, "Structural Welding Code--Steel."
   4. AWS D1.6, "Structural Welding Code--Stainless Steel."

1.06 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication and indicate measurements on Shop Drawings.
   1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating metal
fabrications without field measurements. Coordinate wall and other contiguous construction to ensure that actual dimensions correspond to established dimensions.

2. Provide allowance for trimming and fitting at site.

1.07 COORDINATION

A. Coordinate installation of anchorages for metal fabrications. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

B. Coordinate installation of steel weld plates and angles for casting into concrete that are specified in this Section but required for work of another Section. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.01 METALS, GENERAL

A. Recycled Content: Materials/products shall contain the maximum amount of recycled content allowed that retains material integrity.

B. Regionally Extracted, Harvested, or Recovered and Manufactured Materials:
   1. Preference shall be given to suppliers whose facilities are within a 500 mile radius of the project site.
   2. Preference shall also be given to materials that are harvested, extracted, mined, quarried, etc. within a 500 mile radius of the project site.

C. Metal Surfaces, General: Provide materials with smooth, flat surfaces, unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

2.02 FERROUS METALS

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

B. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 666, Type 304.

C. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304.

D. Steel Tubing: ASTM A 500, cold-formed steel tubing.

E. Steel Pipe: ASTM A 53/A 53M, standard weight (Schedule 40), unless another weight is indicated or required by structural loads.

F. Slotted Channel Framing: Cold-formed metal channels with continuous slot complying with MFMA-3.
   2. Material: Steel complying with ASTM A 1008/A 1008M, commercial steel, Type B; 0.0966-inch minimum thickness; coated with rust-inhibitive, baked-on, acrylic enamel.

G. Cast Iron: ASTM A 48/A 48M, Class 30, unless another class is indicated or required by structural loads.

2.03 NONFERROUS METALS


C. Aluminum Castings: ASTM B 26/B 26M, Alloy 443.0-F.

2.04 FASTENERS

A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 5, at exterior walls. Provide stainless-steel fasteners for fastening aluminum. Select fasteners for type, grade, and class required.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.

C. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, nuts and, where indicated, flat washers; ASTM F 593 for bolts and ASTM F 594 for nuts, Alloy Group 1.

D. Anchor Bolts: ASTM F 1554, Grade 36.
   1. Provide hot-dip or mechanically deposited, zinc-coated anchor bolts where item being fastened is indicated to be galvanized.

E. Eyebolts: ASTM A 489.

F. Machine Screws: ASME B18.6.3.

G. Lag Bolts: ASME B18.2.1.

H. Wood Screws: Flat head, ASME B18.6.1.


K. Cast-in-Place Anchors in Concrete: Anchors capable of sustaining, without failure, a load equal to four times the load imposed, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
   1. Threaded or wedge type; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, hot-dip galvanized per ASTM A 153/A 153M.

L. Expansion Anchors: Anchor bolt and sleeve assembly with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

2.05 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
      a. Apply 2 coats of primer to fabrications that will be inaccessible after erection.


C. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

E. Concrete Materials and Properties: Comply with requirements in Division 03 Section “Cast-in-Place Concrete” for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 3000 psi, unless otherwise indicated.

2.06 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch, unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work true to line and level with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts, unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
   1. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches, with a minimum 6-inch embedment and 2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

2.07 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction, unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction retained by framing and supports. Cut, drill, and tap units to receive hardware, hangers, and similar items.
1. Fabricate units from slotted channel framing where indicated.
2. Furnish inserts if units are installed after concrete is placed.
C. Galvanize miscellaneous framing and supports where indicated.

2.08 LOOSE STEEL LINTELS
A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Weld adjoining members together to form a single unit where indicated.
B. Size loose lintels to provide bearing length at each side of openings equal to 1/12 of clear span but not less than 8 inches, unless otherwise indicated.
C. Galvanize loose steel lintels located in exterior walls.

2.09 SHELF ANGLES
A. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4-inch bolts, spaced not more than 6 inches from ends and 24 inches o.c., unless otherwise indicated.
  1. Provide mitered and welded units at corners.
  2. Provide open joints in shelf angles at expansion and control joints. Make open joint approximately 2 inches larger than expansion or control joint.
B. Galvanize shelf angles located in exterior walls.
C. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete and fully-grouted concrete unit masonry.

2.10 LOOSE BEARING AND LEVELING PLATES
A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.
B. Galvanize plates after fabrication.

2.11 STEEL WELD PLATES AND ANGLES
A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with not less than two integrally welded steel strap anchors for embedding in concrete.

2.12 MISCELLANEOUS STEEL TRIM
A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.
B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.
  1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.
C. Galvanize exterior miscellaneous steel trim.

2.13 METAL LADDERS
A. General:
  1. Comply with ANSI A14.3, unless otherwise indicated.
  2. For elevator pit ladders, comply with ASME A17.1.
  3. Space siderails 20 inches apart, unless otherwise indicated.

METAL FABRICATIONS
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4. Support each ladder at top and bottom and not more than 60 inches o.c. with welded or bolted brackets, made from same metal as ladder.
   a. Size brackets so centerline of ladder rungs is 7 inches from wall.

B. Steel Ladders:
      a. Extend side rails of ladders at least 42 inches above the top landing.
      Return side rails over tops of walls to support top landing and rungs on opposite side of wall where applicable.
   3. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
   4. Provide nonslip surfaces on top of each rung, either by coating rung with aluminum-oxide granules set in epoxy-resin adhesive or by using a type of manufactured rung filled with aluminum-oxide grout.
   5. Galvanize exterior ladders, including brackets and fasteners.
   6. Ladders Traversing Parapets: Fabricate top landing of 1 inch deep by 3/16 inch thick galvanized bar grating, 1 3/6 inch bar spacing, 4 inch cross-bar centers, sized to span top of wall.

2.14 METAL SHIPS' LADDERS
A. Provide metal ships' ladders where indicated. Fabricate of open-type construction with channel or plate stringers, pipe and tube railings, and bar grating treads, unless otherwise indicated. Provide brackets and fittings for installation.
   1. Fabricate ships' ladders, including treads and railings from steel.
   2. Comply with applicable requirements in Division 05 Section "Metal Stairs" for railings.
B. Galvanize exterior steel ships' ladders, including treads, railings, brackets, and fasteners.

2.15 METAL BOLLARDS
A. Fabricate metal bollards from 1/4-inch wall-thickness rectangular steel tubing.
   1. Cap bollards with 1/4-inch-thick steel plate.
   2. Where bollards are indicated to receive push-button controls for door operators, provide necessary cutouts for push-button controls and hole for wire.
B. Fabricate internal sleeves for removable bollards from Schedule 40 steel pipe or 1/4-inch wall-thickness steel tubing with an OD approximately 1/16 inch less than ID of bollards. Match drill sleeve and bollard for 3/4 inch steel machine bolt.

2.16 ABRASIVE METAL NOSINGS
A. Cast-Metal Units: Cast gray iron, Class 20, with an integral abrasive finish consisting of aluminum oxide, silicon carbide, or a combination of both. Fabricate units in sizes and configurations indicated and in lengths necessary to accurately fit openings or conditions.
   1. Manufacturers:
      a. American Safety Tread Co., Inc.
      b. Balco Inc.
      c. Barry Pattern & Foundry Co., Inc.
      d. Granite State Casting Co.
      e. Safe-T-Metal Co.
      f. Wooster Products Inc.
   2. Nosings: Cross-hatched units, 4 inches wide with 1/4-inch lip, for casting into concrete steps.
B. Apply bituminous paint to concealed bottoms, sides, and edges of cast-metal units set into concrete.
2.17 FINISHES, GENERAL
A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
B. Finish metal fabrications after assembly.

2.18 STEEL AND IRON FINISHES
A. Galvanizing: Hot-dip galvanize items as indicated to comply with applicable standard listed below:
   1. ASTM A 123/A 123M, for galvanizing steel and iron products.
   2. ASTM A 153/A 153M, for galvanizing steel and iron hardware.
B. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface preparation specifications and environmental exposure conditions of installed metal fabrications:
   1. SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
C. Shop Priming: Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finishes and those to be embedded in concrete, sprayed-on fireproofing, or masonry, unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
   1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

2.19 STAINLESS-STEEL FINISHES
A. Remove tool and die marks and stretch lines or blend into finish.
B. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.
C. Bright, Directional Satin Finish: No. 4.
D. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

2.20 ALUMINUM FINISHES
A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
B. As-Fabricated Finish: AA-M10 (Mechanical Finish: as fabricated, unspecified).
C. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL
A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
C. Field Welding: Comply with the following requirements:
1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag bolts, wood screws, and other connectors.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

F. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with a heavy coat of bituminous paint.

3.02 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS
A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.
B. Anchor supports for operable partitions securely to and rigidly brace from building structure.

3.03 INSTALLING BEARING AND LEVELING PLATES
B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.
   1. Use nonshrink grout, either metallic or nonmetallic, in concealed locations where not exposed to moisture; use nonshrink, nonmetallic grout in exposed locations, unless otherwise indicated.
   2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.04 INSTALLING METAL BOLLARDS
A. Anchor bollards in place with concrete footings. Center and align bollards in holes 3 inches above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.
B. Anchor internal sleeves for removable bollards in place with concrete footings. Center and align sleeves in holes 3 inches above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace sleeves in position until concrete has cured.
C. Place removable bollards over internal sleeves and secure with 3/4-inch machine bolts and nuts. After tightening nuts, drill holes in bolts for inserting padlocks. Owner will furnish padlocks.
3.05 INSTALLING NOSINGS
   A. Center nosings on tread widths.
   B. For nosings embedded in concrete steps or curbs, align nosings flush with riser faces and level with tread surfaces.

3.06 ADJUSTING AND CLEANING
   A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
      1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.
   B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 09 painting Sections.
   C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION
SECTION 05 51 00
METAL STAIRS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes:
1. Preassembled steel stairs with concrete-filled treads.
2. Ornamental steel-framed stairs.
3. Steel railings attached to metal stairs.
4. Steel handrails attached to walls adjacent to metal stairs.
5. Railing gates at the level of exit discharge.

B. Related Sections include the following:
1. Division 03 Concrete Sections for concrete fill for stair treads and platforms.
2. Division 05 Section "Metal Fabrications" for metal nosings not installed in metal stairs.
3. Division 05 Section "Pipe and Tube Railings" for pipe and tube railings.
4. Division 05 Section "Decorative Metal Railings" for ornamental metal railings.
5. Division 06 Section "Miscellaneous Rough Carpentry" for wood blocking for anchoring railings.
6. Division 09 Section "Non-Structural Metal Framing" for metal backing for anchoring railings.

1.03 PERFORMANCE REQUIREMENTS

A. Structural Performance of Stairs: Provide metal stairs capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
1. Uniform Load: 100 lbf/sq. ft.
2. Concentrated Load: 300 lbf applied on an area of 4 sq. in.
3. Uniform and concentrated loads need not be assumed to act concurrently.
4. Stair Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.
5. Limit deflection of treads, platforms, and framing members to L/360.

B. Structural Performance of Railings: Provide railings capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
1. Handrails:
   a. Uniform load of 50 lbf/ft. applied in any direction.
   b. Concentrated load of 200 lbf applied in any direction.
   c. Uniform and concentrated loads need not be assumed to act concurrently.

2. Top Rails of Guards:
   a. Uniform load of 50 lbf/ft. applied in any direction.
   b. Concentrated load of 200 lbf applied in any direction.
   c. Uniform and concentrated loads need not be assumed to act concurrently.
3. Infill of Guards:
a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft.

1.04 SUBMITTALS
A. Product Data: For metal stairs and the following:
   1. Nonslip aggregates and nonslip-aggregate finishes.
   2. Abrasive nosings.
   3. Paint products.
B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Provide templates for anchors and bolts specified for installation under other Sections.
   2. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
C. Samples: For the following products, in manufacturer's standard sizes:
   1. Abrasive nosings.
D. LEED Submittals:
   1. Credit MR 4.1 and MR 4.2: Recycled Content: Product Data indicating percentages by weight of postconsumer and preconsumer recycled content for products having recycled content.
      a. Include statement indicating costs for each product having recycled content.
   2. Credits MR 5.1 and MR 5.2: Regionally Extracted, Harvested, or Recovered and Manufactured Materials:
      a. Indicate location of manufacturing facility, including name, address, and distance between manufacturing facility and the project site. Provide manufacturer's documentation indication location where the base materials were extracted, mined, quarried, harvested, etc., and the distance between this location and the project site. Also include material costs, excluding cost of installation.
E. Welding certificates.

1.05 QUALITY ASSURANCE
A. Installer Qualifications: Fabricator of products.
B. NAAMM Stair Standard: Comply with "Recommended Voluntary Minimum Standards for Fixed Metal Stairs" in NAAMM AMP 510, "Metal Stairs Manual," for class of stair designated, unless more stringent requirements are indicated.
   1. Preassembled Stairs: Commercial class.
C. Welding: Qualify procedures and personnel according to the following:
   1. AWS D1.1, "Structural Welding Code--Steel."
   2. AWS D1.3, "Structural Welding Code--Sheet Steel."

1.06 COORDINATION
A. Coordinate installation of anchorages for metal stairs. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
B. Coordinate locations of hanger rods and struts with other work so that they will not encroach on required stair width and will be within the fire-resistance-rated stair enclosure.

PART 2 - PRODUCTS

2.01 METALS, GENERAL

A. Recycled Content: Materials/products shall contain the maximum amount of recycled content allowed that retains material integrity.

B. Regionally Extracted, Harvested, or Recovered and Manufactured Materials:
   1. Preference shall be given to suppliers whose facilities are within a 500 mile radius of the project site.
   2. Preference shall also be given to materials that are harvested, extracted, mined, quarried, etc. within a 500 mile radius of the project site.

C. Metal Surfaces, General: Provide materials with smooth, flat surfaces, unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

2.02 FERROUS METALS

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

B. Steel Bars for Grating Treads: ASTM A 36/A 36M.

C. Uncoated, Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, either commercial steel, Type B, or structural steel, Grade 30, unless another grade is required by design loads.

D. Galvanized Steel Sheet: ASTM A 653/A 653M, G90 coating, either commercial steel, Type B, or structural steel, Grade 33, unless another grade is required by design loads.

2.03 ABRASIVE NOSINGS

A. Extruded Units: Extruded-aluminum units with abrasive filler consisting of aluminum oxide, silicon carbide, or a combination of both, in an epoxy-resin binder. Fabricate units in sizes and configurations indicated and in lengths necessary to accurately fit openings or conditions.
   1. Manufacturers:
      a. ACL Industries, Inc.
      b. American Safety Tread Co., Inc.
      c. Amstep Products.
      d. Armstrong Products, Inc.
      e. Balco Inc.
      f. Granite State Casting Co.
      g. Wooster Products Inc.

   2. Provide ribbed units, with abrasive filler strips projecting 1/16 inch above aluminum extrusion.

   3. Nosings: Square-back units, 3 inches wide, without lip.

B. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with manufacturer.

C. Apply clear lacquer to concealed bottoms, sides, and edges of extruded units set into concrete.
2.04 FASTENERS
A. General: Provide zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 25 for exterior use, and Class Fe/Zn 5 where built into exterior walls. Select fasteners for type, grade, and class required.
B. Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.
C. Anchor Bolts: ASTM F 1554, Grade 36.
1. Provide hot-dip or mechanically deposited, zinc-coated anchor bolts for exterior stairs.
D. Machine Screws: ASME B18.6.3.
E. Lag Bolts: ASME B18.2.1.
H. Expansion Anchors: Anchor bolt and sleeve assembly with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

2.05 MISCELLANEOUS MATERIALS
A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
B. Shop Primers: Tnemec 10-99 long-oil alkyd primer.
E. Concrete Materials and Properties: Comply with requirements in Division 03 Section "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 3000 psi, unless otherwise indicated.
F. Welded Wire Fabric: ASTM A 185, 6 by 6 inches--W1.4 by W1.4, unless otherwise indicated.

2.06 FABRICATION, GENERAL
A. Provide complete stair assemblies, including metal framing, hangers, struts, railings, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.
1. Join components by welding, unless otherwise indicated.
2. Use connections that maintain structural value of joined pieces.
3. Fabricate treads and platforms of exterior stairs so finished walking surfaces slope to drain.
B. Preassembled Stairs: Assemble stairs in shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch, unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

E. Form exposed work true to line and level with accurate angles and surfaces and straight edges.

F. Weld connections to comply with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Weld exposed corners and seams continuously, unless otherwise indicated.
   5. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated. Locate joints where least conspicuous.

H. Fabricate joints that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

2.07 STEEL-FRAMED STAIRS

A. Stair Framing:
   1. Fabricate stringers of steel channels.
      a. Provide closures for exposed ends of channel stringers.
   2. Construct platforms of steel channel headers and miscellaneous framing members as needed to comply with performance requirements.
   3. Weld stringers to headers; weld framing members to stringers and headers.
   4. Where stairs are enclosed by gypsum board assemblies, provide hanger rods or struts to support landings from floor construction above or below. Locate hanger rods and struts where they will not encroach on required stair width and will be within the fire-resistance-rated stair enclosure.
   5. Where masonry walls support metal stairs, provide temporary supporting struts designed for erecting steel stair components before installing masonry.

B. Metal-Pan Stairs: Form risers, subtread pans, and subplatforms to configurations shown from steel sheet of thickness needed to comply with performance requirements but not less than 0.0677 inch.
   1. Steel Sheet: Uncoated hot-rolled steel sheet, unless otherwise indicated.
   2. Directly weld metal pans to stringers; locate welds on top of subtreads where they will be concealed by concrete fill. Do not weld risers to stringers.
   3. Shape metal pans to include nosing integral with riser.
      a. Coordinate height of riser with thickness of nosing.
   4. Provide subplatforms of configuration indicated or, if not indicated, the same as subtreads. Weld subplatforms to platform framing.
2.08 STEEL RAILINGS

A. General: Fabricate railings to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of tube, post spacings, and anchorage, but not less than that needed to withstand indicated loads.

1. Gates: Form gates from steel tube of same size and shape as top rails, with infill to match guards. Provide with cam-type self-closing hinges for fastening to wall and overlapping stop with rubber bumper to prevent gate from opening in direction opposite egress.

B. Welded Connections: Fabricate railings with welded connections. Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.

C. Form changes in direction of railings as follows:

1. By flush bends.

D. Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

E. Close exposed ends of railing members with prefabricated end fittings.

F. Provide wall returns at ends of wall-mounted handrails, unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch or less.

G. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, end closures, flanges, miscellaneous fittings, and anchors for interconnecting components and for attaching to other work. Furnish inserts and other anchorage devices for connecting to concrete or masonry work.

1. Connect posts to stair framing by direct welding, unless otherwise indicated.
2. For galvanized railings, provide galvanized fittings, brackets, fasteners, sleeves, and other ferrous-metal components.
3. For nongalvanized railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves, except galvanize anchors embedded in exterior masonry and concrete construction.

H. Fillers: Provide fillers made from steel plate, or other suitably crush-resistant material, where needed to transfer wall bracket loads through wall finishes to structural supports. Size fillers to suit wall finish thicknesses and to produce adequate bearing area to prevent bracket rotation and overstressing of substrate.

2.09 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish metal stairs after assembly.

C. Galvanizing: Hot-dip galvanize items as indicated to comply with applicable standard listed below:

1. ASTM A 123/A 123M, for galvanizing steel and iron products.
2. ASTM A 153/A 153M, for galvanizing steel and iron hardware.
3. Fill vent and drain holes that will be exposed in finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

D. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface preparation specifications and environmental exposure conditions of installed products:
1. Exterior Stairs (SSPC Zone 1B): SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Interior Stairs (SSPC Zone 1A): SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

E. Apply shop primer to uncoated surfaces of metal stair components, except those with galvanized finishes and those to be embedded in concrete or masonry unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.

C. Install metal stairs by welding stair framing to steel structure or to weld plates cast into concrete, unless otherwise indicated.

D. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

E. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

F. Field Welding: Comply with the following requirements:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

G. Place and finish concrete fill for treads and platforms to comply with Division 03 Section "Cast-in-Place Concrete."
   1. Install abrasive nosings with anchors fully embedded in concrete. Center nosings on tread width.

3.02 INSTALLING METAL STAIRS WITH GROUTED BASEPLATES


B. Set steel stair baseplates on wedges, shims, or leveling nuts. After stairs have been positioned and aligned, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.
   1. Use nonmetallic, nonshrink grout, unless otherwise indicated.
   2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.
3.03 INSTALLING STEEL RAILINGS

A. Adjust railing systems before anchoring to ensure matching alignment at abutting joints. Space posts at spacing indicated or, if not indicated, as required by design loads. Plumb posts in each direction. Secure posts and rail ends to building construction as follows:
1. Anchor posts to steel by welding directly to steel supporting members.
2. Form or core-drill holes not less than 5 inches deep and 3/4 inch larger than OD of post for installing posts in concrete. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer’s written instructions.
3. Anchor handrail ends to concrete and masonry with steel round flanges welded to rail ends and anchored with postinstalled anchors and bolts.

B. Attach handrails to wall with wall brackets. Provide bracket with 1-1/2-inch clearance from inside face of handrail and finished wall surface. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads. Secure wall brackets to building construction as follows:
1. Use type of bracket with flange tapp ed for concealed anchorage to threaded hanger bolt.
2. For hollow masonry anchorage, use toggle bolts.
3. For steel-framed gypsum board assemblies, fasten brackets directly to steel framing or concealed reinforcements using self-tapping screws of size and type required to support structural loads.

3.04 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

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. Steel pipe and bar railings.

B. Related Sections:
1. Division 05 Section "Metal Stairs" for steel tube railings associated with metal stairs.

1.03 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design railings, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. General: In engineering railings to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:
   1. Steel: 72 percent of minimum yield strength.

C. Structural Performance: Railings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
   1. Handrails and Top Rails of Guards:
      a. Uniform load of 50 lbf/ft applied in any direction.
      b. Concentrated load of 200 lbf applied in any direction.
      c. Uniform and concentrated loads need not be assumed to act concurrently.
   2. Infill of Guards:
      a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft.
      b. Infill load and other loads need not be assumed to act concurrently.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
   1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

E. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1.04 SUBMITTALS

A. Product Data: For the following:
   1. Manufacturer's product lines of mechanically connected railings.
   2. Grout, anchoring cement, and paint products.
B. LEED Submittals:
   1. Product Data for Credit MR 4.1 and Credit MR 4.2: Indicating percentages by weight of postconsumer and preconsumer recycled content for products having recycled content. Include statement indicating costs for each product having recycled content.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

D. Samples: For each type of exposed finish required.
   1. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters.
   2. Fittings and brackets.

E. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

F. Welding certificates.

G. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

1.05 QUALITY ASSURANCE
A. Source Limitations: Obtain each type of railing from single source from single manufacturer.

B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.06 PROJECT CONDITIONS
A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

1.07 COORDINATION AND SCHEDULING
A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

C. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not satisfy structural performance requirements.

PART 2 - PRODUCTS
2.01 GENERAL
A. Recycled Content: Materials/products shall contain the maximum amount of recycled content allowed that retains material integrity.
2.02 METALS, GENERAL
A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.
B. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.

2.03 STEEL AND IRON
A. Recycled Content of Steel Products: Provide products with average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
B. Tubing: ASTM A 500 (cold formed) or ASTM A 513.
C. Pipe: ASTM A 53/A 53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.
   1. Provide galvanized finish for exterior installations and where indicated.
D. Plates, Shapes, and Bars: ASTM A 36/A 36M.

2.04 FASTENERS
A. General: Provide the following:
   1. Ungalvanized-Steel Railings: Plated steel fasteners complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5 for zinc coating.
   2. Hot-Dip Galvanized Railings: Type 304 stainless-steel or hot-dip zinc-coated steel fasteners complying with ASTM A 153/A 153M or ASTM F 2329 for zinc coating.
B. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads.
C. Fasteners for Interconnecting Railing Components:
   1. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless exposed fasteners are unavoidable or are the standard fastening method for railings indicated.
   2. Provide square or hex socket flat-head machine screws for exposed fasteners unless otherwise indicated.
D. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
   1. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, unless otherwise indicated.

2.05 MISCELLANEOUS MATERIALS
A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
B. Etching Cleaner for Galvanized Metal: Complying with MPI#25.
C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
D. Shop Primers: Provide primers that comply with Division 09 painting Sections.

2.06 FABRICATION

A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.

B. Assemble railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

D. Form work true to line and level with accurate angles and surfaces.

E. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.

G. Connections: Fabricate railings with welded connections unless otherwise indicated.

H. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.
   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 flux immediately.
   4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.

I. Nonwelded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.
   1. Fabricate splice joints for field connection using an epoxy structural adhesive if this is manufacturer’s standard splicing method.

J. Form changes in direction as follows:
   1. By flush bends

K. Bend members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

L. Close exposed ends of railing members with prefabricated end fittings.

M. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.

N. For railing posts set in concrete, provide stainless-steel sleeves not less than 6 inches long with inside dimensions not less than 1/2 inch greater than outside dimensions of post, with metal plate forming bottom closure.

O. For removable railing posts, fabricate slip-fit sockets from stainless-steel tube or pipe whose ID is sized for a close fit with posts; limit movement of post without lateral load.
measured at top, to not more than one-fortieth of post height. Provide socket covers
designed and fabricated to resist being dislodged.
1. Provide chain with eye, snap hook, and staple across gaps formed by removable
railing sections at locations indicated. Fabricate from same metal as railings.

2.07 FINISHES, GENERAL
A. Comply with NAAMM’s “Metal Finishes Manual for Architectural and Metal Products” for
recommendations for applying and designating finishes.
B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable,
temporary protective covering before shipping.
C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces
are acceptable if they are within one-half of the range of approved Samples. Noticeable
variations in the same piece are not acceptable. Variations in appearance of other
components are acceptable if they are within the range of approved Samples and are
assembled or installed to minimize contrast.
D. Provide exposed fasteners with finish matching appearance, including color and texture,
of railings.

2.08 STEEL AND IRON FINISHES
A. Galvanized Railings:
1. Hot-dip galvanize exterior steel and iron railings, including hardware, after
fabrication.
2. Comply with ASTM A 123/A 123M for hot-dip galvanized railings.
4. Do not quench or apply post galvanizing treatments that might interfere with paint
adhesion.
5. Fill vent and drain holes that will be exposed in the finished Work, unless
indicated to remain as weep holes, by plugging with zinc solder and filing off
smooth.
B. For galvanized railings, provide hot-dip galvanized fittings, brackets, fasteners, sleeves,
and other ferrous components.
C. Preparing Galvanized Railings for Shop Priming: After galvanizing, thoroughly clean
railings of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner.
D. For nongalvanized steel railings, provide nongalvanized ferrous-metal fittings, brackets,
fasteners, and sleeves, except galvanize anchors to be embedded in exterior concrete or
masonry.
E. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with
SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
F. Primer Application: Apply shop primer to prepared surfaces of railings unless otherwise
indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification
No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Primer need
not be applied to surfaces to be embedded in concrete or masonry.
1. Shop prime uncoated railings with Tnemec 10-99 long-oil alkyd primer.
2. Do not apply primer to galvanized surfaces.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL
A. Fit exposed connections together to form tight, hairline joints.
B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.
   1. Do not weld, cut, or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
   2. Set posts plumb within a tolerance of 1/16 inch in 3 feet.
   3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.

C. Adjust railings before anchoring to ensure matching alignment at abutting joints.

D. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.02 RAILING CONNECTIONS

A. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article whether welding is performed in the shop or in the field.

B. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 2 inches beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within 6 inches of post.

3.03 ANCHORING POSTS

A. Use metal sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions.

B. Leave anchorage joint exposed with anchoring material flush with adjacent surface.

C. Anchor posts to metal surfaces with oval flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members as follows:
   1. For steel pipe railings, weld flanges to post and bolt to metal supporting surfaces.

D. Install removable railing sections, where indicated, in slip-fit metal sockets cast in concrete.

3.04 ADJUSTING AND CLEANING

A. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 09 painting Sections.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

3.05 PROTECTION

A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

END OF SECTION
SECTION 06 10 00
MISCELLANEOUS ROUGH CARPENTRY

PART 1 - GENERAL

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

1.02 SUMMARY
A. This Section is general in nature. Rough Carpentry items specified may or may not be
   required for this Project.
B. This Section includes the following:
   1. Framing with dimension lumber.
   2. Wood blocking, cants, and nailers.
   3. Wood furring and grounds.
   4. Plywood backing panels.

1.03 DEFINITIONS
A. Dimension Lumber: Lumber of 2 inches nominal or greater but less than 5 inches
   nominal in least dimension.
B. Lumber grading agencies, and the abbreviations used to reference them, include the
   following:
   2. NLGA: National Lumber Grades Authority.
   3. RIS: Redwood Inspection Service.
   5. WCLIB: West Coast Lumber Inspection Bureau.

1.04 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 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.
   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.
B. LEED Submittals:
   1. Credit MR 4.1 and MR 4.2: Recycled Content: Product Data indicating
      percentages by weight of postconsumer and preconsumer recycled content for
      products having recycled content.
      a. Include statement indicating costs for each product having recycled
         content.
   2. Credits MR 5.1 and MR 5.2: Regionally Extracted, Harvested, or Recovered and
      Manufactured Materials:
a. Indicate location of manufacturing facility, including name, address, and distance between manufacturing facility and the project site. Provide manufacturer’s documentation indicating location where the base materials were extracted, mined, quarried, harvested, etc., and the distance between this location and the project site. Also include material costs, excluding cost of installation.

3. Credit MR 7: Certificates of chain-of-custody signed by manufacturers certifying that products specified to be made from certified wood were made from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC 1.2, "Principles and Criteria." Include evidence that mill is certified for chain-of-custody by an FSC-accredited certification body.


5. Credit EQ 4.4: Low Emitting Materials:
   a. Composite wood manufacturer’s product data for each composite wood product used indicating that bonding agent used contains no urea formaldehyde.
   b. Adhesive manufacturer’s product data for each adhesive used indicating that the adhesive contains no urea-formaldehyde.

C. 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 American Lumber Standard Committee (ALSC) Board of Review.

1.05 QUALITY ASSURANCE

A. Source Limitations for Engineered Wood Products: Obtain each type of engineered wood product through one source from a single manufacturer.

B. Forest Certification: For the following wood products, provide materials produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC 1.2, "Principles and Criteria":
   1. Miscellaneous lumber.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.01 WOOD PRODUCTS, GENERAL

A. Regionally Extracted, Harvested, or Recovered and Manufactured Materials:
   1. Preference shall be given to supplier whose facilities are within a 500 mile radius of the project site.
   2. Preference shall also be given to materials that are harvested, extracted, mined, quarried, etc. within a 500 mile radius of the project site.

B. Lumber fabricated from old growth timber is not permitted.

C. Lumber salvaged from deconstruction or demolition of existing buildings or structures is permitted provided it is clean, denailed, and free of paint and finish materials, and other contamination; identify source: see Division 01 Section "Sustainable Design Requirements" for requirements for reused products.
D. Lumber fabricated from recovered timber (abandoned in transit) is permitted, unless otherwise noted, provided it meets the specified requirements for new lumber and is free of contamination; identify source.

E. 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. 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.
   3. Provide dressed lumber, S4S, unless otherwise indicated.

2.02 WOOD-PRESERVATIVE-TREATED LUMBER
A. Preservative Treatment by Pressure Process: AWPA C2.
   1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.

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.

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, sleepers, 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 in crawlspaces or unexcavated areas.
   5. Wood floor plates that are installed over concrete slabs-on-grade.

2.03 FIRE-RETARDANT-TREATED MATERIALS
A. General: Comply with performance requirements in AWPA C20 (lumber) and AWPA C27 (plywood).
   1. Use Exterior type for exterior locations and where indicated.
   2. Use Interior Type A, unless otherwise indicated.

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

C. Application: Treat all rough carpentry, unless otherwise indicated.

2.04 DIMENSION LUMBER FRAMING
A. Maximum Moisture Content: 15 percent.

B. Non-Load-Bearing Interior Partitions: Construction or No. 2 grade of any species.
   1. Framing Other Than Non-Load-Bearing Interior Partitions: Any species of machine stress-rated dimension lumber with a grade of not less than 2100f-1.8E.
2.05 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. Rooftop equipment bases and support curbs.
   5. Furring.

B. For items of dimension lumber size, provide Construction or No. 2 grade lumber with 15 percent maximum moisture content of any species.

C. For exposed boards, provide lumber with 15 percent maximum moisture content and any of the following species and grades:
   1. Eastern white pine, Idaho white, lodgepole, ponderosa, or sugar pine; Standard or No. 3 Common grade; NeLMA, NLGA, WCLIB, or WWPA.
   2. Mixed southern pine, No. 2 grade; SPIB.
   3. Hem-fir or hem-fir (north), Construction or No. 2 Common grade; NLGA, WCLIB, or WWPA.
   4. Spruce-pine-fir (south) or spruce-pine-fir, Construction or No. 2 Common grade; NeLMA, NLGA, WCLIB, or WWPA.

D. For concealed boards, provide lumber with 15 percent maximum moisture content and any of the following species and grades:
   1. Mixed southern pine, No. 2 grade; SPIB.
   2. Hem-fir or hem-fir (north), Construction or 2 Common grade; NLGA, WCLIB, or WWPA.
   3. Spruce-pine-fir (south) or spruce-pine-fir, Construction or 2 Common grade; NeLMA, NLGA, WCLIB, or WWPA.
   4. Eastern softwoods, No. 2 Common grade; NeLMA.
   5. Northern species, No. 2 Common grade; NLGA.
   6. Western woods, Construction or No. 2 Common grade; WCLIB or WWPA.

E. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.

F. 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.

G. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.

2.06 PLYWOOD BACKING PANELS

A. Telephone and Electrical Equipment Backing Panels: DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than 3/4 inch nominal thickness.

2.07 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, Brads, and Staples: ASTM F 1667.
D. Wood Screws: ASME B18.6.1.
E. Lag Bolts: ASME B18.2.1.
F. Bolts: Steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers.
G. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.
   2. Material: Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2.

2.08 MISCELLANEOUS MATERIALS
A. Adhesives for Gluing Furring and Sleepers to Concrete or Masonry: Formulation complying with ASTM D 3498 that is approved for use indicated by adhesive manufacturer.
   1. Adhesives must meet or exceed the VOC limits of South Coast Air Quality Management District Rule #1168. Provide low VOC, FS MMMA125C, Type II, water and mold resistant adhesives.
B. 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
3.01 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 "Details for Conventional Wood Frame Construction," unless otherwise indicated.
C. Do not splice structural members between supports, unless otherwise indicated.
D. 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.
E. 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.
F. 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.
G. 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.

H. 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 between members. Install fasteners without splitting wood; do not countersink nail heads, unless otherwise indicated.

3.02 WOOD GROUND, 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. Provide permanent grounds of dressed, pressure-preservative-treated, key-beveled lumber not less than 1-1/2 inches wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

3.03 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 Plywood or Hardboard Paneling: Install 1-by-3-inch nominal-size furring horizontally at 24 inches o.c.
   C. Furring to Receive Gypsum Board: Install 1-by-2-inch nominal-size furring vertically at 16 inches o.c.

3.04 WALL AND PARTITION FRAMING INSTALLATION
   A. General: Provide single bottom plate and double top plates using members of 2-inch nominal thickness whose widths equal that of studs, except single top plate may be used for non-load-bearing partitions. Fasten plates to supporting construction, unless otherwise indicated.
      1. For interior partitions and walls, provide 2-by-4-inch nominal-size wood studs spaced 16 inches o.c., unless otherwise indicated.
      2. Provide continuous horizontal blocking at midpoint of partitions more than 96 inches high, using members of 2-inch nominal thickness and of same width as wall or partitions.
   B. Construct corners and intersections with three or more studs, except that two studs may be used for interior non-load-bearing partitions.
   C. Frame openings with multiple studs and headers. Provide nailed header members of thickness equal to width of studs. Support headers on jamb studs.
      1. For non-load-bearing partitions, provide double-jamb studs and headers not less than 4-inch nominal depth for openings 48 inches and less in width, 6-inch nominal depth for openings 48 to 72 inches in width, 8-inch nominal depth for openings 72 to 120 inches in width, and not less than 10-inch nominal depth for openings 10 to 12 feet in width.
3.05 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

A. Construction waste shall be managed in accordance with provisions of Division 01 Section - Construction Waste Management and Disposal. Documentation shall be submitted to satisfy the requirements of that section.

B. Waste Disposal: Comply with the requirements of Division 01 Section "Construction Waste Management and Disposal," and as follows:
   1. Comply with applicable regulations.
   2. Do not burn scrap on project site.
   3. Do not burn scraps that have been pressure treated.
   4. Do not send materials treated with pentachlorophenol, CCA, or ACA to co-generation facilities or “waste-to-energy” facilities.

C. Do not leave any wood, shavings, sawdust, etc. on the ground or buried in fill.

D. Prevent sawdust and wood shavings from entering the storm drainage system.

3.06 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.
SECTION 06 16 00
SHEATHING

PART 1 - GENERAL

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

1.02 SUMMARY
A. This Section is general in nature. Sheathing items specified may or may not be required for this Project.
B. This Section includes the following:
   1. Wall sheathing.
   2. Roof sheathing.
   5. Flexible flashing at openings in sheathing.
C. Related Sections include the following:
   1. Division 01 Section "Sustainable Design Requirements" for additional LEED requirements.
   2. Division 06 Section "Miscellaneous Rough Carpentry" for plywood backing panels.

1.03 SUBMITTALS
A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
B. LEED Submittals:
   2. Credit EQ 4.4:
      a. Composite wood manufacturer's product data for each composite wood product used indicating that bonding agent used contains no urea formaldehyde.
      b. Adhesive manufacturer's product data for each adhesive used indicating that the adhesive contains no urea-formaldehyde.
   3. Credit MR 4.1 and MR 4.2: Product Data indicating percentages by weight of postconsumer and preconsumer recycled content for products having recycled content.
      a. Include statement indicating costs for each product having recycled content.
   4. Credit MR 5.1 and MR 5.2: Regionally Extracted, Harvested, or Recovered and Manufactured Materials:
      a. Indicate location of manufacturing facility, including name, address, and distance between manufacturing facility and the project site. Provide manufacturer's documentation indication location where the base materials were extracted, mined, quarried, harvested, etc., and the distance between this location and the project site. Also include material costs, excluding cost of installation.
5. Credit MR 7: Certificates of chain-of-custody signed by manufacturers certifying that products specified to be made from certified wood were made from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC 1.2, "Principles and Criteria." Include evidence that mill is certified for chain-of-custody by an FSC-accredited certification body.

C. Research/Evaluation Reports: For the following, showing compliance with building code in effect for Project:
1. Preservative-treated plywood.
2. Fire-retardant-treated plywood.

1.04 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: For assemblies with fire-resistance ratings, provide materials and construction identical to those of assemblies tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.


B. Forest Certification: For the following wood products, provide materials produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC 1.2, "Principles and Criteria":
1. Plywood.
2. Oriented strand board.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Stack plywood and other panels flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.01 WOOD PANEL PRODUCTS, GENERAL

A. Regionally Extracted, Harvested, or Recovered and Manufactured Materials:
1. Preference shall be given to supplier whose facilities are within a 500 mile radius of the project site.
2. Preference shall also be given to materials that are harvested, extracted, mined, quarried, etc. within a 500 mile radius of the project site.

B. Plywood: Either DOC PS 1 or DOC PS 2, unless otherwise indicated.

C. Oriented Strand Board: DOC PS 2.

D. Thickness: As needed to comply with requirements specified, but not less than thickness indicated.

E. Factory mark panels to indicate compliance with applicable standard.

2.02 PRESERVATIVE-TREATED PLYWOOD

1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.

B. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.
C. Application: Treat items indicated on Drawings and plywood in contact with masonry or concrete or used with roofing, flashing, vapor barriers, and waterproofing.

2.03 FIRE-RETARDANT-TREATED PLYWOOD
A. General: Comply with performance requirements in AWPA C27.
   1. Use treatment that does not promote corrosion of metal fasteners.
   2. Use Exterior type for exterior locations and where indicated.
   3. Use Interior Type A, High Temperature (HT) for roof sheathing and where indicated.
   4. Use Interior Type A, except as indicated above.
B. Kiln-dry material after treatment to a maximum moisture content of 15 percent. Do not use material that is warped or does not comply with requirements for untreated material.
C. Identify fire-retardant-treated plywood with appropriate classification marking of UL, U.S. Testing, Timber Products Inspection, or another testing and inspecting agency acceptable to authorities having jurisdiction.
D. Application: Treat all plywood, unless otherwise indicated.

2.04 WALL SHEATHING
   1. Span Rating: Not less than 16/0.
   2. Nominal Thickness: Not less than 1/2 inch.
B. Glass-Mat Gypsum Wall Sheathing: ASTM C 1177/1177M.
   1. Products: Subject to compliance with requirements, provide one of the following:
      2. "Dens-Glass Gold" by G-P Gypsum Corporation.
   4. Type and Thickness: Type X, 5/8 inch thick.

2.05 ROOF SHEATHING
A. Plywood Roof Sheathing: Exterior, Structural I sheathing.
   1. Nominal Thickness: Not less than 1/2 inch.

2.06 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 and wall sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.
B. Nails, Brads, and Staples: ASTM F 1667.
D. Wood Screws: ASME B18.6.1.
E. Screws for Fastening Wood Structural Panels to Cold-Formed Metal Framing: ASTM C 954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.
   1. For wall and roof sheathing panels, provide screws with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B 117.
F. Screws for Fastening Gypsum Sheathing to Cold-Formed Metal Framing: Steel drill screws, in length recommended by sheathing manufacturer for thickness of sheathing
board to be attached, with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B 117.
1. For steel framing less than 0.0329 inch thick, attach sheathing to comply with ASTM C 1002.
2. For steel framing from 0.033 to 0.112 inch thick, attach sheathing to comply with ASTM C 954.

2.07 WEATHER-RESISTANT SHEATHING PAPER
A. Building Paper: ASTM D 226, Type 1 (No. 15 asphalt-saturated organic felt), unperforated.
B. Building Wrap: ASTM E 1677, Type I air retarder; with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, when tested according to ASTM E 84; UV stabilized; and acceptable to authorities having jurisdiction.
   2. Water-Vapor Permeance: Not less than 152 g through 1 sq. m of surface in 24 hours per ASTM E 96, Desiccant Method (Procedure A).
   3. Allowable UV Exposure Time: Not less than three months.
C. Building-Wrap Tape: Pressure-sensitive plastic tape recommended by building-wrap manufacturer for sealing joints and penetrations in building wrap.

2.08 MISCELLANEOUS MATERIALS
A. Adhesives for Field Gluing Panels to Framing: Formulation complying with ASTM D 3498 that is approved for use with type of construction panel indicated by manufacturers of both adhesives and panels.
   1. Use adhesives that have a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
B. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film to produce an overall thickness of not less than 0.025 inch.
   1. Products: Subject to compliance with requirements, provide one of the following:
      c. MFM Building Products Corp.; Window Wrap.
      d. Polyguard Products, Inc.; Polyguard 300.
      e. Protecto Wrap Company; BT-25 XL.
C. Primer for Flexible Flashing: Product recommended by manufacturer of flexible flashing for substrate.

PART 3 - EXECUTION

3.01 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.
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.

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. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.

G. 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.

3.02 WOOD STRUCTURAL PANEL INSTALLATION

B. Fastening Methods: Fasten panels as indicated below:
1. Wall and Roof Sheathing:
   a. Nail to wood framing. Apply a continuous bead of glue to framing members at edges of wall sheathing panels.
   b. Screw to cold-formed metal framing.
   c. Space panels 1/8 inch apart at edges and ends.

3.03 GYPSUM SHEATHING INSTALLATION
A. Comply with GA-253 and with manufacturer’s written instructions.
1. Fasten gypsum sheathing to wood framing with nails or screws.
2. Fasten gypsum sheathing to cold-formed metal framing with screws.
4. Install boards with a 1/4-inch gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.

B. Apply fasteners so heads bear tightly against face of sheathing boards but do not cut into facing.

C. Horizontal Installation: Install sheathing with V-grooved edge down and tongue edge up. Interlock tongue with groove to bring long edges in contact with edges of adjacent boards without forcing. Abut ends of boards over centers of studs, and stagger end joints of adjacent boards not less than one stud spacing. Attach boards at perimeter and within field of board to each steel stud.
1. Space fasteners approximately 8 inches o.c. and set back a minimum of 3/8 inch from edges and ends of boards.
2. For sheathing under stucco cladding, boards may be initially tacked in place with screws if overlying self-furring metal lath is screw-attached through sheathing to studs immediately after sheathing is installed.
3. Extend sheathing to underside of deck where applicable. Ensure air barrier is continuous and complete.
D.** Vertical Installation**: Install board vertical edges centered over studs. Abut ends and edges of each board with those of adjacent boards. Attach boards at perimeter and within field of board to each stud.
   1. Space fasteners approximately 8 inches o.c. and set back a minimum of 3/8 inch from edges and ends of boards.
   2. For sheathing under stucco cladding, boards may be initially tacked in place with screws if overlying self-furring metal lath is screw-attached through sheathing to studs immediately after sheathing is installed.
   3. Extend sheathing to underside of deck where applicable. Ensure air barrier is continuous and complete.

### 3.04** WEATHER-RESISTANT SHEATHING-PAPER INSTALLATION**

**A. General**: Cover sheathing with weather-resistant sheathing paper as follows:
   1. Cut back barrier 1/2 inch on each side of the break in supporting members at expansion- or control-joint locations.
   2. Apply barrier to cover vertical flashing with a minimum 4-inch overlap, unless otherwise indicated.

**B. Building Paper**: Apply horizontally with a 2-inch overlap and a 6-inch end lap; fasten to sheathing with galvanized staples or roofing nails.

**C. Building Wrap**: Comply with manufacturer's written instructions.
   1. Seal seams, edges, fasteners, and penetrations with tape.
   2. Extend into jambs of openings and seal corners with tape.
   3. Extend building wrap to underside of deck where applicable. Ensure air barrier is continuous and complete.

### 3.05** FLEXIBLE FLASHING INSTALLATION**

**A. Apply flexible flashing where indicated to comply with manufacturers written instructions.**
   1. Prime substrates as recommended by flashing manufacturer.
   2. Lap seams and junctures with other materials at least 4 inches, except that at flashing flanges of other construction, laps need not exceed flange width.
   3. Lap flashing over weather-resistant building paper at bottom and sides of openings.
   4. Lap weather-resistant building paper over flashing at heads of openings.
   5. After flashing has been applied, roll surfaces with a hard rubber or metal roller to ensure that flashing is completely adhered to substrates.

### 3.06** CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL**

**A. Waste Disposal**: Comply with the requirements of Division 01 Section "Construction Waste Management and Disposal," and as follows:
   1. Comply with applicable regulations.
   2. Do not burn scrap on project site.
   3. Do not burn scraps that have been pressure treated.
   4. Do not send materials treated with pentachlorophenol, CCA, or ACA to co-generation facilities or “waste-to-energy” facilities.

**B. Do not leave any wood, shavings, sawdust, etc. on the ground or buried in fill.**

**C. Prevent sawdust and wood shavings from entering the storm drainage system.**

**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. This Section includes the following:
   1. Interior standing and running trim.
   2. Railing caps.
   5. Solid-surfacing-material countertops and window stools.
B. Related Sections include the following:
   1. Division 01 Section "Sustainable Design Requirements" for additional LEED requirements.
   2. Division 06 Section "Miscellaneous Rough Carpentry" for wood furring, blocking, shims, and hanging strips required for installing woodwork and concealed within other construction before woodwork installation.

1.03 DEFINITIONS
A. Interior architectural woodwork includes wood furring, blocking, shims, and hanging strips for installing woodwork items unless concealed within other construction before woodwork installation.

1.04 SUBMITTALS
A. Product Data: For each type of product indicated, including cabinet hardware and accessories and finishing materials and processes.
   1. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements.
B. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.
   1. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
   2. Show locations and sizes of cutouts and holes for plumbing fixtures faucets soap dispensers and other items installed in architectural woodwork.
   3. Show veneer leaves with dimensions, grain direction, exposed face, and identification numbers indicating the flitch and sequence within the flitch for each leaf.
C. Samples:
   1. Lumber with or for transparent finish, not less than 5 inches wide by 24 inches long, for each species and cut, finished on 1 side and 1 edge.
   2. Veneer-faced panel products with or for transparent finish, 12 by 24 inches, for each species and cut. Include at least one face-veneer seam and finish as specified.
3. Plastic laminates, 8 by 10 inches, for each type, color, pattern, and surface finish, with 1 sample applied to core material and specified edge material applied to 1 edge.

4. Solid-surfacing materials, 6 inches square.

D. LEED Submittals:
1. Credit MR 4.1 and MR 4.2: Recycled Content: Product Data indicating percentages by weight of postconsumer and preconsumer recycled content for products having recycled content.
   a. Include statement indicating costs for each product having recycled content.

2. Credit MR 5.1 and MR 5.2: Regionally Extracted, Harvested, or Recovered and Manufactured Materials:
   a. Indicate location of manufacturing facility, including name, address, and distance between manufacturing facility and the project site. Provide manufacturer's documentation indicating location where the base materials were extracted, mined, quarried, harvested, etc., and the distance between this location and the project site. Also include material costs, excluding cost of installation.

3. Credit MR 7: Certified Wood: Certificates of chain-of-custody signed by manufacturers certifying that products specified to be made from certified wood were made from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC 1.2, "Principles and Criteria." Include evidence that mill is certified for chain-of-custody by an FSC-accredited certification body.


5. Credit EQ 4.4: Low Emitting Materials:
   a. Composite wood manufacturer's product data for each composite wood product used indicating that bonding agent used contains no urea formaldehyde.
   b. Adhesive manufacturer's product data for each adhesive used indicating that the adhesive contains no urea-formaldehyde.

1.05 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate products similar to those required for this Project and whose products have a record of successful in-service performance. Shop is a certified participant in AWI's Quality Certification Program.

B. Installer Qualifications: Certified participant in AWI's Quality Certification Program.

C. Source Limitations: Engage a qualified woodworking firm to assume undivided responsibility for production of interior architectural woodwork with sequence-matched wood veneers.

D. Quality Standard: Unless otherwise indicated, comply with AWI's "Architectural Woodwork Quality Standards" for grades of interior architectural woodwork indicated for construction, finishes, installation, and other requirements.

E. Fire-Test-Response Characteristics: Where fire-retardant materials or products are indicated, provide materials and products with specified fire-test-response characteristics as determined by testing identical products per test method indicated by UL, ITS, or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify with appropriate markings of applicable testing and inspecting agency in the form of separable paper label or, where required by authorities having jurisdiction, imprint on surfaces of materials that will be concealed from view after installation.
F. Forest Certification: Provide interior architectural woodwork produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC 1.2, "Principles and Criteria."

G. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

H. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.06 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver woodwork until painting and similar operations that could damage woodwork have been completed in installation areas. If woodwork must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Project Conditions" Article.

1.07 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install woodwork until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

B. Environmental Limitations: Do not deliver or install woodwork until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature between 60 and 90 deg F and relative humidity between 17 and 50 percent during the remainder of the construction period.

C. Field Measurements: Where woodwork is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being enclosed, and indicate measurements on Shop Drawings.
2. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating woodwork without field measurements. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.08 COORDINATION

A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that interior architectural woodwork can be supported and installed as indicated.

PART 2 - PRODUCTS

2.01 MATERIALS

A. General: Provide materials that comply with requirements of AWI's quality standard for each type of woodwork and quality grade specified, unless otherwise indicated.

B. Regionally Extracted, Harvested, or Recovered and Manufactured Materials:
1. Preference shall be given to supplier whose facilities are within a 500 mile radius of the project site.
2. Preference shall also be given to materials that are harvested, extracted, mined, quarried, etc. within a 500 mile radius of the project site.

C. Lumber fabricated from old growth timber is not permitted.

D. Lumber salvaged from deconstruction or demolition of existing buildings or structures is permitted provided it is clean, denailed, and free of paint and finish materials, and other contamination; identify source: see Division 01 Section "Sustainable Design Requirements" for requirements for reused products.

E. Lumber fabricated from recovered timber (abandoned in transit) is permitted, unless otherwise noted, provided it meets the specified requirements for new lumber and is free of contamination; identify source.

F. Wood Products: Comply with the following:
   1. Hardboard: AHA A135.4, made with binder containing no urea formaldehyde.

G. Thermoset Decorative Panels: Particleboard or medium-density fiberboard finished with thermally fused, melamine-impregnated decorative paper complying with LMA SAT-1.
   1. Provide PVC or polyester edge banding complying with LMA EDG-1 on components with exposed or semiexposed edges.

H. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or, if not indicated, as required by woodwork quality standard.
   1. Manufacturer: Subject to compliance with requirements, provide high-pressure decorative laminates by one of the following:
      a. Abet Laminati, Inc.
      b. Arborite; Division of ITW Canada, Inc.
      c. Formica Corporation.
      d. Lamin-Art, Inc.
      e. Nevamar Company, LLC; Decorative Products Div.
      f. Panolam Industries International Incorporated.
      g. Westinghouse Electric Corp.; Specialty Products Div.
      h. Wilsonart International; Div. of Premark International, Inc.

   1. Basis of Design Materials:
         1) Color: "Snow White."
      b. Window Stools: Corian by DuPont.
         1) Color: "Arctic Ice."
   2. Substitutions: Architect will consider comparable products. Submit in accordance with Division 01 Section "Product Requirements."

2.02 FIRE-RETARDANT-TREATED MATERIALS

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.
   1. Do not use treated materials that do not comply with requirements of referenced woodworking standard or that are warped, discolored, or otherwise defective.
2. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.

3. Identify fire-retardant-treated materials with appropriate classification marking of UL, U.S. Testing, Timber Products Inspection, or another testing and inspecting agency acceptable to authorities having jurisdiction.

B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Comply with performance requirements of AWPA C20 (lumber) and AWPA C27 (plywood). Use the following treatment type:

1. Interior Type A: Low-hygroscopic formulation.

2. Mill lumber before treatment and implement special procedures during treatment and drying processes that prevent lumber from warping and developing discolorations from drying sticks or other causes, marring, and other defects affecting appearance of treated woodwork.

3. Kiln-dry materials before and after treatment to levels required for untreated materials.

2.03 CABINET HARDWARE AND ACCESSORIES

A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets.

B. Frameless Concealed Hinges (European Type): BHMA A156.9, B01602, 120 degrees of opening.

1. Product: Model VS83800 by Grass America, Inc.

2. Comparable products by the following manufacturers are acceptable:
   a. Hafele.
   b. Prameta.

C. Back-Mounted Pulls: BHMA A156.9, B02011: Locate as indicated on Drawings.

1. 7/8" knob drawer pull DP-2 by Doug Mockett and Company.
   a. Finish: Black Chrome.

2. 3" tab drawer pull DP-3A by Doug Mockett and Company.

3. 5 1/2" bar pull DP-54B by Doug Mockett and Company.
   a. Finish: Stainless Steel.

D. Catches: Magnetic catches, BHMA A156.9, B03141 or Roller catches, BHMA A156.9, B03071.

E. Shelf Rests: BHMA A156.9, B04013; plastic, two-pin type with shelf hold-down clip.

F. Drawer Slides: BHMA A156.9, B05091.

1. Standard Duty (Grade 1, Grade 2, and Grade 3): Side mounted and extending under bottom edge of drawer; full-extension type; epoxy-coated steel with polymer rollers.

2. Heavy Duty (Grade 1HD-100 and Grade 1HD-200): Side mounted; full-extension type; zinc-plated steel ball-bearing slides.

3. Box Drawer Slides: Grade 1HD-100; for drawers not more than 6 inches high and 24 inches wide.
   a. Products:
      1) Grass 6610.
      2) Blum No. 230E.

4. File Drawer Slides: Grade 1HD-100; for drawers more than 6 inches high or 24 inches wide.
   a. Products:
      1) Accuride No. 3832.
2) Blum No. 430E.

5. Pencil Drawer Slides: Grade 2; for drawers not more than 3 inches high and 24 inches wide.
6. Keyboard Slides: Grade 1HD-100; for computer keyboard shelves.
7. Trash Bin Slides: Grade 1HD-100; for trash bins not more than 20 inches high and 16 inches wide.

G. Door Locks: BHMA A156.11, E07121.

H. Drawer Locks: BHMA A156.11, E07041.

I. Grommets for Cable Passage through Countertops: 2-inch OD, molded-plastic grommets and matching plastic caps with slot for wire passage.
1. Product: Subject to compliance with requirements, provide "TG series" by Doug Mockett & Company, Inc.
   a. Color: As selected by Architect from manufacturer's full range.

J. Exposed Hardware Finishes: Unless indicated otherwise, for exposed hardware, provide finish that complies with BHMA A156.18 for BHMA finish number indicated.
   1. Satin Chromium Plated: BHMA 626 for brass or bronze base; BHMA 652 for steel base.
   2. Satin Stainless Steel: BHMA 630.

K. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in BHMA A156.9.

2.04 MISCELLANEOUS MATERIALS

A. Furring, Blocking, Shims, and Hanging Strips: Fire-retardant-treated softwood lumber, kiln dried to less than 15 percent moisture content.

B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.

C. Adhesives, General: Do not use adhesives that contain urea formaldehyde.

D. VOC Limits for Installation Adhesives and Glues: Use installation adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
   1. Adhesives must meet or exceed the VOC limits of South Coast Air Quality Management District Rule #1168. Provide low VOC, FS MMMA125C, Type II, water and mold resistant adhesives.

E. Adhesive for Bonding Plastic Laminate: Unpigmented contact cement.

   1. Adhesive for Bonding Edges: Hot-melt adhesive or adhesive specified above for faces.

2.05 FABRICATION, GENERAL

A. Interior Woodwork Grade: Unless otherwise indicated, provide Custom-grade interior woodwork complying with referenced quality standard.

B. Wood Moisture Content: Comply with requirements of referenced quality standard for wood moisture content in relation to ambient relative humidity during fabrication and in installation areas.

C. Sand fire-retardant-treated wood lightly to remove raised grain on exposed surfaces before fabrication.
D. Complete fabrication, including assembly, finishing, and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
   1. Notify Architect seven days in advance of the dates and times woodwork fabrication will be complete.
   2. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements indicated on Shop Drawings before disassembling for shipment.

E. Shop-cut openings to maximum extent possible to receive hardware, appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.
   1. Seal edges of openings in countertops with a coat of varnish.

2.06 RAILING CAPS
A. Grade: Custom.
B. Wood Species and Cut for Transparent Finish: White birch, plain sawn or sliced.

2.07 PLASTIC-LAMINATE CABINETS
A. Grade: Custom.
B. AWI Type of Cabinet Construction: Flush overlay.
C. Laminate Cladding for Exposed Surfaces: High-pressure decorative laminate complying with the following requirements:
   1. Horizontal Surfaces Other Than Tops: Grade HGS.
   2. Vertical Surfaces: Grade VGS.
   3. Edges: Grade HGS.
D. Materials for Semiexposed Surfaces:
   1. Surfaces Other Than Drawer Bodies: Thermoset decorative panels
      a. Edges of Plastic-Laminate Shelves: PVC tape, 0.018-inch minimum thickness, matching laminate in color, pattern, and finish. For semiexposed backs of panels with exposed plastic-laminate surfaces, provide surface of high-pressure decorative laminate, Grade CLS.
   2. Drawer Sides and Backs: Thermoset decorative panels.
   3. Drawer Bottoms: Thermoset decorative panels.
E. Concealed Backs of Panels with Exposed Plastic Laminate Surfaces: High-pressure decorative laminate, Grade BKL.
F. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
   1. As selected by Architect from laminate manufacturer's full range in the following categories:
      a. Solid colors, matte finish.
G. Provide dust panels of 1/4-inch plywood or tempered hardboard above compartments and drawers, unless located directly under tops.

2.08 PLASTIC-LAMINATE COUNTERTOPS
A. Grade: Custom.
B. High-Pressure Decorative Laminate Grade: HGS.

C. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
   1. As selected by Architect from manufacturer's full range in the following categories:
      a. Solid colors, matte finish.

D. Edge Treatment: High-Pressure decorative laminate grade HGS, solid colors with core same color as surface, matte finish.

E. Core Material: Exterior-grade plywood.

F. Core Material at Sinks: Exterior-grade plywood.

G. Backer Sheet: Provide plastic-laminate backer sheet, Grade BKL, on underside of countertop substrate.

2.09 SOLID-SURFACING-MATERIAL COUNTERTOPS AND WINDOW STOOLS

A. Grade: Custom.

B. Solid-Surfacing-Material Thickness: 3/4 inch.

C. Fabricate stools in one piece, unless otherwise indicated. Comply with solid-surfacing-material manufacturer's written recommendations for adhesives, sealers, fabrication, and finishing.
   1. Fabricate stools with shop-applied edges of materials and configuration indicated.

2.10 WALL SHELVING

A. Plastic-Laminate Shelving: Plastic-laminate sheet, Grade HGL or HGP, shop bonded to both sides of particleboard or plywood. Sand surfaces to which plastic laminate is to be bonded.
   1. Shelf Thickness: 1 inch.
   2. Edge Treatment: Finish both edges with rigid PVC extrusion, through color with satin finish, 3 mm thick.

B. Adjustable Shelf Supports: Powder-coated steel standards and shelf brackets, complying with BHMA A156.9, Types B04102 and B04112, surface mounted.
   1. Products:
      a. No. 85 double-slot heavy-duty standard by Knape and Vogt.
      b. No. 185 heavy-duty double bracket by Knape and Vogt.

2.11 SHOP FINISHING

A. Grade: Provide finishes of same grades as items to be finished.

B. General: Finish architectural woodwork at fabrication shop as specified in this Section. Defer only final touchup, cleaning, and polishing until after installation.

C. Preparation for Finishing: Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing architectural woodwork, as applicable to each unit of work.
   1. Backpriming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of woodwork. Apply two coats to back of paneling and to end-grain surfaces. Concealed surfaces of plastic-laminate-clad woodwork do not require backpriming when surfaced with plastic laminate, backing paper, or thermoset decorative panels.
D. Transparent Finish:
   1. Grade: Custom.
   2. AWI Finish System: Catalyzed polyurethane.

PART 3 - EXECUTION

3.01 PREPARATION
   A. Before installation, condition woodwork to average prevailing humidity conditions in installation areas.
   B. Before installing architectural woodwork, examine shop-fabricated work for completion and complete work as required, including removal of packing and backpriming.

3.02 INSTALLATION
   A. Grade: Install woodwork to comply with requirements for the same grade specified in Part 2 for fabrication of type of woodwork involved.
   B. Assemble woodwork and complete fabrication at Project site to comply with requirements for fabrication in Part 2, to extent that it was not completed in the shop.
   C. Install woodwork level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb (including tops) to a tolerance of 1/8 inch in 96 inches.
   D. Scribe and cut woodwork to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
   E. Fire-Retardant-Treated Wood: Handle, store, and install fire-retardant-treated wood to comply with chemical treatment manufacturer's written instructions, including those for adhesives used to install woodwork.
   F. Anchor woodwork to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing as required for complete installation. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork and matching final finish if transparent finish is indicated.
   G. Cabinets: Install without distortion so doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
      1. Install cabinets with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.
      2. Maintain veneer sequence matching of cabinets with transparent finish.
      3. Fasten wall cabinets through back, near top and bottom, at ends and not more than 16 inches o.c. with No. 10 wafer-head screws sized for 1-inch penetration into wood framing, blocking, or hanging strips and No. 10 wafer-head sheet metal screws through metal backing or metal framing behind wall finish.
   H. Countertops: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop.
      1. Install countertops with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.
      2. Secure backsplashes to walls with adhesive.
      3. Calk space between backsplash and wall with sealant specified in Division 07 Section "Joint Sealants."
I. Touch up finishing work specified in this Section after installation of woodwork. Fill nail holes with matching filler where exposed.

3.03 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

A. Construction waste shall be managed in accordance with provisions of Division 01 Section - Construction Waste Management and Disposal. Documentation shall be submitted to satisfy the requirements of that section.

B. Waste Disposal: Comply with the requirements of Division 01 Section "Construction Waste Management and Disposal," and as follows:
   1. Comply with applicable regulations.
   2. Do not burn scrap on project site.
   3. Do not burn scraps that have been pressure treated.
   4. Do not send materials treated with pentachlorophenol, CCA, or ACA to co-generation facilities or “waste-to-energy” facilities.

C. Do not leave any wood, shavings, sawdust, etc. on the ground or buried in fill.

D. Prevent sawdust and wood shavings from entering the storm drainage system.

3.04 ADJUSTING AND CLEANING

A. Repair damaged and defective woodwork, where possible, to eliminate functional and visual defects; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.

B. Clean, lubricate, and adjust hardware.

C. Clean woodwork on exposed and semiexposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

END OF SECTION
SECTION 07 11 13

BITUMINOUS DAMPPROOFING

PART 1 - GENERAL

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

1.02 SUMMARY
A. This Section includes the following:
   1. Cold-applied, cut-back asphalt dampproofing.

1.03 SUBMITTALS
A. Product Data: For each type of product indicated. Include recommendations for method of application, primer, number of coats, coverage or thickness, and protection course.
B. LEED Submittals:
   1. Credit EQ 4.2: Product Data for dampproofing used on the interior of the building indicating VOC content in g/L calculated according to 40 CFR 59, Subpart D (EPA Method 24).

1.04 QUALITY ASSURANCE
A. Applicator Qualifications: Company specializing in bituminous dampproofing systems with 5 years minimum experience who is acceptable to the manufacturer of the bituminous materials.
B. Source Limitations: Obtain primary dampproofing materials and primers through one source from a single manufacturer. Provide secondary materials recommended by manufacturer of primary materials.

1.05 PROJECT CONDITIONS
A. Weather Limitations: Maintain ambient and surface temperatures above 40 degrees F for 24 hours before application, and continuously until dampproofing has cured unless more stringent requirements are required by the manufacturer.
B. Ventilation: Provide adequate ventilation during application of dampproofing in enclosed spaces. Maintain ventilation until dampproofing has cured.

PART 2 - PRODUCTS

2.01 COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. ChemMasters Corp.
   2. Degussa Building Systems; Sonneborn Brand Products.
   3. Gardner Gibson, Inc.
   6. Koppers Inc.
   7. Malarkey Roofing Products.

B. Trowel Coats: ASTM D 1227, Type II, Class 1.
C. Fibere Brush and Spray Coats: ASTM D 1227, Type II, Class 1.
D. Brush and Spray Coats: ASTM D 1227, Type III, Class 1.
E. VOC Content: Zero.

2.02 PROTECTION COURSE
A. Protection Course, Roll-Roofing Type: Smooth-surfaced roll roofing complying with
   ASTM D 6380, Class S, Type III.

2.03 MISCELLANEOUS MATERIALS
A. Emulsified-Asphalt Primer: ASTM D 1227, Type III, Class 1, except diluted with water as
   recommended by manufacturer.
B. Asphalt-Coated Glass Fabric: ASTM D 1668, Type I.
C. Patching Compound: Manufacturer's fibered mastic of type recommended by
dampproofing manufacturer.

PART 3 - EXECUTION

3.01 EXAMINATION
A. Examine substrates, with Installer present, for compliance with requirements for surface
   smoothness and other conditions affecting performance of work.
   1. Proceed with dampproofing application only after substrate construction and
      penetrating work have been completed and unsatisfactory conditions have been
      corrected.
   2. Test for surface moisture according to ASTM D 4263.

3.02 PREPARATION
A. Protection of Other Work: Mask or otherwise protect adjoining exposed surfaces from
   being stained, spotted, or coated with dampproofing. Prevent dampproofing materials
   from entering and clogging weep holes and drains.
B. Clean substrates of projections and substances detrimental to work; fill voids, seal joints,
   and apply bond breakers if any, as recommended by prime material manufacturer.
C. Apply patching compound for filling and patching tie holes, honeycombs, reveals, and
   other imperfections.

3.03 APPLICATION, GENERAL
A. Comply with manufacturer's written recommendations unless more stringent
   requirements are indicated or required by Project conditions to ensure satisfactory
   performance of dampproofing.
   1. Apply additional coats if recommended by manufacturer or if required to achieve
      coverages indicated.
   2. Allow each coat of dampproofing to cure 24 hours before applying subsequent
      coats.
   3. Allow 48 hours drying time prior to backfilling.
B. Apply dampproofing to footings and foundation walls that do not enclose interior space.
1. Apply from finished-grade line to top of footing, extend over top of footing, and down a minimum of 6 inches over outside face of footing.
2. Extend 12 inches onto intersecting walls and footings, but do not extend onto surfaces exposed to view when Project is completed.
3. Install flashings and corner protection stripping at internal and external corners, changes in plane, construction joints, cracks, and where shown as "reinforced," by embedding an 8-inch- wide strip of asphalt-coated glass fabric in a heavy coat of dampproofing. Dampproofing coat for embedding fabric is in addition to other coats required.

3.04 COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING

A. On Concrete Foundations: Apply 2 brush or spray coats at not less than 1.5 gal./100 sq. ft. for first coat and 1 gal./100 sq. ft. for second coat, 1 fibered brush or spray coat at not less than 3 gal./100 sq. ft., or 1 trowel coat at not less than 4 gal./100 sq. ft..

3.05 INSTALLATION OF PROTECTION COURSE

A. Where indicated, install protection course over completed-and-cured dampproofing. Comply with dampproofing material manufacturer's written recommendations for attaching protection course.
   1. Support protection course with spot application of adhesive of type recommended by protection board manufacturer over cured coating.
   2. Install protection course within 24 hours of installation of dampproofing (while coating is tacky) to ensure adhesion.

3.06 CLEANING

A. Remove dampproofing materials from surfaces not intended to receive dampproofing.

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. This Section includes the following:
      1. Modified bituminous sheet waterproofing.
   B. Related Sections include the following:
      1. Division 07 Section "Joint Sealants" for joint-sealant materials and installation.

1.03 SUBMITTALS
   A. Product Data: Include manufacturer's written instructions for evaluating, preparing, and treating substrate, technical data, and tested physical and performance properties of waterproofing.
   B. Shop Drawings: Show locations and extent of waterproofing. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.
   C. Installer Certificates: Signed by an officer of the manufacturer, stating that the applicator is certified to apply the system specified in this section.
   D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for waterproofing.
   E. Submit complete manufacturer's data including suggested installation procedures and details.

1.04 QUALITY ASSURANCE
   A. Installer Qualifications: A firm that is approved or licensed by waterproofing manufacturer for installation of waterproofing required for this Project.
   B. Source Limitations: Obtain waterproofing materials through one source from a single manufacturer.
   C. Preinstallation Conference: Conduct conference at Project site.
      1. Review waterproofing requirements including surface preparation, substrate condition and pretreatment, minimum curing period, forecasted weather conditions, special details and sheet flashings, installation procedures, testing and inspection procedures, and protection and repairs.
         a. Require manufacturer's technical representative to participate in the conference.

1.05 DELIVERY, STORAGE, AND HANDLING
   A. Deliver liquid materials to Project site in original packages with seals unbroken, labeled with manufacturer's name, product brand name and type, date of manufacture, and directions for storing and mixing with other components.
B. Store liquid materials in their original undamaged packages in a clean, dry, protected location and within temperature range required by waterproofing manufacturer.

C. Remove and replace liquid materials that cannot be applied within their stated shelf life.

D. Store rolls according to manufacturer's written instructions.

E. Protect stored materials from direct sunlight.

1.06 PROJECT CONDITIONS

A. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate.
   1. Do not apply waterproofing in snow, rain, fog, or mist.

B. Maintain adequate ventilation during preparation and application of waterproofing materials.

1.07 WARRANTY

A. Special Manufacturer's Warranty: Manufacturer's standard form in which manufacturer agrees to replace waterproofing material that does not comply with requirements or that fails to remain watertight within specified warranty period.
   1. Failure includes, but is not limited to, failure of waterproofing due to failure of substrate prepared and treated according to requirements or formation of new joints and cracks in substrate exceeding 1/16 inch in width.
   2. Warranty Period: Five years from date of Substantial Completion.

B. Special Installer's Warranty: Specified form, signed by Installer, covering Work of this Section, for warranty period of two years.
   1. Warranty includes removing and reinstalling protection board.

PART 2 - PRODUCTS

2.01 MODIFIED BITUMINOUS SHEET WATERPROOFING

A. Modified Bituminous Sheet: 60-mil- thick, self-adhering sheet consisting of 56 mils of rubberized asphalt laminated to a 4-mil- thick, polyethylene film with release liner on adhesive side and formulated for application with primer or surface conditioner that complies with VOC limits of authorities having jurisdiction.
   1. Products: Subject to compliance with requirements, provide one of the following:
      b. Protecto Wrap; Jiffy Seal.
      c. Polyguard Products; Polyguard 650.
      d. Polyken Technologies; Polyken 660.

   2. Physical Properties:
      a. Tensile Strength: 250 psi minimum; ASTM D 412, Die C, modified.
      b. Ultimate Elongation: 300 percent minimum; ASTM D 412, Die C, modified.
      d. Crack Cycling: Unaffected after 100 cycles of 1/8-inch movement; ASTM C 836.
      e. Puncture Resistance: 40 lbf minimum; ASTM E 154.
      f. Hydrostatic-Head Resistance: 150 feet minimum; ASTM D 5385.
      g. Water Absorption: 0.15 percent weight-gain maximum after 48-hour immersion at 70 deg F; ASTM D 570.
      h. Vapor Permeance: 0.05 perms; ASTM E 96, Water Method.
2.02 AUXILIARY MATERIALS

A. General: Furnish auxiliary materials recommended by waterproofing manufacturer for intended use and compatible with sheet waterproofing.
   1. Furnish liquid-type auxiliary materials that comply with VOC limits of authorities having jurisdiction.

B. Primer: Liquid waterborne primer recommended for substrate by manufacturer of sheet waterproofing material.

C. Surface Conditioner: Liquid, waterborne surface conditioner recommended for substrate by manufacturer of sheet waterproofing material.

D. Liquid Membrane: Elastomeric, two-component liquid, cold fluid applied, trowel grade or low viscosity.

E. Substrate Patching Membrane: Low-viscosity, two-component, asphalt-modified coating.

F. Sheet Strips: Self-adhering, rubberized-asphalt sheet strips of same material and thickness as sheet waterproofing.

G. Mastic, Adhesives, and Tape: Liquid mastic and adhesives, and adhesive tapes recommended by waterproofing manufacturer.

H. Metal Termination Bars: Aluminum bars, approximately 1 by 1/8 inch thick, predrilled at 9-inch centers.

I. Protection Course: ASTM D 6506, semirigid sheets of fiberglass or mineral-reinforced-asphaltic core, pressure laminated between two asphalt-saturated fibrous liners and as follows:
   1. Thickness: 1/8 inch, nominal, for vertical applications; 1/4 inch, nominal, elsewhere.
   2. Adhesive: Rubber-based solvent type recommended by waterproofing manufacturer for type of protection course.

2.03 MOLDED-SHEET DRAINAGE PANELS

A. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panel: Manufactured composite subsurface drainage panels consisting of a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding No. 70 sieve laminated to one side with a polymeric film bonded to the other side of a studded, nonbiodegradable, molded-plastic-sheet drainage core, with a vertical flow rate of 9 to 15 gpm per ft.

2.04 DRAINAGE CONDUITS

A. Molded-Sheet Drainage Conduits: Prefabricated geocomposite with cuspated, molded-plastic drainage core wrapped in geotextile filter fabric.
   1. Manufacturers:
      b. JDR Enterprises, Inc.
      c. TC Mirafi.
   2. Nominal Size: 18 inches high by approximately 1 inch thick.
      a. Minimum In-Plane Flow: 45 gpm at hydraulic gradient of 1.0 when tested according to ASTM D 4716.
   4. Fittings: HDPE with combination NPS 4 and NPS 6 (DN 100 and DN 150) outlet connection.
PART 3 - EXECUTION

3.01 EXAMINATION
A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance.
   1. Verify that concrete has cured and aged for minimum time period recommended by waterproofing manufacturer.
   2. Verify that concrete is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
   3. Verify that compacted subgrade is dry, smooth, and sound; and ready to receive adhesive-coated HDPE sheet.
   4. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 SURFACE PREPARATION
A. Clean, prepare, and treat substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrates for waterproofing application.
B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.
C. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.
D. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids.
E. Prepare, fill, prime, and treat joints and cracks in substrates. Remove dust and dirt from joints and cracks according to ASTM D 4258.
   1. Install sheet strips and center over treated construction and contraction joints and cracks exceeding a width of 1/16 inch.
F. Bridge and cover isolation joints, expansion joints and discontinuous deck-to-wall and deck-to-deck joints with overlapping sheet strips.
   1. Invert and loosely lay first sheet strip over center of joint. Firmly adhere second sheet strip to first and overlap to substrate.
G. Corners: Prepare, prime, and treat inside and outside corners according to ASTM D 6135.
   1. Install membrane strips centered over vertical inside corners. Install 3/4-inch fillets of liquid membrane on horizontal inside corners and as follows:
      a. At footing-to-wall intersections, extend liquid membrane each direction from corner or install membrane strip centered over corner.
      b. At plaza deck-to-wall intersections, extend liquid membrane or sheet strips onto deck waterproofing and to finished height of sheet flashing.
H. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations through waterproofing and at drains and protrusions according to ASTM D 6135.

3.03 MODIFIED BITUMINOUS SHEET WATERPROOFING APPLICATION
A. Install modified bituminous sheets according to waterproofing manufacturer's written instructions and according to recommendations in ASTM D 6135.
B. Apply primer to substrates at required rate and allow to dry. Limit priming to areas that will be covered by sheet waterproofing in same day. Reprime areas exposed for more than 24 hours.

C. Apply and firmly adhere sheets over area to receive waterproofing. Accurately align sheets and maintain uniform 2-1/2-inch minimum lap widths and end laps. Overlap and seal seams and stagger end laps to ensure watertight installation.
   1. When ambient and substrate temperatures range between 25 and 40 deg F, install self-adhering, modified bituminous sheets produced for low-temperature application. Do not use low-temperature sheets if ambient or substrate temperature is higher than 60 deg F.

D. Two-Ply Application: Install sheets to form a membrane with lap widths not less than 50 percent of sheet widths to provide a minimum of 2 thicknesses of sheet membrane over areas to receive waterproofing.

E. Horizontal Application: Apply sheets from low point to high point of decks to ensure that side laps shed water.

F. Apply continuous sheets over sheet strips bridging substrate cracks, construction, and contraction joints.

G. Seal exposed edges of sheets at terminations not concealed by metal counterflashings or ending in reglets with mastic.

H. Install sheet waterproofing and auxiliary materials to tie into adjacent waterproofing.

I. Repair tears, voids, and lapped seams in waterproofing not complying with requirements. Slit and flatten fishmouths and blisters. Patch with sheet waterproofing extending 6 inches beyond repaired areas in all directions.

J. Install protection course with butted joints over waterproofing membrane immediately.
   1. Molded-sheet drainage panels may be used in place of a separate protection course to vertical applications when approved by waterproofing manufacturer and installed immediately.

K. Correct deficiencies in or remove sheet waterproofing that does not comply with requirements; repair substrates, reapply waterproofing, and repair sheet flashings.

3.04 MOLDED-SHEET DRAINAGE PANEL INSTALLATION

A. Place and secure molded-sheet drainage panels, with geotextile facing away from wall or deck substrate, according to manufacturer's written instructions. Use adhesives[ or mechanical fasteners] that do not penetrate waterproofing. Lap edges and ends of geotextile to maintain continuity. Protect installed molded-sheet drainage panels during subsequent construction.
   1. For vertical applications, install protection course before installing drainage panels.


3.05 INSULATION INSTALLATION

A. Install one or more layers of board insulation to achieve required thickness over waterproofed surfaces. Cut and fit to within 3/4 inch of projections and penetrations.

B. On vertical surfaces, set insulation units in adhesive or tape applied according to manufacturer's written instructions.
C. On horizontal surfaces, loosely lay insulation units according to manufacturer’s written instructions. Stagger end joints and tightly abut insulation units.

3.06 PROTECTION AND CLEANING

A. Protect waterproofing from damage and wear during remainder of construction period.

B. Protect installed board insulation from damage due to UV light, harmful weather exposures, physical abuse, and other causes. Provide temporary coverings where insulation will be subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

C. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION
SECTION 07 14 13
HOT FLUID-APPLIED RUBBERIZED ASPHALT WATERPROOFING

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. Rubberized-asphalt waterproofing membrane, unreinforced.
2. Insulation.
3. Plaza deck pavers.

B. Related Sections:
1. Division 07 Section "Joint Sealants" for joint-sealant materials and installation.
2. Division 07 Section "Expansion Control" for expansion-joint systems.

1.03 SUBMITTALS
A. Product Data: For each type of product indicated. Include manufacturer's written instructions for evaluating, preparing, and treating substrate, installation instructions, technical data, and tested physical and performance properties of waterproofing.

B. Shop Drawings: Show locations and extent of waterproofing. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins to adjoining waterproofing, and other termination conditions.
1. Include setting drawings showing layout, sizes, sections, profiles, and joint details of pedestal-supported concrete pavers.

C. Samples: For the following products in manufacturer's standard sizes unless otherwise indicated:
1. Plaza deck paver, full sized in each color and texture required.

D. Certificate: Submit letter signed by an officer of the manufacturer stating that the applicator is certified to apply the system specified in this section.

E. Field quality-control reports.

1.04 QUALITY ASSURANCE
A. Installer Qualifications: A firm that is approved or licensed by manufacturer for installation of waterproofing required for this Project and is eligible to receive special warranties specified, with not less than 5 years successful experience on projects of similar size and scope using materials of the type specified.

B. Source Limitations: Obtain waterproofing materials sheet flashings, protection course insulation, pavers, and pedestals from single source from single manufacturer.

C. Preinstallation Conference: Conduct conference at Project site.
1. Review waterproofing requirements including surface preparation, substrate condition and pretreatment, minimum curing period, forecasted weather conditions, special details and sheet flashings, installation procedures, testing and inspection procedures, and protection and repairs.
a. Require manufacturer's technical representative to participate in the conference.

1.05 DELIVERY, STORAGE, AND HANDLING
A. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by waterproofing manufacturer.
B. Remove and replace liquid materials that cannot be applied within their stated shelf life.
C. Protect stored materials from direct sunlight.

1.06 PROJECT CONDITIONS
A. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate, or when temperature is below 0 deg F.
   1. Do not apply waterproofing in snow, rain, fog, or mist.
B. Maintain adequate ventilation during application and curing of waterproofing materials.

1.07 WARRANTY
A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace waterproofing and sheet flashings that do not comply with requirements or that fail to remain watertight within specified warranty period.
   1. Warranty includes removing and reinstalling protection board, drainage panels, insulation, pedestals, and pedestal-mounted pavers on plaza decks.
   2. Warranty Period: 2 years from date of Substantial Completion.
B. Special Installer's Warranty: Specified form signed by Installer, covering Work of this Section, for warranty period of 1 year.
   1. Warranty includes removing and reinstalling protection board, drainage panels, insulation, pedestals, and pedestal-mounted pavers on plaza decks.

PART 2 - PRODUCTS

2.01 WATERPROOFING MEMBRANE
A. Hot Fluid-Applied, Rubberized-Asphalt Waterproofing Membrane: Single component; 100 percent solids; hot fluid-applied, rubberized asphalt.
   1. Products: Subject to compliance with requirements, provide one of the following:
      b. 3M Co.; Scotch Clad Brand Water Containment System.
      c.

2.02 FLASHING SHEET MATERIALS
A. Elastomeric Flashing Sheet: 50-mil- minimum, uncured sheet neoprene as follows:
   1. Tensile Strength: 1400 psi minimum; ASTM D 412, Die C.
   2. Elongation: 300 percent minimum; ASTM D 412.
   3. Tear Resistance: 125 psi minimum; ASTM D 624, Die C.

2.03 AUXILIARY MATERIALS
A. Primer: ASTM D 41, asphaltic primer.
B. Elastomeric Sheet: 50-mil- minimum, uncured sheet neoprene as follows:
   1. Tensile Strength: 1400 psi minimum; ASTM D 412, Die C.
2. Elongation: 300 percent minimum; ASTM D 412.
3. Tear Resistance: 125 psi minimum; ASTM D 624, Die C.

C. Metal Termination Bars: Manufacturer's standard, predrilled stainless-steel or aluminum termination bars; approximately 1 by 1/8 inch thick; with anchors.

D. Sealants and Accessories: Manufacturer's recommended sealants and accessories.


F. Protection Course: Manufacturer's standard, 80- to 90-mil- thick, fiberglass-reinforced rubberized asphalt or modified bituminous sheet.

2.04 INSULATION

A. Board Insulation: Extruded-poly styrene board insulation complying with ASTM C 578, square or shiplap edged.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. DiversiFoam Products.
   b. Dow Chemical Company (The).
   c. Owens Corning.
   d. Pactiv Corporation.
   e. T. Clear Corporation.

2. Type VII, 60-psi minimum compressive strength.

B. Unfaced Plaza Deck Insulation Drainage Panels: Extruded-poly styrene board insulation complying with ASTM C 578, Type VII, 60-psi minimum compressive strength; unfaced; fabricated with shiplapped or channel edges and with one side having ribbed drainage channels.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. DiversiFoam Products; CertiFoam Plaza Deck.
   b. Dow Chemical Company; Styrofoam Ribbed Roofmate.
   c. Owens Corning; Foamular 604 RB.

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.
1. Verify that concrete has cured and aged for minimum time period recommended by waterproofing manufacturer.
2. Verify that substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Clean and prepare substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrate for waterproofing application.

B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.

C. Close off deck drains and other deck penetrations to prevent spillage and migration of waterproofing fluids.
D. Remove grease, oil, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.
   1. Abrasive blast clean concrete surfaces uniformly to expose top surface of fine aggregate according to ASTM D 4259 with a self-contained, recirculating, blast-cleaning apparatus. Remove material to provide a sound surface free of laitance, glaze, efflorescence, curing compounds, concrete hardeners, or form-release agents. Remove remaining loose material and clean surfaces according to ASTM D 4258.

E. Remove fins, ridges, and other projections and fill honeycomb, aggregate pockets, and other voids.

3.03 JOINTS, CRACKS, AND TERMINATIONS

A. Prepare and treat substrates to receive waterproofing membrane, including joints and cracks, deck drains, corners, and penetrations according to manufacturer's written instructions.
   1. Rout and fill joints and cracks in substrate. Before filling, remove dust and dirt according to ASTM D 4258.
   2. Adhere strip of elastomeric sheet to substrate in a layer of hot rubberized asphalt. Extend elastomeric sheet a minimum of 6 inches on each side of moving joints and cracks or joints and cracks exceeding 1/8 inch thick, and beyond deck drains and penetrations. Apply second layer of hot fluid-applied, rubberized asphalt over elastomeric sheet.
   3. Embed strip of reinforcing fabric into a layer of hot rubberized asphalt. Extend reinforcing fabric a minimum of 6 inches on each side of nonmoving joints and cracks not exceeding 1/8 inch thick, and beyond roof drains and penetrations.
      a. Apply second layer of hot fluid-applied, rubberized asphalt over reinforcing fabric.

B. At expansion joints and discontinuous deck-to-wall or deck-to-deck joints, bridge joints with elastomeric sheet extended a minimum of 6 inches on each side of joints and adhere to substrates in a layer of hot rubberized asphalt. Apply second layer of hot fluid-applied, rubberized asphalt over elastomeric sheet.

3.04 FLASHING INSTALLATION

A. Install elastomeric flashing sheets at terminations of waterproofing membrane according to manufacturer's written instructions.

B. Prime substrate with asphalt primer.

C. Install elastomeric flashing sheet and adhere to deck and wall substrates in a layer of hot rubberized asphalt.

D. Extend elastomeric flashing sheet up walls or parapets a minimum of 8 inches above plaza deck pavers and 6 inches onto deck to be waterproofed.

E. Install termination bars and mechanically fasten to top of elastomeric flashing sheet at terminations and perimeter of roofing.

3.05 MEMBRANE APPLICATION

A. Apply primer, at manufacturer's recommended rate, over prepared substrate and allow to dry.

B. Heat and apply rubberized asphalt according to manufacturer's written instructions.
   1. Heat rubberized asphalt in an oil- or air-jacketed melter with mechanical agitator specifically designed for heating rubberized asphalt.

C. Start application with manufacturer's authorized representative present.
D. Unreinforced Membrane: Apply hot rubberized asphalt to substrates and adjoining surfaces indicated. Spread to form a uniform, unreinforced, seamless membrane, 180-mil average thickness, but not less than 125 mil thick and not more than 205 mil thick.

E. Apply waterproofing over prepared joints and up wall terminations and vertical surfaces to heights indicated or required by manufacturer.

F. Cover waterproofing with protection course with overlapped joints before membrane is subject to construction or vehicular traffic.

3.06 INSULATION INSTALLATION

A. Install one or more layers of board insulation to achieve required thickness and insulation drainage panels over waterproofed surfaces. Cut and fit to within 3/4 inch of projections and penetrations.

B. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.

3.07 FIELD QUALITY CONTROL

A. Engage a full-time site representative qualified by waterproofing membrane manufacturer to inspect substrate conditions; surface preparation; and application of the membrane, flashings, protection, and drainage components; furnish daily reports to Architect.

B. Flood Testing: Flood test each deck area for leaks, according to recommendations in ASTM D 5957, after completing and protecting waterproofing but before overlaying construction is placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water.
   1. Flood to an average depth of 2-1/2 inches with a minimum depth of 1 inch and not exceeding a depth of 4 inches. Maintain 2 inches of clearance from top of sheet flashings.
   2. Flood each area for 48 hours.
   3. After flood testing, repair leaks, repeat flood tests, and make further repairs until waterproofing installation is watertight.

C. Engage an independent testing agency to observe flood testing and examine underside of decks and terminations for evidence of leaks during flood testing.

3.08 CLEANING AND PROTECTION

A. Protect waterproofing from damage and wear during remainder of construction period.

B. Protect installed board insulation and insulation drainage panels from damage due to UV light, harmful weather exposures, physical abuse, and other causes. Provide temporary coverings where insulation will be subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

C. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION
SECTION 07 17 00

BENTONITE WATERPROOFING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes geotextile/bentonite sheet waterproofing.

B. Related Sections include the following:
   1. Division 03 Section "Cast-in-Place Concrete" for forms and for concrete placement.
   2. Division 07 sheet waterproofing Sections for flexible flashing that may be part of adjoining waterproofing work.
   3. Division 07 Section "Joint Sealants" for elastomeric sealants.
   4. Division 31 Section "Earthwork" for excavating and backfilling.
   5. Division 33 Section "Foundation Drainage" for subsurface drainage systems.

1.03 PERFORMANCE REQUIREMENTS

A. Provide waterproofing that prevents the passage of water according to the following criteria:
   1. Permeability: 1 by 10^{-9} cm/sec. according to ASTM D 5084.
   2. Grab Tensile Strength: 95 lbf according to ASTM D 4632.
   3. Elongation: 75 percent according to ASTM D 4632.
   4. Puncture Resistance: 120 psi according to ASTM D 4833.

1.04 SUBMITTALS

A. Product Data: For each type of product indicated. Include product specifications and manufacturer's written installation instructions.

B. Shop Drawings: Show installation details for interface with other work.

C. Preconstruction Test Reports: For water samples taken at Project site along with recommendations resulting from these tests.

1.05 QUALITY ASSURANCE

A. Source Limitations: Obtain bentonite waterproofing system through one source from a single manufacturer. Obtain accessory products used with bentonite waterproofing from sources acceptable to bentonite waterproofing manufacturer.

B. Preconstruction Testing: Engage a qualified independent testing agency to test water for compliance with requirements.
   1. Obtain water samples from Project site at approximate locations where waterproofing will be installed and test for acids, alkalis, brine, or other contaminants that may inhibit performance of waterproofing materials.
   2. Comply with manufacturer's written instructions for testing.

C. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."
1.06 DELIVERY, STORAGE, AND HANDLING
A. Deliver materials to Project site in manufacturer's original unopened and undamaged containers.
B. Store materials in a dry, well-ventilated space.
C. Remove and replace bentonite materials that have been prematurely exposed to moisture.

1.07 PROJECT CONDITIONS
A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit bentonite waterproofing to be installed according to manufacturers' written instructions and warranty requirements.
   1. Do not apply waterproofing materials to surfaces where ice or frost is visible. Do not apply bentonite waterproofing materials in areas with standing water.
   2. Placing of bentonite clay products in panel or composite form on damp surfaces is allowed if approved in writing by manufacturer.

1.08 WARRANTY
A. Special Warranty: Manufacturer's standard form in which manufacturer and Installer agrees to repair or replace components of bentonite waterproofing system that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Water penetrating the building or structure resulting from substrate cracking of up to 1/8 inch.
      b. Deteriorated or displaced waterproofing materials.
   2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS
A. Products: Subject to compliance with requirements, provide one of the products listed in other Part 2 articles.

2.02 MATERIALS, GENERAL
A. Granular Bentonite: Sodium bentonite clay containing a minimum of 90 percent montmorillonite (hydrated aluminum silicate), with a minimum of 90 percent passing a No. 20 sieve.
B. Bentonite Mastic: Trowelable consistency, bentonite compound, specifically formulated for application at joints and penetrations.
C. Preformed Waterstop: Flexible strip of bentonite waterproofing compound in cartridge or coil form; designed specifically for vertical and horizontal joints in concrete construction.

2.03 GEOTEXTILE/BENTONITE SHEETS
A. Geotextile/Bentonite Waterproofing: Minimum of 1.1 lb/sq. ft. of bentonite clay granules between 2 layers of geotextile polypropylene fabric, one woven and one nonwoven, needlepunched and heat fused together.
   1. Products:
      a. CETCO; Voltex.
      b. Carlisle Coatings & Waterproofing Inc.; CCW Clay Mat.
      c. MiraDRI Moisture Protection Products, TC MiraDRI; MiraCLAY.
2.04 INSTALLATION ACCESSORIES

A. Protection Board: Provide products recommended in writing by waterproofing manufacturer to suit Project. Available types include the following:
1. Semirigid board with mineral-reinforced asphaltic core laminated between an asphalt-saturated felt liner on one side and a weather-coated, glass-mat liner covered with a bond-breaking film on the other.
   a. Thickness: 1/4 inch.

B. Molded-Sheet Drainage Panels: Prefabricated, composite drainage panels, manufactured with a permeable geotextile facing laminated to a molded-plastic, three-dimensional sheet drainage core.
1. Products:
   a. CETCO; Aquadrain.
   b. MiraDRI Moisture Protection Products, TC MiraDRI; MiraDRAIN 8000.

C. Termination Bar: Extruded-aluminum or formed-stainless-steel bars with upper flange to receive sealant.

D. Fasteners: Case-hardened nails or hardened-steel, powder-actuated fasteners. Depending on manufacturer's written requirements, provide 1/2- or 1-inch-diameter washers under fastener heads.

E. Sealants: As recommended in writing by waterproofing manufacturer. Comply with requirements specified in Division 07 Section "Joint Sealants."

F. Tapes: As recommended in writing by waterproofing manufacturer for joints between sheets or panels.

G. Adhesive: Water-based adhesive used to secure membrane to both vertical and horizontal surfaces.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrate preparations affecting performance of bentonite waterproofing.
1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of bentonite waterproofing.
2. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Verify that substrate is complete and that all work that will penetrate waterproofing is complete and rigidly installed. Verify locations of waterproofing termination.

3.02 PREPARATION

A. Coordinate work in the vicinity of waterproofing to ensure proper conditions for installing the waterproofing system and to prevent damage to waterproofing after installation.

B. Formed Concrete Surfaces: Remove fins and projections. Fill voids, rock pockets, form-tie holes, and other defects with bentonite mastic or cementitious patching material according to manufacturer's written instructions.

3.03 INSTALLATION, GENERAL

A. Install waterproofing and accessories according to manufacturer's written instructions, standard details, and recommended practices.
1. Apply linear joint-sealing tubes, bentonite mastic, or both at changes of plane, construction joints in substrate, projections, and penetrations.
2. Apply granular bentonite around penetrations in horizontal surfaces according to manufacturer's written instructions.

B. Static Construction Joints: Protect construction joints with bentonite preformed waterstop flexible strips. Either place concrete directly over flexible strips or press strips into preformed cavities. Comply with manufacturer's written instructions where joint waterproofing is not otherwise indicated.

C. Apply granular bentonite continuously at base of wall waterproofing (on footing, against wall) according to manufacturer's written instructions.

D. Protect waterproofing from damage and wetting before and during subsequent construction operations. Repair punctures, tears, and cuts according to manufacturer's written instructions.

E. Apply sealants to comply with requirements specified in Division 07 Section "Joint Sealants" and with manufacturer's written instructions.

3.04 GEOTEXTILE/BENTONITE SHEET INSTALLATION

A. General: Install a continuous layer of waterproofing sheets with woven geotextile side directly against concrete to be waterproofed. Lap ends and edges a minimum of 4 inches on horizontal and vertical substrates. Stagger end joints between sheets a minimum of 24 inches. Fasten seams by stapling to adjacent sheet or nailing to substrate.

B. Below Structural Slabs-on-Grade: Place waterproofing sheets on compacted substrate with woven geotextile side up with ends and edges lapped and stapled.

1. Install a layer of waterproofing sheets under footings, grade beams, and pile caps; or continue waterproofing through key joints between footings and foundation walls, and extend a minimum of 8 inches up or beyond perimeter slab forms.

C. Concrete Walls: Starting at bottom of wall, apply waterproofing sheets horizontally with primary backing side against wall. Secure with powder-actuated fasteners or case-hardened, steel-cap masonry nails; spaced according to manufacturer's written instructions. Extend to bottom of footing, grade beam, or wall and secure as recommended in writing by manufacturer.

1. Termination at Grade: Extend waterproofing sheets to within 2 inches of finish grade, unless otherwise indicated. Secure top edge with termination bar. Apply sealant to top edge of termination bar.

3.05 FIELD QUALITY CONTROL

A. Inspection: Arrange for manufacturer's representative to inspect completed installation and provide written report that installation complies with manufacturer's written instructions.

1. Remove and replace applications of bentonite waterproofing where inspection indicates that it does not comply with specified requirements.

B. Perform additional testing and inspecting, at Contractor's expense, to determine compliance of replaced or additional work with specified requirements.

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. This Section includes penetrating water-repellent coatings for the following vertical and horizontal surfaces:
   1. Concrete (unpainted).
   2. Cast stone.
B. Related Sections include the following:
   1. Division 03 Section "Cast-in-Place Concrete" for curing compounds, and penetrating liquid floor treatments.
   2. Division 07 Section "Joint Sealants."
   3. Division 09 painting Sections for paints and coatings.

1.03 PERFORMANCE REQUIREMENTS
A. Performance Testing: Provide water repellents that comply with test-performance requirements indicated, as evidenced by reports of tests performed by manufacturer by a qualified independent testing agency on manufacturer's standard products applied to substrates simulating those on Project using same application methods to be used for Project.
B. Absorption: Minimum 90 percent reduction of absorption after 24 hours in comparison of treated and untreated specimens.
   2. Hardened Concrete: ASTM C 642.
C. Water-Vapor Transmission: Maximum 10 percent reduction in rate of vapor transmission in comparison of treated and untreated specimens, per ASTM E 96.
D. Permeability: Minimum 80 percent water-vapor transmission in comparison of treated and untreated specimens, per ASTM D 1653.
E. Water Penetration and Leakage through Masonry: Maximum 90 percent reduction in leakage rate in comparison of treated and untreated specimens, per ASTM E 514.
F. Durability: Maximum 5 percent loss of water repellency after 2500 hours of weathering in comparison to specimens before weathering, per ASTM G 154.
G. Chloride-Ion Intrusion in Concrete: NCHRP Report 244, Series II tests.
   1. Reduction of Water Absorption: 80 percent.
   2. Reduction in Chloride Content: 80 percent.

1.04 SUBMITTALS
A. Product Data: For each type of product indicated.
   1. Include manufacturer's printed statement of VOC content.
B. Samples: For each type of water repellent and substrate indicated, 12 by 12 inches in size, with specified water-repellent treatment applied to half of each Sample.

1.05 QUALITY ASSURANCE
A. Installer Qualifications: An employer of workers trained and approved by manufacturer. Installer shall be a water repellent coating firm specializing in special coatings, experienced in the application of the types of water repellents required with not less than 3 years of successful experience.
B. Manufacturer shall certify application procedures including:
   1. Coverage rate.
   2. Temperature and site conditions.
   3. Conformance with manufacturer's recommendations.
C. Indicate laboratory test results for water repellents on substrate simulating Project conditions. Use same materials and methods of applications to be used on the Project.
D. Test Application: Apply a finish sample for each type of water repellent and substrate required. Duplicate finish of approved sample.
   1. Locate each test application on mockup panel directed by Architect.
   2. Size: 25 sq. ft.
   3. Final approval by Architect of water-repellent application will be from test applications.
E. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.06 PROJECT CONDITIONS
A. Limitations: Proceed with application only when the following existing and forecasted weather and substrate conditions permit water repellents to be applied according to manufacturers' written instructions and warranty requirements:
   1. Ambient temperature is above 40 deg F.
   2. Concrete surfaces and mortar have cured for more than 28 days.
   3. Concrete or brick masonry walls are not treated prior to 30 days after building close-in.
   4. Rain or snow is not predicted within 24 hours.
   5. Application proceeds more than seven days after surfaces have been wet.
   6. Substrate is not frozen, or surface temperature is above 40 deg F.
   7. Windy conditions do not exist that may cause water repellent to be blown onto vegetation or surfaces not intended to be treated.

1.07 WARRANTY
A. Special Warranty: Manufacturer's standard form in which manufacturer and Applicator agree to repair or replace materials that fail to maintain water repellency specified in Part 1 "Performance Requirements" Article within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS
2.01 PENETRATING WATER REPELLENTS
A. Silane/Siloxane-Blend, Penetrating Water Repellent: Clear, silane and siloxane blends with 3.3 lb/gal. or less of VOCs.
   1. Products:
      a. Hydrozo, a division of ChemRex; Enviroseal 7.
      b. ProSoCo, Inc.; Weatherseal GP.
c. Tamms Industries, Inc.; Chemstop WB Regular.

PART 3 - EXECUTION

3.01 PREPARATION

A. Clean substrate of substances that might interfere with penetration or performance of water repellents. Test for moisture content, according to water-repellent manufacturer's written instructions, to ensure that surface is dry enough.
   1. Cast-in-Place Concrete: Remove oil, curing compounds, laitance, and other substances that could prevent adhesion or penetration of water repellents.
   2. Clay Brick Masonry: Clean clay brick masonry per ASTM D 5703.

B. Test for pH level, according to water-repellent manufacturer's written instructions, to ensure chemical bond to silicate minerals.

C. Protect adjoining work, including sealant bond surfaces, from spillage or blow-over of water repellent. Cover adjoining and nearby surfaces of aluminum and glass if there is the possibility of water repellent being deposited on surfaces. Cover live plants and grass.

D. Coordination with Sealants: Do not apply water repellent until sealants for joints adjacent to surfaces receiving water-repellent treatment have been installed and cured.
   1. Water-repellent work may precede sealant application only if sealant adhesion and compatibility have been tested and verified using substrate, water repellent, and sealant materials identical to those used in the work.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 APPLICATION

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect the substrate before application of water repellent and to instruct Applicator on the product and application method to be used.

B. Apply a heavy-saturation spray coating of water repellent on surfaces indicated for treatment using low-pressure spray equipment. Comply with manufacturer's written instructions for using airless spraying procedure, unless otherwise indicated.
   1. Precast Concrete: At Contractor's option, first application of water repellent on precast concrete units may be completed before installing units. Mask sealant-bond surfaces to prevent water repellent from migrating onto joint surfaces.

C. Apply a second saturation spray coating, repeating first application. Comply with manufacturer's written instructions for limitations on drying time between coats and after rainstorm wetting of surfaces between coats. Consult manufacturer's technical representative if written instructions are not applicable to Project conditions.

3.03 CLEANING

A. Immediately clean water repellent from adjoining surfaces and surfaces soiled or damaged by water-repellent application as work progresses. Repair damage caused by water-repellent application. Comply with manufacturer's written cleaning instructions.

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. This Section includes the following:
      1. Perimeter insulation under slabs-on-grade.
      2. Perimeter wall insulation (supporting backfill).
      3. Cavity-wall insulation.
      5. Vapor retarders.
   B. Related Sections include the following:
      1. Division 01 Section "Sustainable Design Requirements" for additional LEED
         requirements.
      2. Division 04 Section "Unit Masonry" for insulation installed in masonry cells.
      3. Division 07 Section "EPDM Roofing" for insulation specified as part of roofing
         construction.
      4. Division 07 Section "Fire-Resistive Joint Systems" for insulation installed as part
         of a perimeter fire-resistive joint system.
      5. Division 09 Section "Non-Structural Metal Framing" for installation in metal-
         framed assemblies of insulation specified by referencing this Section.
      6. Division 09 Section "Gypsum Board" for acoustical insulation.
      7. Division 21 Section "Fire-Suppression Systems Insulation."
      8. Division 22 Section "Plumbing Insulation."
      9. Division 23 Section "HVAC Insulation."

1.03 DEFINITIONS
   A. Mineral-Fiber Insulation: Insulation composed of rock-wool fibers, slag-wool fibers, or
      glass fibers; produced in boards and blanket with latter formed into batts (flat-cut lengths)
      or rolls.

1.04 SUBMITTALS
   A. Product Data: For each type of product indicated.
   B. LEED Submittals:
      1. Credit MR 4.1 and MR 4.2: Recycled Content: Product Data indicating
         percentages by weight of postconsumer and preconsumer recycled content for
         products having recycled content.
         a. Include statement indicating costs for each product having recycled
            content.
      2. Credit MR 5.1 and MR 5.2: Regionally Extracted, Harvested, or Recovered and
         Manufactured Materials:
         a. Indicate location of manufacturing facility, including name, address, and
            distance between manufacturing facility and the project site. Provide
            manufacturer’s documentation indication location where the base
            materials were extracted, mined, quarried, harvested, etc., and the
distance between this location and the project site. Also include material costs, excluding cost of installation.

3. Credit EQ 4.2: Low Emitting Materials:
   a. Submit product data and material safety data sheets (MSDS) for products used on the interior of the building indicating chemical composition and VOC content of each product used.

1.05 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of building insulation through one source from a single manufacturer.

B. Fire-Test-Response Characteristics: Provide insulation and related materials with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect insulation materials from physical damage and from deterioration by moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

B. Protect plastic insulation as follows:
   1. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
   2. Protect against ignition at all times. Do not deliver plastic insulating materials to Project site before installation time.
   3. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.01 GENERAL:

A. Recycled Content: Materials/products shall contain the maximum amount of recycled content allowed that retains material integrity.

B. Regionally Extracted, Harvested, or Recovered and Manufactured Materials:
   1. Preference shall be given to supplier whose facilities are within a 500 mile radius of the project site.
   2. Preference shall also be given to materials that are harvested, extracted, mined, quarried, etc. within a 500 mile radius of the project site.

2.02 FOAM-PLASTIC BOARD INSULATION

A. Extruded-Polystyrene Board Insulation: ASTM C 578, tongue and groove edge, of type and density indicated below, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively:
   1. Manufacturers:
      a. DiversiFoam Products.
      b. Dow Chemical Company.
      c. Owens Corning.
      d. Pactiv Building Products Division.
2. Type IV, 1.60 lb/cu. ft., unless otherwise indicated.
   a. Use for:
      1) Foundation insulation.
      2) Cavity Wall insulation.

2.03 GLASS-FIBER BOARD INSULATION

A. Manufacturers:
   1. CertainTeed Corporation.
   2. Johns Manville.
   3. Owens Corning.

B. Foil-Faced, Flexible Glass-Fiber Board Insulation: ASTM C 612, Type IA or
   ASTM C 553, Types I, II, and III; faced on 1 side with foil-scrim-kraft vapor retarder; with
   maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; and of
   the following nominal density and thermal resistivity:
   1. Nominal density of not less than 1.5 lb/cu. ft. nor more than 1.7 lb/cu. ft., thermal
      resistivity of 4 deg F x h x sq. ft./Btu x in. at 75 deg F.
      a. Use for: Curtain Wall insulation.

C. Unfaced, Glass-Fiber Board Insulation: ASTM C 612, Type IA or Types IA and IB; with
   maximum flame-spread and smoke-developed indexes of 25 and 50,
   respectively; passing ASTM E 136 for combustion characteristics; and of the following
   nominal density and thermal resistivity:
   1. Nominal density of 2.25 lb/cu. ft., thermal resistivity of 4.3 deg F x h x sq. ft./Btu x
      in. at 75 deg F.
      a. Use for:

2.04 GLASS-FIBER BLANKET INSULATION

A. Manufacturers:
   1. CertainTeed Corporation.
   2. Johns Manville.
   3. Owens Corning.

B. Faced, Glass-Fiber Blanket Insulation: ASTM C 665, Type III (blankets with reflective
   membrane facing), Class A (membrane-faced surface with a flame-spread index of 25 or
   less); Category 1 (membrane is a vapor barrier), faced with foil-scrim-kraft, foil-scrim, or
   foil-scrim-polyethylene vapor-retarder membrane on 1 face.
   1. Use for:
      a. General building insulation as indicated on Drawings.
      b. Framed exterior wall construction.

C. Where glass-fiber blanket insulation is indicated by the following thicknesses, provide
   blankets in batt or roll form with thermal resistances indicated:
   1. 8 inches thick with a thermal resistance of 25 deg F x h x sq. ft./Btu at 75 deg F.
   2. 9-1/2 inches thick with a thermal resistance of 30 deg F x h x sq. ft./Btu at 75
      deg F.

2.05 SLAG-WOOL-FIBER/ROCK-WOOL-FIBER BLANKET INSULATION

A. Manufacturers:
   1. Owens Corning.
   2. Thermafiber.

B. Unfaced, Slag-Wool-Fiber/Rock-Wool-Fiber Blanket Insulation: ASTM C 665, Type I
   (blankets without membrane facing); consisting of fibers; with maximum flame-spread
   and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for
   combustion characteristics.
   1. Use for: Fire-safing insulation.
2.06 VAPOR RETARDERS
A. Polyethylene Vapor Retarders: ASTM D 4397, 6 mils thick, with maximum permeance rating of 0.13 perm.
B. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.
C. Vapor-Retarder Fasteners: Pancake-head, self-tapping steel drill screws; with fender washers.
D. Single-Component Nonsag Urethane Sealant: ASTM C 920, Type I, Grade NS, Class 25, Use NT related to exposure, and Use O related to vapor-barrier-related substrates.
E. Adhesive for Vapor Retarders: Product recommended by vapor-retarder manufacturer and with demonstrated capability to bond vapor retarders securely to substrates indicated.

2.07 AUXILIARY INSULATING MATERIALS
A. Spray Foam Insulation: Two component polyurethane spray foam insulation system, consisting of two fast-reacting foam forming ingredients combined in special mixing spray gun at the moment of application.
   1. Product: “Froth-Pak” by Dow Polyurethane Systems:
   2. Use for:
      a. Sealing cracks and gaps in board insulation.
      b. Sealing spaces around doors and windows.
      c. Sealing shim spaces, crevices, and expansion joints.
      d. Sealing other voids in exterior walls and roof.
B. Adhesive for Bonding Insulation: Product with demonstrated capability to bond insulation securely to substrates indicated without damaging insulation and substrates.

2.08 METAL Z-FURRING
A. Steel Sheet, General: Complying with ASTM C 645 requirements for metal and with ASTM A 653/A 653M, G40, hot-dip galvanized zinc coating.
B. Slotted web, face flange of 1-1/4 inches, wall attachment flange of 7/8 inch, minimum bare metal thickness of 0.0179 inch, and depth required to fit insulation thickness indicated.

2.09 INSULATION FASTENERS
A. Adhesively Attached, Spindle-Type Anchors: Plate welded to projecting spindle; capable of holding insulation of thickness indicated securely in position indicated with self-locking washer in place; and complying with the following requirements:
   1. Products:
      a. AGM Industries, Inc.; Series T TACTOO Insul-Hangers.
      b. Eckel Industries of Canada; Stic-Klip Type N Fasteners.
      c. Gemco; Spindle Type.
   2. Plate: Perforated galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
   3. Spindle: Copper-coated, low carbon steel; fully annealed; 0.105 inch in diameter; length to suit depth of insulation indicated.
B. Adhesively Attached, Angle-Shaped, Spindle-Type Anchors: Angle welded to projecting spindle; capable of holding insulation of thickness indicated securely in position indicated with self-locking washer in place; and complying with the following requirements:
   1. Products:
a. Gemco; 90-Degree Insulation Hangers.

2. **Angle:** Formed from 0.030-inch-thick, perforated, galvanized carbon-steel sheet with each leg 2 inches square.

3. **Spindle:** Copper-coated, low carbon steel; fully annealed; 0.105 inch in diameter; length to suit depth of insulation indicated.

C. **Insulation-Retaining Washers:** Self-locking washers formed from 0.016-inch-thick galvanized steel sheet, with beveled edge for increased stiffness, sized as required to hold insulation securely in place, but not less than 1-1/2 inches square or in diameter.

   1. **Products:**
      a. AGM Industries, Inc.; RC150.
      b. AGM Industries, Inc.; SC150.
      c. Gemco; Dome-Cap.
      d. Gemco; R-150.
      e. Gemco; S-150.

2. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in the following locations:

   a. Crawlspace.
   b. Ceiling plenums.
   c. Attic spaces.
   d. Where indicated.

D. **Anchor Adhesive:** Product with demonstrated capability to bond insulation anchors securely to substrates indicated without damaging insulation, fasteners, and substrates.

   1. **Products:**
      a. AGM Industries, Inc.; TACTOO Adhesive.
      b. Eckel Industries of Canada; Stic-Klip Type S Adhesive.
      c. Gemco; Tuff Bond Hanger Adhesive.

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**PART 3 - EXECUTION**

**3.01 EXAMINATION**

A. Examine substrates and conditions, with Installer present, for compliance with requirements of Sections in which substrates and related work are specified and for other conditions affecting performance.

   1. Proceed with installation only after unsatisfactory conditions have been corrected.

**3.02 PREPARATION**

A. Clean substrates of substances harmful to insulation or vapor retarders, including removing projections capable of puncturing vapor retarders or of interfering with insulation attachment.

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**3.03 INSTALLATION, GENERAL**

A. Comply with insulation manufacturer's written instructions applicable to products and application indicated.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed at any time to ice, rain, and snow.

C. Extend insulation in thickness indicated to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
D. Water-Piping Coordination: If water piping is located within insulated exterior walls, coordinate location of piping to ensure that it is placed on warm side of insulation and insulation encapsulates piping.

E. For preformed insulating units, provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

F. Seal crack, gaps and other voids in exterior wall and roof construction with spray-foam insulation.
   1. Comply with spray-foam insulation manufacturer's installation instructions.

3.04 INSTALLATION OF PERIMETER AND UNDER-SLAB INSULATION

A. On vertical surfaces, set insulation units in adhesive applied according to manufacturer's written instructions. Use adhesive recommended by insulation manufacturer.
   1. If not otherwise indicated, extend insulation a minimum of 24 inches below exterior grade line.

B. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.

3.05 INSTALLATION OF CAVITY-WALL INSULATION

A. On units of foam-plastic board insulation, install pads of adhesive spaced approximately 24 inches o.c. both ways on inside face, and as recommended by manufacturer. Fit courses of insulation between wall ties and other obstructions, with edges butted tightly in both directions. Press units firmly against inside substrates indicated.
   1. Supplement adhesive attachment of insulation by securing boards with two-piece wall ties designed for this purpose and specified in Division 04 Section "Unit Masonry."

3.06 INSTALLATION OF GENERAL BUILDING INSULATION

A. Apply insulation units to substrates, complying with manufacturer's written instructions. Bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.

B. Seal joints between foam-plastic insulation units by applying adhesive, mastic, or sealant to edges of each unit to form a tight seal as units are shoved into place. Fill voids in completed installation with spray foam insulation.

C. Z-Furring Members:
   1. Erect board insulation horizontally and hold in place with Z-furring members spaced 24 inches o.c., unless indicated otherwise.
   2. Except at exterior corners, securely attach narrow flanges of furring members to framing members with fasteners spaced 16 inches o.c.
   3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches from corner and cut insulation to fit.

D. Install board insulation on concrete substrates by adhesively attached, spindle-type insulation anchors as follows:
   1. Fasten insulation anchors to concrete substrates with insulation anchor adhesive according to anchor manufacturer's written instructions. Space anchors according to insulation manufacturer's written instructions for insulation type, thickness, and application indicated.
2. Apply insulation standoffs to each spindle to create cavity width indicated between concrete substrate and insulation.
3. After adhesive has dried, install board insulation by pressing insulation into position over spindles and securing it tightly in place with insulation-retaining washers, taking care not to compress insulation below indicated thickness.
4. Where insulation will not be covered by other building materials, apply capped washers to tips of spindles.

E. Install board insulation in curtain-wall construction where indicated on Drawings according to curtain-wall manufacturer's written instructions.
   1. Retain insulation in place by metal clips and straps or integral pockets within window frames, spaced at intervals recommended in writing by insulation manufacturer to hold insulation securely in place without touching spandrel glass. Maintain cavity width of dimension indicated between insulation and glass.
   2. Install insulation where it contacts perimeter fire-containment system to prevent insulation from bowing under pressure from perimeter fire-containment system.

3.07 INSTALLATION OF INSULATION IN CEILINGS FOR SOUND ATTENUATION
A. Install 3-inch thick acoustical insulation specified in Division 09 Section "Gypsum Board" over suspended ceilings at partitions in a width that extends insulation 48 inches on either side of partition.

3.08 INSTALLATION OF VAPOR RETARDERS
A. General: Extend vapor retarder to extremities of areas to be protected from vapor transmission. Secure in place with adhesives or other anchorage system as indicated. Extend vapor retarder to cover miscellaneous voids in insulated substrates, including those filled with loose-fiber insulation.
B. Seal vertical joints in vapor retarders over framing by lapping not less than two wall studs. Fasten vapor retarders to wood framing at top, end, and bottom edges; at perimeter of wall openings; and at lap joints. Space fasteners 16 inches o.c.
C. Before installing vapor retarder, apply urethane sealant to flanges of metal framing including runner tracks, metal studs, and framing around door and window openings. Seal overlapping joints in vapor retarders with vapor-retarder tape according to vapor-retarder manufacturer's written instructions. Seal butt joints with vapor-retarder tape. Locate all joints over framing members or other solid substrates.
D. Firmly attach vapor retarders to metal framing and solid substrates with vapor-retarder fasteners as recommended by vapor-retarder manufacturer.
E. Seal joints caused by pipes, conduits, electrical boxes, and similar items penetrating vapor retarders with vapor-retarder tape to create an airtight seal between penetrating objects and vapor retarder.
F. Repair tears or punctures in vapor retarders immediately before concealment by other work. Cover with vapor-retarder tape or another layer of vapor retarder.

3.09 PROTECTION
A. Protect installed insulation and vapor retarders from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.
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:
   2. Underlayment.
   3. Snow guards.
B. Related Sections:
   1. Division 06 Section "Sheathing" for roof sheathing.

1.03 DEFINITIONS

1.04 SUBMITTALS
A. Product Data: For each type of product indicated.
B. LEED Submittal:
   1. Product Test Reports for Credit SS 7.2: For clay roof tiles, documentation indicating compliance with Solar Reflectance Index requirement.
C. Samples: For the following products, in manufacturer's standard sizes:
   1. Clay Roof Tile: 4 full size units of each color, demonstrating range of color variations.
   2. Accessory Tile: Full size, each type.
D. Maintenance Data: For roofing to include in maintenance manuals.

1.05 QUALITY ASSURANCE
A. Installer Qualifications: Firm specializing in the installation of clay tile roofing systems with a minimum of 5 years experience and having completed 2 such projects in the past 4 years.
   1. Obtain pre-bid approval of proposed firms from Owner prior to awarding contract for clay roof tiles
B. Installation Procedures: Obtain Owner's approval of installation procedures prior to commencing clay roof tile work.
C. Source Limitations: Obtain clay roof tiles and accessory tiles from single source from single manufacturer.
D. Fire-Test-Response Characteristics: Provide clay roof tiles and related roofing materials with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency.
acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.

1. Exterior Fire-Test Exposure: Class A; UL 790 or ASTM E 108, for application and roof slopes indicated.

E. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockups for clay roof tiles including related roofing materials.
   a. Ground Level Mock-up:
      1) Size: 4'-0" wide by 8'-0" long.
      2) Demonstrate full range of color, color distribution and trim pieces.
      a) Modify blends and colors as required.
      3) Order tile based on approved mockup.
   b. Roof Mock-up:
      1) Size: 16'-0" wide by 16'-0" long.
      2) Demonstrate full range of color, color distribution and trim pieces.
      3) Obtain Architect's acceptance before proceeding with remainder of roof installation.
      a) Revise mockup until accepted.

2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

3. Approved mockups may become part of the completed Work if undisturbed at time of Completion.

F. Preinstallation Conference: Conduct conference at Project site.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store underlayment rolls on end, on pallets or other raised surfaces. Do not double stack rolls.
   1. Handle, store, and place roofing materials in a manner to avoid significant or permanent damage to roof deck or structural supporting members.

B. Protect unused underlayment from weather, sunlight, and moisture when left overnight or when roofing work is not in progress.

1.07 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing to be performed according to manufacturer's written instructions and warranty requirements.
   1. Install self-adhering sheet underlayment within the range of ambient and substrate temperatures recommended by manufacturer.

1.08 WARRANTY

A. Special Warranty: Standard form in which manufacturer agrees to repair or replace clay roof tiles that fail in materials within specified warranty period.
   1. Materials-Only Warranty Period: [50] years from date of Completion.

B. Special Project Warranty: Roofing Installer's Warranty, on warranty form at end of this Section, signed by roofing Installer, covering Work of this Section, in which roofing Installer agrees to repair or replace components of roofing that fail in materials or workmanship within the following warranty period:
1. Warranty Period: [Two] [Five] <Insert number> years from date of Substantial Completion.

1.09 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Clay Roof Tiles: 2 percent of quantity installed, for each type, in unbroken bundles.

PART 2 - PRODUCTS

2.01 CLAY ROOF TILES

A. Clay Roof Tiles: ASTM C 1167, molded- or extruded-clay roof tile units of shape and configuration indicated, kiln fired to vitrification, and free of surface imperfections. Provide with fastening holes prepunched at factory before firing.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Spanish Tile by Ludowici Roof Tile.
   2. Durability: Grade 1.
   3. High-Profile Shape: Type I, straight barrel mission, two piece.
   5. Solar Reflectance Index: Provide clay roof tile with Solar Reflectance Index not less than 29 when calculated according to ASTM E 1980, based on testing of identical products by a qualified testing agency.
   7. Color:
      a. Pans: Red range.
      b. Covers: Blended as follows:
         1) Summer Rose, 60 percent
         2) Clay Red, 12 percent
         3) Santiago Rose, 10 percent
         4) Burgundy, 10 percent.
         5) Beach Brown, 6 percent.
         6) Lava Black, 2 percent.
   8. High-Profile-Shape Accessory Tiles: Ridge, ridge end, roll rake edge starter, eave closure and top fixture units, in color matching clay roof tiles.
      a. Tile at hips, ridges, and starter course shall be 18 inch tile with 2 holes.

2.02 ACCESSORIES

A. Asphalt Roofing Cement: ASTM D 4586, Type II, asbestos free.
B. Elastomeric Sealant: ASTM C 920, elastomeric polyurethane-based joint sealant; Type S, Grade NS, Class 25, Use NT related to exposure, and, as applicable to joint substrates indicated, Use O.
C. Mortar: ASTM C 270, Type M, with ASTM C 979, pigmented mortar matching the color of clay roof tiles for exposed-to-view mortar, and natural color for concealed-from-view mortar.
D. Eave Closure: Manufacturer's standard eave closure formed to shape of clay roof tile.
E. Wood Nailers: Comply with requirements for pressure-preservative-treated wood in Division 06 Section "Miscellaneous Rough Carpentry."
2.03 FASTENERS
   A. Roofing Nails: ASTM F 1667, copper, 0.135-inch-diameter shank, sharp-pointed,
      conventional roofing nails with barbed shanks; minimum 3/8-inch-diameter head; of
      sufficient length to penetrate 3/4 inch into roof-deck sheathing.
      1. Where nails are in contact with metal flashing, use nails made from same metal
         as flashing.
   B. Wire Ties: Copper, 0.083-inch minimum diameter.

2.04 UNDERLAYMENT MATERIALS
   A. Felt Underlayment: ASTM D 226, Type II, asphalt-saturated organic felt, unperforated.
   B. Self-Adhering Sheet Underlayment, Polyethylene Faced: ASTM D 1970, a minimum of
      40-mil-thick, slip-resisting, polyethylene-film-reinforced top surface laminated to SBS-
      modified asphalt adhesive, with release paper backing; cold applied. Provide primer for
      adjoining concrete or masonry surfaces to receive underlayment.
      1. Manufacturers: Subject to compliance with requirements, provide products by
         one of the following:
            b. Polyguard Products, Inc.; Deck Guard
            c. Polyken Technologies; Polyken 640 Underlayment Membrane.

2.05 SNOW GUARDS
   A. Snow-Guard Pads: Fabricated stainless-steel units, designed to be installed without
      penetrating roof tiles, and complete with predrilled holes or hooks for anchoring.
      1. Order snow guard pads through Owner's Department of Facilities Management.

2.06 METAL FLASHING AND TRIM
   A. General: Comply with requirements in Division 07 Section "Sheet Metal Flashing and
      Trim."
      1. Sheet Metal: Copper
   B. Fabricate sheet metal flashing and trim to comply with recommendations that apply to
      design, dimensions, metal, and other characteristics of the item in SMACNA's
      1. Apron Flashings: Fabricate with lower flange extending a minimum of 4 inches
         over and 4 inches beyond each side of downslope tile roofing and 6 inches up
         the vertical surface.
      2. Step Flashings: Fabricate with a head lap of 3 inches and a minimum extension
         of 5 inches both horizontally and vertically.
      3. Channel Flashings: Fabricate with vertical surface extending a minimum of 5
         inches above the clay roof tile and 6 inches beneath the tile roofing, with a 1-
         inch-high vertical return to form a runoff channel.
      4. Rake Pan Flashings: Fabricate with vertical surface extending over fasciae and
         6 inches beneath the tile roofing, with a 1-inch-high vertical return to form a
         runoff channel.
      5. Cricket Flashings: Fabricate with concealed flange extending a minimum of 24
         inches beneath upslope tile roofing, 6 inches beyond each side of obstruction,
         and 6 inches above the roof plane.
      6. Drip Edges: Fabricate in lengths not exceeding 10 feet, with 2-inch roof-deck
         flange and 1-1/2-inch fascia flange with 3/8-inch drip at lower edge.
   C. Vent-Pipe Flashings: ASTM B 749, Type L51121, at least 1/16 inch thick. Provide lead
      sleeve sized to slip over and turn down into pipe, soldered to skirt at slope of roof and
      extending at least 4 inches from pipe onto roof.
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.
   1. Examine roof sheathing to verify that sheathing joints are supported by framing and blocking or metal clips and that installation is within flatness tolerances.
   2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and completely anchored and that provision has been made for flashings and penetrations through roofing.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 UNDERLAYMENT INSTALLATION

A. General: Comply with clay roof tile manufacturer's written instructions and recommendations in NRCA's "The NRCA Roofing and Waterproofing Manual."
   1. Cover ridge wood nailers with underlayment strips.

B. Double-Layer Felt Underlayment: Install on roof deck parallel with and starting at the eaves. Install a 19-inch-wide starter course at eaves and completely cover with full-width second course. Install succeeding courses lapping previous courses 19 inches in shingle fashion. Lap ends a minimum of 6 inches. Stagger end laps between succeeding courses at least 72 inches. Fasten with galvanized steel roofing nails.
   1. Install felt underlayment on roof sheathing not covered by self-adhering sheet underlayment. Lap edges over self-adhering sheet underlayment not less than 3 inches in direction to shed water.

C. Self-Adhering Sheet Underlayment: Install wrinkle free; comply with low-temperature installation restrictions of underlayment manufacturer if applicable. Install at locations indicated below, lapped in direction to shed water. Lap sides not less than 3-1/2 inches. Lap ends not less than 6 inches, staggered 24 inches between succeeding courses. Roll laps with roller. Cover underlayment within seven days.
   1. Prime concrete and masonry surfaces to receive self-adhering sheet underlayment.
   2. Extend self-adhering sheet underlayment over roof deck as follows:
      a. Apply minimum 6'-0" wide layer of underlayment at entire perimeter of surface to receive roofing, including eaves, ridges, hips, valleys, skylights, vertical wall penetrations, dormers, and edges.
      b. Extend underlayment a minimum of 24 inches inside exterior wall line; 36 inches at at eaves.
      c. Apply underlayment horizontally using maximum available width to eliminate or minimize horizontal joints.

3.03 METAL FLASHING INSTALLATION

A. General: Install metal flashings and other sheet metal to comply with requirements in Division 07 Section "Sheet Metal Flashing and Trim."
   1. Install metal flashings according to clay roof tile manufacturer's written instructions and recommendations in NRCA's "The NRCA Roofing and Waterproofing Manual."
   2. Flashings to be lapped 6" and to be secured with 4" wide floating 20 gage stainless steel cleats at 36" on center or continuous 20 gage stainless steel cleat.

B. Apron Flashings: Extend lower flange over and beyond each side of downslope tile roofing and up the vertical surface.
C. Step Flashings: Install with a head lap of 3 inches and extend both horizontally and vertically. Install with lower edge of flashing just upslope of, and concealed by, butt of overlying tile. Fasten to roof deck only.

D. Cricket Flashings: Install against roof-penetrating elements, extending concealed flange beneath upslope tile roofing and beyond each side.

E. Channel Flashings: Install over underlayment and fasten to roof deck.

F. Eave Drip Edges: Install beneath underlayment and fasten to roof deck.

G. Pipe Flashings: Form flashing around pipe penetrations and tile roofing. Fasten and seal to tile roofing.

3.04 WOOD NAILERS

A. Install wood nailers at ridges and rakes and securely fasten to roof deck.

B. Apply wood strips at cover tile and ridges of proper height to support tile. Place across roof slope and space to support each row of cover tile.

1. At eave, notch batten to receive eave closure (avoid short nailers).

2. Toenail wood strips to substrate with 16d nails, staggered pattern 18 inches on center.

3.05 CLAY ROOF TILE INSTALLATION

A. General: Install clay roof tiles to match Owner's existing roofs, accepted mockup, and according to manufacturer's written instructions, recommendations in TRI/WSRCA's "Concrete and Clay Roof Tile Design Criteria Installation Manual for Moderate Climate Regions," and to NRCA's "The NRCA Roofing and Waterproofing Manual."

1. Maintain uniform exposure and coursing of clay roof tiles throughout roof.

2. Extend tiles 2 inches over eave fasciae.

3. Nail Fastening: Drive nails to clear the clay roof tile so the tile hangs from the nail and is not drawn up.

a. Secure with nails with side and head lap as recommended by manufacturer for required exposure, climate, wind conditions, and roof slope.

1) Ensure nails penetrate wood substrate 3/4 inch minimum.

b. All tiles, including pan and cover tiles, shall be nailed.

1) Install wire through nail holes of cut tiles that cannot be nailed directly to roof deck, and fasten to nails driven into deck.

c. Caulk all exposed nail heads with elastomeric sealant.

4. Take special care in handling and working over installed tile to avoid cracking, chipping or breaking of tiles.

5. Cut and fit clay roof tiles neatly around roof vents, pipes, ventilators, and other projections through roof. Fill voids with mortar.

6. Install clay roof tiles with color blend approved by Architect.

B. High-Profile Clay Roof Tile Installation:

1. Install eave closure.

2. Provide minimum 3-inch lap between succeeding courses of clay roof tiles.

3. Install roll rake tiles. Seal rake tiles to field tile with elastomeric sealant.

4. Install ridge tiles with laps facing away from prevailing wind. Seal laps and seal ridge tiles to field tile with elastomeric sealant.
3.06 SNOW-GUARD INSTALLATION
   A. Snow-Guard Pads: Install snow-guard pads at locations indicated, according to manufacturer's written installation instructions.

3.07 ADJUSTING AND CLEANING
   A. Remove and replace damaged or broken clay roof tiles.
   B. Remove excess clay roof tiles and debris from Project site.

END OF SECTION
METAL WALL PANELS

PART 1 - GENERAL

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

1.02 SUMMARY
A. This Section includes the following:
   1. Standing Seam Metal Wall Panels.
B. Related Sections include the following:
   1. Division 01 Section "Sustainable Design Requirements" for additional LEED requirements.
   2. Division 07 Section "Sheet Metal Flashing and Trim" for copings, flashings and other sheet metal work not part of metal wall panel assemblies.
   3. Division 07 Section "Joint Sealants" for field-applied sealants not otherwise specified in this Section.

1.03 DEFINITIONS
A. Metal Wall Panel Assembly: Metal wall panels, attachment system components, miscellaneous metal framing, thermal insulation, and accessories necessary for a complete weathertight system.
B. Steel Sheet Thickness: Minimum thickness of base metal without metallic coatings or painted finishes.

1.04 PERFORMANCE REQUIREMENTS
A. General: Provide metal wall panel assemblies that comply with performance requirements specified as determined by testing manufacturers' standard assemblies similar to those indicated for this Project, by a qualified testing and inspecting agency.
B. Structural Performance: Provide metal wall panel assemblies capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated, based on testing according to ASTM E 330:
   1. Wind Loads: Determine loads based on the following minimum design wind pressures:
      a. Uniform pressure of 30 lbf/sq. ft., acting inward or outward.
   2. Deflection Limits: Engineer metal wall panel assemblies to withstand test pressures with deflection no greater than 1/240 of the span and no evidence of material failure, structural distress, or permanent deformation exceeding 0.2 percent of the clear span.
      a. Test Pressures: 150 percent of inward and outward wind-load design pressures.
C. Thermal Movements: Provide metal wall panel assemblies that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base
engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

1.05 SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of metal wall panel and accessory.

B. Shop Drawings: Show fabrication and installation layouts of metal wall panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details. Distinguish between factory- and field-assembled work.

1. Accessories: Include details of the following items, at a scale of not less than 1-1/2 inches per 12 inches:
   a. Flashing and trim.

C. Coordination Drawings: Exterior elevations drawn to scale and coordinating penetrations and wall-mounted items. Show the following:

1. Wall panels and attachments.
2. Steel framing.
3. Metal decking.
4. Wall-mounted items.

D. Samples: For each type of exposed finish required, prepared on Samples of size indicated below.

1. Metal Wall Panels: 12 inches long by actual panel width. Include fasteners, closures, and other metal wall panel accessories.
2. Exposed Sealants: For each type and color of joint sealant required. Install joint sealants in 1/2-inch- wide joints formed between two 6-inch- long strips of material matching the appearance of metal wall panels adjacent to joint sealants.

E. LEED Submittals:

1. Credit MR 4.1 and MR 4.2: Recycled Content: Product Data indicating percentages by weight of postconsumer and preconsumer recycled content for products having recycled content.
   a. Include statement indicating costs for each product having recycled content.

2. Credit MR 5.1 and MR 5.2: Regionally Extracted, Harvested, or Recovered and Manufactured Materials:
   a. Indicate location of manufacturing facility, including name, address, and distance between manufacturing facility and the project site. Provide manufacturer’s documentation indicating location where the base materials were extracted, mined, quarried, harvested, etc., and the distance between this location and the project site. Also include material costs, excluding cost of installation.

F. Compatibility and Adhesion Test Reports: From sealant manufacturer indicating the following:

1. Materials forming joint substrates and joint sealant backings have been tested for compatibility and adhesion with joint sealants.
2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.

G. Maintenance Data: For metal wall panels to include in maintenance manuals.
1.06 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

B. Source Limitations: Obtain each type of metal wall panel through one source from a single manufacturer.

C. Product Options: Drawings indicate size, profiles, and dimensional requirements of metal wall panels and are based on the specific system indicated. Refer to Division 01 Section “Product Requirements.”
   1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.

D. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.
   1. Use manufacturer's standard test methods to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
      a. Perform tests under environmental conditions replicating those that will exist during installation.
   2. Submit no fewer than nine pieces of each type of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
   3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
   4. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures, including the use of specially formulated primers.
   5. Testing will not be required if joint-sealant manufacturers submit joint preparation data that are based on previous testing of current sealant products for adhesion to, and compatibility with, joint substrates and other materials matching those submitted.

E. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." Review methods and procedures related to metal wall panel assemblies including, but not limited to, the following:
   1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
   2. Review methods and procedures related to metal wall panel installation, including manufacturer's written instructions.
   3. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
   4. Review flashings, special siding details, wall penetrations, openings, and condition of other construction that will affect metal wall panels.
   5. Review governing regulations and requirements for insurance, certificates, and testing and inspecting if applicable.
   6. Review temporary protection requirements for metal wall panel assembly during and after installation.
   7. Review wall panel observation and repair procedures after metal wall panel installation.
   8. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.
1.07 DELIVERY, STORAGE, AND HANDLING
A. Deliver components, sheets, metal wall panels, and other manufactured items so as not to be damaged or deformed. Package metal wall panels for protection during transportation and handling.
B. Unload, store, and erect metal wall panels in a manner to prevent bending, warping, twisting, and surface damage.
C. Stack metal wall panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal wall panels to ensure dryness, with positive slope for drainage of water. Do not store metal wall panels in contact with other materials that might cause staining, denting, or other surface damage.
D. Protect strippable protective covering on metal wall panels from exposure to sunlight and high humidity, except to extent necessary for period of metal wall panel installation.

1.08 PROJECT CONDITIONS
A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal wall panels to be performed according to manufacturers’ written instructions and warranty requirements.
B. Field Measurements: Verify locations of structural members and wall opening dimensions by field measurements before metal wall panel fabrication and indicate measurements on Shop Drawings.
   1. Established Dimensions: Where field measurements cannot be made without delaying the Work, either establish framing and opening dimensions and proceed with fabricating metal wall panels without field measurements, or allow for field trimming of panels. Coordinate wall construction to ensure that actual building dimensions, locations of structural members, and openings correspond to established dimensions.

1.09 COORDINATION
A. Coordinate metal wall panel assemblies with rain drainage work, flashing, trim, and construction of other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.10 WARRANTY
A. Special Warranty on Panel Finishes: Manufacturer’s standard form in which manufacturer agrees to repair finish or replace metal wall panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
   1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
      a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
      b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
      c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
   2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 GENERAL
A. Recycled Content: Materials/products shall contain the maximum amount of recycled content allowed that retains material integrity.
B. Regionally Extracted, Harvested, or Recovered and Manufactured Materials:
1. Preference shall be given to manufacturer’s whose facilities are within a 500 mile radius of the project site.
2. Preference shall also be given to materials that are harvested, extracted, mined, quarried, etc. within a 500 mile radius of the project site.

2.02 BASIS OF DESIGN PRODUCTS
A. The design for each metal wall panel specified is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified. Plans, elevations, details, characteristics, and other requirements indicated are based upon standards of the Basis of Design Product. Other manufacturers listed may be acceptable, provided their details and characteristics comply with size and profile requirements, and material and performance standards.

2.03 PANEL MATERIALS
A. Metallic-Coated Steel Sheet Prepainted with Coil Coating: Steel sheet metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
1. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 coating designation; structural quality.
2. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Class AZ50 or AZ55 coating designation, Grade 40; structural quality.
4. Exposed Finishes: Apply the following coil coating, as specified or indicated on Drawings.
   a. High-Performance Organic Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      1) Fluoropolymer Three-Coat System: Manufacturer's standard three-coat, thermocured system consisting of specially formulated inhibitive primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight, with a minimum total dry film thickness of 1.5 mil; complying with physical properties and coating performance requirements of AAMA 2605, except as modified below:
         a) Humidity Resistance: 1000 hours.
         b) Salt-Spray Resistance: 1000 hours.
5. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

B. Panel Sealants:
1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.
2. Joint Sealant: ASTM C 920; elastomeric polyurethane sealant; of type, grade, class, and use classifications required to seal joints in metal wall panels and remain weathertight; and as recommended in writing by metal wall panel manufacturer.
2.04 MISCELLANEOUS METAL FRAMING
A. Steel Sheet Components, General: Complying with ASTM C 645 requirements for metal and with ASTM A 653/A 653M, G40, hot-dip galvanized zinc coating.
B. Base or Sill Angles and Channels: 0.079-inch bare steel thickness, cold-formed, galvanized steel sheet.
C. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

2.05 MISCELLANEOUS MATERIALS
A. Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other fasteners designed to withstand design loads. Provide exposed fasteners with heads matching color of metal wall panels by means of plastic caps or factory-applied coating.
   1. Fasteners for Wall Panels: Self-drilling or self-tapping 410 stainless or zinc-alloy steel hex washer head, with EPDM or PVC washer under heads of fasteners bearing on weather side of metal wall panels.
   2. Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws with hex washer head.

2.06 STANDING SEAM METAL WALL PANELS
A. Vertical-Rib, Snap-Joint, Standing-Seam Metal Wall Panels: Formed with vertical ribs at panel edges and flat pan between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels and engaging opposite edge of adjacent panels, and snapping panels together.
   1. Basis-of-Design Product: "Snap Seam Panels" by AEP-SPAN or a comparable product of one of the following:
      b. Architectural Roofing and Siding, Inc.
      c. ATAS International, Inc.
      d. Berridge Manufacturing Company.
      e. BHP Steel Building Products USA Inc.
      f. CENTRIA Architectural Systems.
      g. Custom Panel Industries, LLC.
      h. Delcoa Industries, Inc.
      i. Fabral, Inc.
      j. Innovative Metals Company, Inc.
      k. K-Metals Inc.
      l. MBCI; Div. of NCI Building Systems.
      m. McElroy Metal, Inc.
      n. Merchant & Evans, Inc.
      o. Metal-Fab Manufacturing, LLC.
      p. Metal Sales Manufacturing Corporation.
      q. Modern Metal Systems, Inc.
      r. Morin Corporation; a Metecno Group Company.
      s. Perma-Clad Products.
      t. Petersen Aluminum Corporation.
      u. VICWEST; Div. of Jenisys Engineered Products.
   2. Material: Zinc-coated (galvanized) steel sheet, 0.0159 inch thick.
      b. Color: As selected by Architect from manufacturer's full range.
   3. Material: Aluminum-zinc alloy-coated steel sheet, 0.0159 inch thick.
b. Color: As selected by Architect from manufacturer’s full range.

a. Material: 0.0209-inch-thick, zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.

5. Panel Coverage: 12 inches.
6. Panel Height: 1.75 inches.

2.07 ACCESSORIES

A. Wall Panel Accessories: Provide components required for a complete metal wall panel assembly including trim, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal wall panels, unless otherwise indicated.

1. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.

B. Flashing and Trim: Formed from 0.0179-inch-thick, zinc-coated (galvanized) steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal wall panels.

2.08 FABRICATION

A. General: Fabricate and finish metal wall panels and accessories at the factory to greatest extent possible, by manufacturer’s standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

1. Form panel lines, breaks, and angles to be sharp and true, with surfaces free from warp and buckle.
2. Fabricate wall panels with panel stiffeners as required to maintain fabrication tolerances and to withstand design loads.

B. Fabricate metal wall panels in a manner that eliminates condensation on interior side of panel and with joints between panels designed to form weathertight seals.

C. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

D. Where indicated, fabricate metal wall panel joints with factory-installed captive gaskets or separator strips that provide a tight seal and prevent metal-to-metal contact, in a manner that will minimize noise from movements within panel assembly.

E. Sheet Metal Accessories: Fabricate flashing and trim to comply with recommendations in SMACNA’s “Architectural Sheet Metal Manual” that apply to the design, dimensions, metal, and other characteristics of item indicated.

1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
2. Seams: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
3. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.
4. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
5. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended by metal wall panel manufacturer.  
   a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal wall panel manufacturer for application but not less than thickness of metal being secured.

2.09 FINISHES, GENERAL

   A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
   B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
   C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.01 EXAMINATION

   A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal wall panel supports, and other conditions affecting performance of work.
      1. Examine primary and secondary wall framing to verify that structural panel support members and anchorage have been installed within alignment tolerances required by metal wall panel manufacturer.
   B. Examine roughing-in for components and systems penetrating metal wall panels to verify actual locations of penetrations relative to seam locations of metal wall panels before metal wall panel installation.
   C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

   A. Clean substrates of substances harmful to insulation, including removing projections capable of interfering with insulation attachment.
   B. Install flashings and other sheet metal to comply with requirements specified in Division 07 Section "Sheet Metal Flashing and Trim."
   C. Miscellaneous Framing: Install miscellaneous wall panel support members and anchorage according to ASTM C 754 "Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products," and metal wall panel manufacturer's written recommendations.

3.03 METAL WALL PANEL INSTALLATION, GENERAL

   A. General: Install metal wall panels in orientation, sizes, and locations indicated on Drawings. Install panels perpendicular to girts and subgirts, unless otherwise indicated. Anchor metal wall panels and other components of the Work securely in place, with provisions for thermal and structural movement.
      1. Field cutting of metal wall panels by torch is not permitted.
      2. Shim or otherwise plumb substrates receiving metal wall panels.
3. Rigidly fasten base end of metal wall panels and allow eave end free movement due to thermal expansion and contraction. Predrill panels.
4. Install screw fasteners in predrilled holes.
5. Locate and space fastenings in uniform vertical and horizontal alignment.
6. Install flashing and trim as metal wall panel work proceeds.
7. Align bottom of metal wall panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
8. Provide weatherproof escutcheons for pipe and conduit penetrating exterior walls.

B. Fasteners:
1. Steel Wall Panels: Use stainless-steel fasteners for surfaces exposed to the exterior.

C. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by metal wall panel manufacturer.

D. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of metal wall panel assemblies. Provide types of gaskets, fillers, and sealants indicated or, if not indicated, types recommended by metal wall panel manufacturer.
1. Seal metal wall panel end laps with double beads of tape or sealant, full width of panel. Seal side joints where recommended by metal wall panel manufacturer.
2. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants."

3.04 FIELD-ASSEMBLED METAL WALL PANEL INSTALLATION
A. Standing-Seam Metal Roof Panels: Fasten metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended by manufacturer.
1. Install clips to supports with self-tapping fasteners.
2. Install pressure plates at locations indicated in manufacturer's written installation instructions.
3. Seamed Joint: Crimp standing seams with manufacturer-approved motorized seamer tool so clip, metal roof panel, and factory-applied sealant are completely engaged.

3.05 ACCESSORY INSTALLATION
A. General: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.
1. Install components required for a complete metal wall panel assembly including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.

B. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
1. Install exposed flashing and trim that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped or bayonet-type expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

3.06 ERECTION TOLERANCES

A. Installation Tolerances: Shim and align metal wall panel units within installed tolerance of 1/4 inch in 20 feet, nonaccumulative, on level, plumb, and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.07 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal wall panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal wall panel installation, clean finished surfaces as recommended by metal wall panel manufacturer. Maintain in a clean condition during construction.

B. After metal wall panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.

C. Replace metal wall panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

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 metal-faced composite wall panels.
B. Related Sections include the following:
   1. Division 05 Section "Cold-Formed Metal Framing" for cold-formed metal framing supporting metal-faced composite wall panels.
   2. Division 07 Section "Metal Wall Panels" for standing seam metal wall panels.
   3. Division 07 Section "Sheet Metal Flashing and Trim" for field-formed flashings and other sheet metal work not part of metal-faced composite wall panel assemblies.

1.03 DEFINITION
A. Metal-Faced Composite Wall Panel Assembly: Metal-faced composite wall panels, attachment system components, miscellaneous metal framing, and accessories necessary for a complete weathertight wall system.

1.04 PERFORMANCE REQUIREMENTS
A. General Performance: Metal-faced composite wall panel assemblies shall comply with performance requirements without failure due to defective manufacture, fabrication, installation, or other defects in construction.
B. Delegated Design: Design metal-faced composite wall panel assembly, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
C. Air Infiltration: Air leakage through assembly of not more than 0.06 cfm/sq. ft. of wall area when tested according to ASTM E 283 at the following test-pressure difference:
   1. Test-Pressure Difference: 1.57 lbf/sq. ft.
D. Water Penetration Under Static Pressure: No water penetration when tested according to ASTM E 331 at the following test-pressure difference:
   1. Test-Pressure Difference: 2.86 lbf/sq. ft.
E. Water Penetration Under Dynamic Pressure: No evidence of water leakage when tested according to AAMA 501.1 under dynamic pressure equal to 20 percent of inward-acting, wind-load design pressure of not less than 6.24 lbf/sq. ft. and not more than 12 lbf/sq. ft.:
   1. Water Leakage: As defined according to AAMA 501.1
   2. Water Leakage: Uncontrolled water infiltrating the system or appearing on system's normally exposed interior surfaces from sources other than condensation. Water controlled by flashing and gutters that is drained back to the exterior and cannot damage adjacent materials or finishes is not water leakage.
F. Structural Performance: Provide metal-faced composite wall panel assemblies capable of withstanding the effects of the following loads and stresses within limits and under conditions indicated, based on testing according to ASTM E 330:

1. Wind Loads: Determine loads based on the following minimum design wind pressures:
   a. Uniform pressure of 30 lbf/sq. ft., acting inward or outward.

2. Deflection Limits: Metal-faced composite wall panel assemblies shall withstand wind loads with horizontal deflections no greater than 1/180 of the span.

G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): Minus 20 to plus 180 deg F ambient; 180 deg F material surfaces.

1.05 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of metal-faced composite wall panel and accessory.

B. Shop Drawings: Show fabrication and installation layouts of metal-faced composite wall panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details. Distinguish among factory-, shop-, and field-assembled work.

1. Accessories: Include details of the following items, at a scale of not less than 1-1/2 inches per 12 inches:
   a. Flashing and trim.
   b. Anchorage systems.

C. Samples: For each type of exposed finish required, prepared on Samples of size indicated below:

1. Metal-Faced Composite Wall Panels: 12 inches long by actual panel width. Include fasteners, closures, and other metal-faced composite wall panel accessories.

2. Trim and Closures: 12 inches long. Include fasteners and other exposed accessories.

3. Accessories: 12-inch-long Samples for each type of accessory.

4. Exposed Gaskets: 12 inches long.

D. Delegated-Design Submittal: For metal-faced composite wall panel assembly indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

E. Coordination Drawings: Exterior elevations, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Wall panels and attachments.

2. Stud framing.

3. Wall-mounted items including doors, windows, louvers, and lighting fixtures.

4. Penetrations of wall by pipes and utilities.

F. Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:
1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.

G. Field quality-control reports.
H. Maintenance Data: For metal wall panels to include in maintenance manuals.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.
B. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
C. Source Limitations: Obtain each type of metal-faced composite wall panel from single source from single manufacturer.
D. Preconstruction Compatibility and Adhesion Testing: Submit samples of materials that will contact joint sealants to joint-sealant manufacturers for testing indicated in subparagraphs below:
   1. Use manufacturer's standard test methods to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
      a. Perform tests under environmental conditions replicating those that will exist during installation.
   2. Submit no fewer than nine pieces of each type of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
   3. Schedule enough time for testing and analyzing results to prevent delaying the Work.
   4. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures, including use of specially formulated primers.
E. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
   1. Build mockup of typical panel as shown on Drawings.
   2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
F. Preinstallation Conference: Conduct conference at Project site.
   1. Meet with Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, metal-faced composite wall panel Installer, metal-faced composite wall panel manufacturer's representative, structural-support Installer, and installers whose work interfaces with or affects metal-faced composite wall panels including installers of doors, windows, and louvers.
   2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
   3. Review methods and procedures related to metal-faced composite wall panel installation, including manufacturer's written instructions.
   4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
   5. Review flashings, special siding details, wall penetrations, openings, and condition of other construction that will affect metal-faced composite wall panels.
   6. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.
7. Review temporary protection requirements for metal-faced composite wall panel assembly during and after installation.
8. Review wall panel observation and repair procedures after metal-faced composite wall panel installation.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, sheets, metal-faced composite wall panels, and other manufactured items so as not to be damaged or deformed. Package metal-faced composite wall panels for protection during transportation and handling.

B. Unload, store, and erect metal-faced composite wall panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Store metal-faced composite wall panels vertically, covered with suitable weathertight and ventilated covering. Store metal-faced composite wall panels to ensure dryness, with positive slope for drainage of water. Do not store metal-faced composite wall panels in contact with other materials that might cause staining, denting, or other surface damage. Do not allow storage space to exceed 120 deg F.

D. Retain strippable protective covering on metal-faced composite wall panel for period of panel installation.

1.08 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal-faced composite wall panels to be performed according to manufacturer’s written instructions and warranty requirements.

B. Field Measurements: Verify locations of structural members and wall opening dimensions by field measurements before metal-faced composite wall panel fabrication and indicate measurements on Shop Drawings.

1.09 COORDINATION

A. Coordinate metal-faced composite wall panel assemblies with rain drainage work, flashing, trim, and construction of studs, soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.10 WARRANTY

A. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components of metal-faced composite wall panel assemblies that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures, including rupturing, cracking, or puncturing.
      b. Deterioration of metals and other materials beyond normal weathering.
   2. Warranty Period: Two years from date of Substantial Completion.

B. Special Warranty on Panel Finishes: Manufacturer’s standard form in which manufacturer agrees to repair finish or replace metal-faced composite wall panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
   1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
      a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
      b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
      c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PANEL MATERIALS

A. Aluminum Sheet: Coil-coated sheet, ASTM B 209, alloy as standard with manufacturer, with temper as required to suit forming operations and structural performance required.
   1. Surface: Smooth, flat finish.
   2. Exposed Coil-Coated Finishes:
      a. Metallic Fluoropolymer: AAMA 620. 3-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers’ written instructions.
   3. Concealed Finish: Apply pretreatment and manufacturer’s standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

B. Panel Sealants:
   1. Joint Sealant: ASTM C 920; elastomeric silicone sealant; of type, grade, class, and use classifications required to seal joints in metal-faced composite wall panels and remain weathertight; and as recommended in writing by panel manufacturer.

2.02 MISCELLANEOUS METAL FRAMING

A. Miscellaneous Metal Framing, General: ASTM C 645, cold-formed metallic-coated steel sheet, ASTM A 653/A 653M, G40 hot-dip galvanized or coating with equivalent corrosion resistance unless otherwise indicated.

B. Fasteners for Miscellaneous Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten miscellaneous metal framing members to substrates.

2.03 MISCELLANEOUS MATERIALS

A. Aluminum Extrusions: ASTM B 221, alloy and temper recommended by manufacturer for type of use and finish indicated.

B. Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Provide exposed fasteners with heads matching color of metal-faced composite wall panels by means of plastic caps or factory-applied coating. Provide EPDM, PVC, or neoprene sealing washers.

2.04 METAL-FACED COMPOSITE WALL PANELS

A. General: Provide factory-formed and -assembled, metal-faced composite wall panels fabricated from two metal facings bonded, using no glues or adhesives, to solid, extruded thermoplastic core; formed into profile for installation method indicated. Include attachment system components and accessories required for weathertight system.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Alcan Composites USA Inc.; Alucobond Alucobond Plus.
      b. Alcoa Inc.; Reynobond PE.
      c. ALPOLIC, Division of Mitsubishi Chemical America, Inc.; ALPOLIC.
      d. CENTRIA Architectural Systems; Formabond Wall System.
f. Protean Construction Products, Inc.; ACM 100.

B. Aluminum-Faced Composite Wall Panels: Formed with 0.020-inch-thick, coil-coated aluminum sheet facings.
1. Panel Thickness: 0.157 inch.
2. Core: Standard.

C. Attachment System Components: Formed from extruded aluminum.
1. Include manufacturer's standard perimeter extrusions with integral weather stripping, panel stiffeners, panel clips, and anchor channels.

2.05 ACCESSORIES

A. Wall Panel Accessories: Provide components required for a complete metal-faced composite wall panel assembly including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal-faced composite wall panels unless otherwise indicated.

B. Flashing and Trim: Formed from 0.018-inch-minimum thickness, zinc-coated (galvanized) steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal-faced composite wall panels.

C. Self-Adhering, High-Temperature Sheet: 30 to 40 mils thick minimum, consisting of slip-resistant polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.
2. Low Temperature Flexibility: Passes after testing at minus 20 deg F; ASTM D 1970.
3. Products:
   a. Carlisle Coatings & Waterproofing, Div. of Carlisle Companies Inc.; Dri-Start "HR."
   c. Henry Company; Perma-Seal PE.
   d. Metal-Fab Manufacturing, LLC; MetShield.
   e. TC MiraDRI; WIP 300HT.

2.06 FABRICATION

A. General: Fabricate and finish metal-faced composite wall panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. Fabricate metal-faced composite wall panels in a manner that eliminates condensation on interior side of panel and with joints between panels designed to form weathertight seals.

C. Metal-Faced Composite Wall Panels: Factory form panels in a continuous process with no glues or adhesives between dissimilar materials. Trim and square edges of sheets with no displacement of face sheets or protrusion of core material.
1. Form panel lines, breaks, and angles to be sharp and true, with surfaces free from warp and buckle.
2. Fabricate panels with sharply cut edges, with no displacement of face sheets or protrusion of core material.
3. Fabricate panels with panel stiffeners, as required to comply with deflection limits, attached to back of panels with structural silicone sealant or bond tape.
4. Dimensional Tolerances:
   a. Length: Plus 0.188 inch.
   b. Width: Plus 0.188 inch.
   c. Thickness: Plus or minus 0.008 inch.
   d. Panel Bow: 0.8 percent maximum of panel length or width.
   e. Squareness: 0.2 inch maximum.

D. Sheet Metal Accessories: Fabricate flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.
1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
3. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.
4. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
5. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended by metal-faced composite wall panel manufacturer.
   a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal-faced composite wall panel manufacturer for application, but not less than thickness of metal being secured.

2.07 GENERAL FINISH REQUIREMENTS
A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION
3.01 EXAMINATION
A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal-faced composite wall panel supports, and other conditions affecting performance of the Work.
1. Examine wall framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal-faced composite wall panel manufacturer.
2. Examine wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal-faced composite wall panel manufacturer.
3. Verify that weather-resistant sheathing paper has been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Examine roughing-in for components and systems penetrating metal-faced composite wall panels to verify actual locations of penetrations relative to seam locations of panels before panel installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Miscellaneous Framing: Install subgirts, base angles, sills, furring, and other miscellaneous wall panel support members and anchorage according to ASTM C 754 and metal-faced composite wall panel manufacturer's written instructions.

3.03 UNDERLAYMENT INSTALLATION

A. Self-Adhering Sheet Underlayment: Install self-adhering sheet underlayment, wrinkle free, on sheathing under composite metal panels. Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation; use primer rather than nails for installing underlayment at low temperatures. Apply at locations indicated on Drawings, in shingle fashion to shed water, with end laps of not less than 6 inches staggered 24 inches between courses. Overlap side edges not less than 3-1/2 inches. Roll laps with roller. Cover underlayment within 14 days.

3.04 METAL-FACED COMPOSITE WALL PANEL INSTALLATION

A. General: Install metal-faced composite wall panels according to manufacturer's written instructions in orientation, sizes, and locations indicated on Drawings. Install panels perpendicular to girts and subgirts unless otherwise indicated. Anchor panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Shim or otherwise plumb substrates receiving metal-faced composite wall panels.
2. Flash and seal metal-faced composite wall panels at perimeter of all openings. Do not begin installation until weather barrier and flashings that will be concealed by panels are installed.
3. Install flashing and trim as metal-faced composite wall panel work proceeds.
4. Apply elastomeric sealant continuously between metal base channel (sill angle) and concrete, and elsewhere as indicated or, if not indicated, as necessary for waterproofing.
5. Provide weathertight escutcheons for pipe and conduit penetrating exterior walls.

B. Fasteners: Use aluminum or stainless-steel fasteners for surfaces exposed to the exterior and aluminum or galvanized-steel fasteners for surfaces exposed to the interior.

C. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action as recommended by metal-faced composite wall panel manufacturer.

D. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weathertight performance of metal-faced composite wall panel assemblies. Provide types of gaskets, fillers, and sealants indicated or, if not indicated, types recommended by panel manufacturer.

1. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants."

E. Attachment System Installation, General: Install attachment system required to support metal-faced composite wall panels and to provide a complete weathertight wall system,
including subgirts, perimeter extrusions, tracks, drainage channels, panel clips, and anchor channels.

1. Include attachment to supports, panel-to-panel joinery, panel-to-dissimilar-material joinery, and panel-system joint seals.
2. Do not begin installation until weather barrier and flashings that will be concealed by composite panels are installed.

F. Clip Installation: Attach panel clips to supports at each metal-faced composite wall panel joint at locations, spacings, and with fasteners recommended by manufacturer. Attach routed-and-returned flanges of wall panels to panel clips with manufacturer's standard fasteners.
1. Seal horizontal and vertical joints between adjacent panels with sealant backing and sealant. Install sealant backing and sealant according to requirements specified in Division 07 Section "Joint Sealants."

3.05 ACCESSORY INSTALLATION

A. General: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.
1. Install components required for a complete metal-faced composite wall panel assembly including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.

B. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
1. Install exposed flashing and trim that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

3.06 ERECTION TOLERANCES

A. Installation Tolerances: Shim and align metal-faced composite wall panel units within installed tolerance of 1/4 inch in 20 feet, nonaccumulative, on level, plumb, and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.07 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Water Penetration: Test areas of installed system indicated on Drawings for compliance with system performance requirements according to ASTM E 1105 at minimum differential pressure of 20 percent of inward-acting, wind-load design pressure as defined by SEI/ASCE 7, but not less than 6.24 lbf/sq. ft.

C. Water-Spray Test: After completing the installation of 75-foot- by-2-story minimum area of metal-faced composite wall panel assembly, test assembly for water penetration according to AAMA 501.2 in a 2-bay area directed by Architect.
D. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust completed metal-faced composite wall panel installation, including accessories.

E. Metal-faced composite wall panels will be considered defective if they do not pass tests and inspections.

F. Additional tests and inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

G. Prepare test and inspection reports.

3.08 CLEANING

A. Remove temporary protective coverings and strippable films, if any, as metal-faced composite wall panels are installed unless otherwise indicated in manufacturer’s written installation instructions. On completion of metal-faced composite wall panel installation, clean finished surfaces as recommended by panel manufacturer. Maintain in a clean condition during construction.

B. After metal-faced composite wall panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.

C. Replace metal-faced composite wall panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.
SECTION 07 53 23
EPDM ROOFING

PART 1 - GENERAL

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

1.02 SUMMARY
A. This Section includes the following:
   1. Adhered membrane roofing system.
   2. Roof insulation.
B. Related Sections include the following:
   1. Division 06 Section "Miscellaneous Rough Carpentry" for wood nailers, curbs, and blocking.
   2. Division 07 Section "Sheet Metal Flashing and Trim" for metal roof penetration flashings, flashings, and counterflashings.
   3. Division 07 Section "Joint Sealants."

1.03 DEFINITIONS
A. Roofing Terminology: Refer to ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" for definition of terms related to roofing work in this Section.

1.04 PERFORMANCE REQUIREMENTS
A. General: Provide installed roofing membrane and base flashings that remain watertight; do not permit the passage of water; and resist specified uplift pressures, thermally induced movement, and exposure to weather without failure.
B. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by roofing membrane manufacturer based on testing and field experience.
C. Roofing System Design: Provide a membrane roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist uplift pressure calculated according to ASCE 7.
   2. Perimeter Uplift Pressure: 60 lbf/sq. ft.
   3. Field-of-Roof Uplift Pressure: 30 lbf/sq. ft.
D. FMG Listing: Provide roofing membrane, base flashings, and component materials that comply with requirements in FMG 4450 and FMG 4470 as part of a membrane roofing system and that are listed in FMG's "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FMG markings.
   1. Fire/Windstorm Classification: Class 1A- 90.
   2. Hail Resistance: SH.

1.05 SUBMITTALS
A. Product Data: For each type of product indicated.
B. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other Work.
   1. Base flashings and membrane terminations.
   2. Tapered insulation, including slopes.
   3. Insulation fastening patterns.

C. Samples: For the following products:
   1. 12-by-12-inch square of sheet roofing, of color specified, including T-shaped side and end lap seam.

D. Installer Certificates: Signed by roofing system manufacturer certifying that Installer is approved, authorized, or licensed by manufacturer to install roofing system.

E. Manufacturer Certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.
   1. Submit evidence of meeting performance requirements.

F. Maintenance Data: For roofing system to include in maintenance manuals.

G. Inspection Report: Copy of roofing system manufacturer's inspection report of completed roofing installation.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's warranty.

B. Manufacturer Qualifications: A qualified manufacturer that has UL listing or FMG approval for membrane roofing system identical to that used for this Project.

C. Source Limitations: Obtain components for membrane roofing system approved by roofing membrane manufacturer.

D. Fire-Test-Response Characteristics, Roofing: Provide membrane roofing materials with the fire-test-response characteristics indicated as determined by testing identical products per test method below by UL, FMG, or another testing and inspecting agency acceptable to authorities having jurisdiction. Materials shall be identified with appropriate markings of applicable testing and inspecting agency.
   1. Exterior Fire-Test Exposure: Class A; ASTM E 108, for application and roof slopes indicated.

E. Preinstallation Conference: Conduct conference at Project site. Comply with requirements in Division 01 Section "Project Management and Coordination." Review methods and procedures related to roofing system including, but not limited to, the following:
   1. Meet with Owner; Architect; Owner's insurer if applicable; roofing Installer; roofing system manufacturer's representative; deck Installer; and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
   2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
   3. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
   4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
   5. Review structural loading limitations of roof deck during and after roofing.
   6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

1.07 DELIVERY, STORAGE, AND HANDLING
A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, and directions for storing and mixing with other components.
B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
D. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

1.08 PROJECT CONDITIONS
A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

1.09 WARRANTY
A. Special Warranty: Manufacturer's standard form, signed by manufacturer and installer, without monetary limitation, in which manufacturer agrees to repair or replace components of membrane roofing system that fail in materials or workmanship within specified warranty period. Failure includes roof leaks.
1. Special warranty includes roofing membrane, base flashings, roof insulation fasteners cover boards substrate board vapor retarder roof pavers walkway products and other components of membrane roofing system.
2. Warranty Period: 10 years from date of Substantial Completion.
B. Special Project Warranty: Submit roofing Installer's warranty, signed by Installer, covering Work of this Section, including all components of membrane roofing system such as roofing membrane, base flashing, roof insulation, fasteners, cover boards, substrate boards, vapor retarders, roof pavers, and walkway products, for the following warranty period:
1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 EPDM ROOFING MEMBRANE
A. EPDM Roofing Membrane: ASTM D 4637, Type I, nonreinforced uniform, flexible sheet made from EPDM, and as follows:
1. Manufacturers:
   a. Carlisle SynTec Incorporated.
   b. Firestone Building Products Company.
2. Thickness: 60 mils, nominal.

2.02 AUXILIARY MATERIALS

A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with membrane roofing.
   1. Liquid-type auxiliary materials shall meet VOC limits of authorities having jurisdiction.

B. Sheet Flashing: 60-mil thick EPDM, partially cured or cured, according to application.

C. Bonding Adhesive: Manufacturer's standard bonding adhesive.

D. Seaming Material: Single-component butyl splicing adhesive and splice cleaner or Manufacturer's standard synthetic-rubber polymer primer and 3-inch wide minimum, butyl splice tape with release film.

E. Lap Sealant: Manufacturer's standard single-component sealant, color to match roofing membrane.

F. Water Cutoff Mastic: Manufacturer's standard butyl mastic sealant.

G. Metal Termination Bars: Manufacturer's standard predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch thick; with anchors.

H. Metal Battens: Manufacturer's standard aluminum-zinc-alloy-coated or zinc-coated steel sheet, approximately 1 inch wide by 0.05 inch thick, prepunched.

I. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FMG 4470, designed for fastening membrane to substrate, and acceptable to membrane roofing system manufacturer.

J. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, in-seam sealants, termination reglets, cover strips, and other accessories.

K. Liquid coating, specifically formulated for coating EPDM roofing membrane, as follows:
   1. Type: Acrylic emulsion.

2.03 ROOF INSULATION

A. General: Provide preformed roof insulation boards that comply with requirements and referenced standards, selected from manufacturer's standard sizes and of thicknesses indicated.

B. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, felt or glass-fiber mat facer on both major surfaces.
   1. Manufacturers:
      b. Apache Products Company.
      d. Carlisle SynTec Incorporated.
      e. Celotex Corporation.
      f. Firestone Building Products Company.
      g. GAF Materials Corp.
      h. GenFlex Roofing Systems.
      i. Hunter Panels, LLC.
      k. Koppers Industries.
      l. RMAX.
C. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches, unless otherwise indicated.
D. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

2.04 INSULATION ACCESSORIES
A. General: Furnish roof insulation accessories recommended by insulation manufacturer for intended use and compatible with membrane roofing.
B. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FMG 4470, designed for fastening roof insulation to substrate, and acceptable to roofing system manufacturer.
C. Cold Fluid-Applied Adhesive: Manufacturer's standard cold fluid-applied adhesive formulated to adhere roof insulation to substrate.
D. Cover Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/2 inch thick.
   1. Product: Subject to compliance with requirements, provided "Dens-Deck" manufactured by Georgia-Pacific Corporation.

2.05 WALKWAYS
A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, solid-rubber, slip-resisting, surface-textured walkway pads or rolls, approximately 3/16 inch thick, and acceptable to membrane roofing system manufacturer.

PART 3 - EXECUTION

3.01 EXAMINATION
A. Examine substrates, areas, and conditions, with Installer present, for compliance with the following requirements and other conditions affecting performance of roofing system:
   1. Verify that roof openings and penetrations are in place and set and braced and that roof drains are securely clamped in place.
   2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
   3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Division 05 Section "Steel Decking."
   4. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
   5. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
   6. Verify that concrete curing compounds that will impair adhesion of roofing components to roof deck have been removed.
   7. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION
A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.
B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.
C. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

3.03 INSULATION INSTALLATION

A. Coordinate installing membrane roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.

B. Comply with membrane roofing system manufacturer's written instructions for installing roof insulation.

C. Install tapered insulation under area of roofing to conform to slopes indicated.

D. Install one or more layers of insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2 inches or greater, install 2 or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches in each direction.

E. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.

F. 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.

G. Mechanically Fastened and Adhered Insulation: Install each layer of insulation and secure first layer of insulation to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.

1. Fasten first layer of insulation according to requirements in FMG's "Approval Guide" for specified Windstorm Resistance Classification.

2. Fasten first layer of insulation to resist uplift pressure at corners, perimeter, and field of roof.

3. Install subsequent layers of insulation in a cold fluid-applied adhesive.

H. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Loosely butt cover boards together and fasten to roof deck.

1. Fasten according to requirements in FMG’s "Approval Guide" for specified Windstorm Resistance Classification.

2. Fasten to resist uplift pressure at corners, perimeter, and field of roof.

3.04 ADHERED ROOFING MEMBRANE INSTALLATION

A. Install roofing membrane over area to receive roofing according to membrane roofing system manufacturer's written instructions. Unroll roofing membrane and allow to relax before installing.

B. Start installation of roofing membrane in presence of membrane roofing system manufacturer's technical personnel.

C. Accurately align roofing membrane and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.

D. Bonding Adhesive: Apply bonding adhesive to substrate and underside of roofing membrane at rate required by manufacturer and allow to partially dry before installing roofing membrane. Do not apply bonding adhesive to splice area of roofing membrane.

E. Mechanically or adhesively fasten roofing membrane securely at terminations, penetrations, and perimeter of roofing.
F. Apply roofing membrane with side laps shingled with slope of roof deck where possible.

G. Adhesive Seam Installation: Clean both faces of splice areas, apply splicing cement, and firmly roll side and end laps of overlapping roofing membranes according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of roofing membrane terminations.
   1. Apply a continuous bead of in-seam sealant before closing splice if required by membrane roofing system manufacturer.

H. Tape Seam Installation: Clean and prime both faces of splice areas, apply splice tape, and firmly roll side and end laps of overlapping roofing membranes according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of roofing membrane terminations.

I. Repair tears, voids, and lapped seams in roofing that does not meet requirements.

J. Spread sealant or mastic bed over deck drain flange at deck drains and securely seal roofing membrane in place with clamping ring.

K. Install roofing membrane and auxiliary materials to tie in to existing roofing.

3.05 BASE FLASHING INSTALLATION

A. Install sheet flashings and preformed flashing accessories and adhere to substrates according to membrane roofing system manufacturer's written instructions.

B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate and allow to partially dry. Do not apply bonding adhesive to seam area of flashing.

C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.

D. Clean splice areas, apply splicing cement, and firmly roll side and end laps of overlapping sheets to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of sheet flashing terminations.

E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

3.06 COATING INSTALLATION

A. Apply coatings to roofing membrane and base flashings according to manufacturer's written recommendations, by spray, roller, or other suitable application method.

3.07 WALKWAY INSTALLATION

A. Flexible Walkways: Install walkway products in locations indicated. Adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

3.08 FIELD QUALITY CONTROL

A. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion and submit report to Architect.
   1. Notify Architect or Owner 48 hours in advance of date and time of inspection.

B. Repair or remove and replace components of membrane roofing system where test results or inspections indicate that they do not comply with specified requirements.

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

A. Protect membrane roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.

B. Correct deficiencies in or remove membrane roofing system that does not comply with requirements, repair substrates and repair or reinstall membrane roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION
SECTION 07 62 00

SHEET METAL FLASHING AND TRIM

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. Manufactured Products:
      a. Manufactured reglets.
   2. Formed Products:
      a. Formed roof drainage sheet metal fabrications.
      b. Formed low-slope roof sheet metal fabrications.
      c. Formed steep-slope roof sheet metal fabrications.
      d. Formed overhead-piping safety pans.

B. Related Sections:
   1. Division 01 Section "Sustainable Design Requirements" for additional LEED requirements.
   2. Division 06 Section "Miscellaneous Rough Carpentry" for wood nailers, curbs, and blocking.
   3. Division 07 Section "Clay Roof Tiles" for installing sheet metal flashing and trim integral with roofing.
   4. Division 07 Section "EPDM Roofing" for installing sheet metal flashing and trim integral with membrane roofing.
   5. Division 07 Section "Metal Wall Panels" for sheet metal flashing and trim integral with metal wall panels.
   6. Division 07 Section "Roof Accessories" for set-on-type curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.

1.03 PERFORMANCE REQUIREMENTS

A. General: Sheet metal flashing and trim assemblies as indicated shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.

B. Fabricate and install roof edge flashing and copings capable of resisting the following forces according to recommendations in FMG Loss Prevention Data Sheet 1-49:
   1. Wind Zone 1: For velocity pressures of 21 to 30 lbf/sq. ft.: 60-lbf/sq. ft. perimeter uplift force, 90-lbf/sq. ft. corner uplift force, and 30-lbf/sq. ft. outward force.

C. Thermal Movements: Provide sheet metal flashing and trim that allows for thermal movements from ambient and surface temperature changes.
   1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
1.04 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each manufactured product and accessory.

B. Shop Drawings: Show fabrication and installation layouts of sheet metal flashing and trim, including plans, elevations, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled work. Include the following:
   1. Identification of material, thickness, weight, and finish for each item and location in Project.
   2. Details for forming sheet metal flashing and trim, including profiles, shapes, seams, and dimensions.
   3. Details for joining, supporting, and securing sheet metal flashing and trim, including layout of fasteners, cleats, clips, and other attachments. Include pattern of seams.
   4. Details of termination points and assemblies, including fixed points.
   5. Details of edge conditions, including eaves, ridges, valleys, rakes, crickets, and counterflashings as applicable.
   6. Details of special conditions.
   7. Details of connections to adjoining work.

C. Samples: For each type of exposed finish required, prepared on Samples of size indicated below:
   1. Sheet Metal Flashing: 12 inches long by actual width of unit, including finished seam and in required profile. Include fasteners, cleats, clips, closures, and other attachments.

D. LEED Submittals:
   1. Credits MR 4.1 and MR 4.2: Recycled Content:
      a. Submit documentation from manufacturer indicating separate percentages, by weight, of pre-consumer and post-consumer recycled content per unit of product. Also include material costs, excluding cost of installation.
   2. Credits MR 5.1 and MR 5.2: Regionally Extracted, Harvested, or Recovered and Manufactured Materials:
      a. Indicate location of manufacturing facility, including name, address, and distance between manufacturing facility and the project site. Provide manufacturer’s documentation indicating location where the base materials were extracted, mined, quarried, harvested, etc., and the distance between this location and the project site. Also include material costs, excluding cost of installation.

E. Maintenance Data: For sheet metal flashing, trim, and accessories to include in maintenance manuals.

1.05 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.

B. Sheet Metal Flashing and Trim Standard: Comply with SMACNA's "Architectural Sheet Metal Manual" unless more stringent requirements are specified or shown on Drawings.

C. Copper Sheet Metal Standard: Comply with CDA's "Copper in Architecture Handbook." Conform to dimensions and profiles shown unless more stringent requirements are indicated.
D. Preinstallation Conference: Conduct conference at Project site.
   1. Meet with Installer, and installers whose work interfaces with or affects sheet metal flashing and trim including installers of roofing materials, roof accessories, unit skylights, and roof-mounted equipment.
   2. Review methods and procedures related to sheet metal flashing and trim.
   3. Examine substrate conditions for compliance with requirements, including flatness and attachment to structural members.
   4. Review special roof details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect sheet metal flashing.
   5. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage. Store sheet metal flashing and trim materials away from uncured concrete and masonry.

B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to the extent necessary for the period of sheet metal flashing and trim installation.

1.07 WARRANTY

A. Sheet metal work shall be warranted for a period of 2 years from date of the Notice of Acceptance.
   1. Warranty shall include replacement at Contractor's expense any defects which occur during the warranty period which, in the opinion of the Architect are due to defective materials, workmanship, or for failure to allow for expansion/contraction.

PART 2 - PRODUCTS

2.01 GENERAL

A. Regionally Extracted, Harvested, or Recovered and Manufactured Materials:
   1. Preference shall be given to supplier whose facilities are within a 500 mile radius of the project site.
   2. Preference shall also be given to materials that are harvested, extracted, mined, quarried, etc. within a 500 mile radius of the project site.

2.02 SHEET METALS

A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying a strippable, temporary protective film before shipping.

B. Copper Sheet: Coldrolled sheet copper (H00), complying with ASTM B370, except soft temper (060) where fully concealed and supported for proper performance, CDS 2B (bright) finish, 16 oz. per sq. ft. (0.0216" thick) except as otherwise indicated.

C. Stainless-Steel Sheet: AISI Type 302/304 stainless steel sheet or strip complying with ASTM A167; soft; No. 2D annealed finish, 0.0250" thick (24 gage) except as otherwise indicated.

D. Metallic-Coated Steel Sheet: Restricted flatness steel sheet, metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
   1. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 coating designation; structural quality.
2.03 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.

B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal.

1. Fasteners for Zinc-Coated (Galvanized) and Aluminum-Zinc Alloy-Coated Steel Sheet: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329 or Series 300 stainless steel.

2. Fasteners for Zinc Sheet: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329 or Series 300 stainless steel.

C. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.

D. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.

E. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.

F. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

2.04 MANUFACTURED SHEET METAL FLASHING AND TRIM

A. Reglets: Units of type, material, and profile indicated, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated with factory-mitered and -welded corners and junctions with interlocking counterflashing on exterior face, of same metal as reglet.

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. Cheney Flashing Company.
   b. Fry Reglet Corporation.
   c. Heckmann Building Products Inc.
   d. Hickman, W. P. Company.
   e. Hohmann & Barnard, Inc.; STF Sawtooth Flashing.
   g. National Sheet Metal Systems, Inc.
   h. Sandell Manufacturing Company, Inc.

2. Surface-Mounted Type: Provide with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.
3. Concrete Type: Provide temporary closure tape to keep reglet free of concrete materials, special fasteners for attaching reglet to concrete forms, and guides to ensure alignment of reglet section ends.

4. Masonry Type: Provide with offset top flange for embedment in masonry mortar joint.

5. Accessories:
   a. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing lower edge.

6. Finish: Mill.

2.05 FABRICATION, GENERAL

A. General: Custom fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, geometry, metal thickness, and other characteristics of item indicated. Fabricate items at the shop to greatest extent possible.

1. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.

2. Obtain field measurements for accurate fit before shop fabrication.

3. Form sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.

4. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces exposed to view.

B. Fabrication Tolerances: Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet on slope and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

C. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant.

D. Expansion Provisions: Where lapped expansion provisions cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.

E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

F. Fabricate cleats and attachment devices of sizes as recommended by SMACNA's "Architectural Sheet Metal Manual" and by FMG Loss Prevention Data Sheet 1-49 for application, but not less than thickness of metal being secured.

G. Seams: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Rivet joints where necessary for strength.

H. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints where necessary for strength.

I. Do not use graphite pencils to mark metal surfaces.

2.06 ROOF DRAINAGE SHEET METAL FABRICATIONS

A. Hanging Gutters: Fabricate to cross section indicated, complete with end pieces, outlet tubes, and other accessories as required. Fabricate in minimum 96-inch-long sections. Furnish flat-stock gutter spacers and gutter brackets fabricated from same metal as gutters, of size recommended by SMACNA but not less than twice the gutter thickness.
Fabricate expansion joints, expansion-joint covers, and gutter accessories from same metal as gutters.

1. Gutter Style: half round, 4" deep, 5" wide, both edges rolled over 5/8 inch copper coated steel rod and set at a pitch of 1/4" per 10' to drain.
2. Expansion Joints: Lap type.
3. Gutters with Girth up to 15 Inches: Fabricate from the following materials:
   - Copper: 16 oz./sq. ft.
   - Hangers: Adjustable type, spaced at 24" o.c., Berger Building Products, shank type.

B. Downspouts: Round threaded pipe built into the wall and and fitted with a drip flange, complete with mitered elbows. Furnish with metal hangers, from same material as downspouts, and anchors.

1. Fabricate from the following materials:

2.07 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

A. Copings: Fabricate in minimum 96-inch- long, but not exceeding 10-foot- long, sections. Fabricate joint plates of same thickness as copings. Furnish with continuous cleats to support edge of external leg and drill elongated holes for fasteners on interior leg. Miter corners, seal, and solder or weld watertight.
   1. Coping Profile: SMACNA figure designation 3-4A.
   2. Joint Style: Butt, with 12-inch- wide, concealed backup plate.
   3. Fabricate from the following materials:
      a. Galvanized Steel: 0.040 inch thick.
      b. Aluminum-Zinc Alloy-Coated Steel: 0.040 inch thick.

B. Counterflashing: Fabricate from the following materials:
   1. Galvanized Steel: 0.022 inch thick.
   2. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch thick.

2.08 STEEP-SLOPE ROOF SHEET METAL FABRICATIONS

A. Apron, Step, Cricket, and Backer Flashing: Fabricate from the following materials:
   1. Copper: 16 oz./sq. ft.

B. Drip Edges: Fabricate from the following materials:
   1. Copper: 16 oz./sq. ft.

C. Eave, Rake Flashing: Fabricate from the following materials:
   1. Copper: 16 oz./sq. ft.

D. Counterflashing: Fabricate from the following materials:
   1. Copper: 16 oz./sq. ft.

E. Flashing Receivers: Fabricate from the following materials:
   1. Copper: 16 oz./sq. ft.

F. Roof-Penetration Flashing: Fabricate from the following materials:
   1. Copper: 16 oz./sq. ft.

2.09 MISCELLANEOUS SHEET METAL FABRICATIONS

A. Equipment Support Flashing: Fabricate from the following materials:
   1. Galvanized Steel: 0.028 inch thick.
   2. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch thick.

B. Overhead-Piping Safety Pans: Fabricate from the following materials:
   1. Galvanized Steel: 0.040 inch thick.
   2. Aluminum-Zinc Alloy-Coated Steel: 0.040 inch thick.
PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions and other conditions affecting performance of the Work.
   1. Verify compliance with requirements for installation tolerances of substrates.
   2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION, GENERAL

A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
   1. Install sheet metal flashing and trim true to line and levels indicated. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
   2. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
   3. Space cleats not more than 12 inches apart. Anchor each cleat with two fasteners. Bend tabs over fasteners.
   4. Install exposed sheet metal flashing and trim without excessive oil canning, buckling, and tool marks.
   5. Install sealant tape where indicated.
   6. Torch cutting of sheet metal flashing and trim is not permitted.
   7. Do not use graphite pencils to mark metal surfaces.

B. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by SMACNA.
   1. Coat back side of uncoated aluminum and stainless-steel sheet metal flashing and trim with bituminous coating where flashing and trim will contact wood, ferrous metal, or cementitious construction.

C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently watertight, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with sealant concealed within joints.
   1. Provide for thermal expansion of all exposed sheet metal work exceeding 15'-0" running length, except as otherwise indicated.
      a. Gutters: Locate where shown with 40' 0" maximum spacing, and located at high points in drainage wherever possible.
   2. Conceal fasteners and expansion provisions wherever possible. Fold back edges on concealed side of exposed edges, to form a hem.

D. Fastener Sizes: Use fasteners of sizes that will penetrate wood sheathing not less than 1-1/4 inches for nails and not less than 3/4 inch for wood screws and for metal decking not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.

E. Seal joints as shown and as required for watertight construction.
   1. Where sealant-filled joints are used, embed hooked flanges of joint members not less than 1 inch into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is moderate, between 40 and 70
deg F, set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 40 deg F.

2. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants."

F. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets to be soldered to a width of 1-1/2 inches, except reduce pre-tinning where pre-tinned surface would show in completed Work.

1. Do not solder metallic-coated steel and aluminum sheet.
2. Do not use torches for soldering. Heat surfaces to receive solder and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.

3.03 ROOF DRAINAGE SYSTEM INSTALLATION

A. General: Install sheet metal roof drainage items to produce complete roof drainage system according to SMACNA recommendations and as indicated. Coordinate installation of roof perimeter flashing with installation of roof drainage system.

B. Hanging Gutters: Join sections with soldered joints or with lapped joints sealed with sealant. Provide for thermal expansion. Attach gutters at eave or fascia to firmly anchored gutter brackets spaced not more than 36 inches apart. Provide end closures and seal watertight with sealant. Slope to downspouts.

1. Fasten gutter spacers to front and back of gutter.
2. Loosely lock straps to front gutter bead and anchor to roof deck.
3. Anchor and loosely lock back edge of gutter to continuous eave or apron flashing.
4. Anchor back of gutter that extends onto roof deck with cleats spaced not more than 24 inches apart.
5. Install gutter with expansion joints at locations indicated, but not exceeding, 40 feet apart. Install expansion-joint caps.
6. Provide elbows at base of downspout to direct water away from building.
7. Connect downspouts to underground drainage system indicated.

3.04 ROOF FLASHING INSTALLATION

A. General: Install sheet metal flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, set units true to line, and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

B. Roof Edge Flashing: Anchor to resist uplift and outward forces according to recommendations in FMG Loss Prevention Data Sheet 1-49 for specified wind zone and as indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate at 16-inch centers.

C. Copings: Anchor to resist uplift and outward forces according to recommendations in FMG Loss Prevention Data Sheet 1-49 for specified wind zone and as indicated.

1. Interlock exterior bottom edge of coping with continuous cleat anchored to substrate at 16-inch centers.
2. Anchor interior leg of coping with screw fasteners and washers at 24-inch centers.
D. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending a minimum of 4 inches over base flashing. Install stainless-steel draw band and tighten.

E. Counterflashing: Coordinate installation of counterflashing with installation of base flashing. Anchor by mechanical means, including driven wedges of lead or other compatible metal, spaced 2’0”. Seal the joint with sealant. Extend counterflashing 4 inches over base flashing. Lap counterflashing joints a minimum of 4 inches and bed with sealant. Secure in a waterproof manner by means of interlocking folded seam or blind rivets and sealant.

F. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with elastomeric sealant and clamp flashing to pipes that penetrate roof.

3.05 MISCELLANEOUS FLASHING INSTALLATION
A. Overhead-Piping Safety Pans: Suspend pans independent from structure above as indicated on Drawings. Pipe and install drain line to plumbing waste or drainage system.

B. Equipment Support Flashing: Coordinate installation of equipment support flashing with installation of roofing and equipment. Weld or seal flashing with elastomeric sealant to equipment support member.

3.06 ERECTION TOLERANCES
A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet on slope and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

B. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerances specified in MCA’s "Guide Specification for Residential Metal Roofing."

3.07 CLEANING AND PROTECTION
A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Clean and neutralize flux materials. Clean off excess solder.

C. Clean off excess sealants.

D. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer’s written installation instructions. On completion of installation, remove unused materials and clean finished surfaces. Maintain in a clean condition during construction.

E. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION
SECTION 07 72 00
ROOF ACCESSORIES

PART 1 - GENERAL

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

1.02 SUMMARY
A. This Section includes the following:
   1. Roof curbs.
   2. Equipment supports.
B. Related Sections include the following:
   1. Division 05 Section "Metal Fabrications" for metal vertical ladders, ships' ladders, and stairs for access to roof hatches.
   2. Division 06 Section "Miscellaneous Rough Carpentry" for roof sheathing, wood cants, and wood nailers.
   3. Division 07 Section "Sheet Metal Flashing and Trim" for shop- and field-fabricated metal flashing and counterflashing, roof expansion-joint covers, and miscellaneous sheet metal trim and accessories.

1.03 SUBMITTALS
A. Product Data: For each type of roof accessory indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
B. Shop Drawings: Show fabrication and installation details for roof accessories. Show layouts of roof accessories including plans and elevations. Indicate dimensions, weights, loadings, required clearances, method of field assembly, and components. Include plans, elevations, sections, details, and attachments to other work.
C. Coordination Drawings: Roof plans, drawn to scale, and coordinating penetrations and roof-mounted items. Show the following:
   1. Size and location of roof accessories specified in this Section.
   2. Method of attaching roof accessories to roof or building structure.
   3. Other roof-mounted items including mechanical and electrical equipment, ductwork, piping, and conduit.

1.04 QUALITY ASSURANCE
A. Sheet Metal Standard: Comply with SMACNA's "Architectural Sheet Metal Manual" details for fabrication of units, including flanges and cap flashing to coordinate with type of roofing indicated.

1.05 DELIVERY, STORAGE, AND HANDLING
A. Pack, handle, and ship roof accessories properly labeled in heavy-duty packaging to prevent damage.

1.06 PROJECT CONDITIONS
A. Field Measurements: Verify required openings for each type of roof accessory by field measurements before fabrication and indicate measurements on Shop Drawings.
1.07 COORDINATION
A. Coordinate layout and installation of roof accessories with roofing membrane and base
   flashing and interfacing and adjoining construction to provide a leakproof, weathertight,
   secure, and noncorrosive installation.
   1. With Architect’s approval, adjust location of roof accessories that would interrupt
      roof drainage routes.

PART 2 - PRODUCTS
2.01 METAL MATERIALS
A. Galvanized Steel Sheet: ASTM A 653/A 653M, G90 coated and mill phosphatized for
   field painting.
B. Steel Shapes: ASTM A 36/A 36M, hot-dip galvanized to comply with
   ASTM A 123/A 123M, unless otherwise indicated.
C. Steel Tube: ASTM A 500, round tube, baked-enamel finished.
D. Galvanized Steel Tube: ASTM A 500, round tube, hot-dip galvanized to comply with
   ASTM A 123/A 123M.
E. Galvanized Steel Pipe: ASTM A 53/A 53M.

2.02 MISCELLANEOUS MATERIALS
A. Cellulosic-Fiber Board Insulation: ASTM C 208, Type II, Grade 1, 1 inch thick.
B. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for
   aboveground use, complying with AWPA C2; not less than 1-1/2 inches thick.
C. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-
   mil dry film thickness per coat. Provide inert-type noncorrosive compound free of
   asbestos fibers, sulfur components, and other deleterious impurities.
D. Felt: ASTM D 226, Type II (No. 30), asphalt-saturated organic felt, nonperforated.
E. Fasteners: Same metal as metals being fastened, or nonmagnetic stainless steel or
   other noncorrosive metal as recommended by roof accessory manufacturer. Match finish
   of exposed fasteners with finish of material being fastened. Provide nonremovable
   fastener heads to exterior exposed fasteners.
F. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, or
   PVC; or flat design of foam rubber, sponge neoprene, or cork.
G. Sealants: As specified in Division 07 Section "Joint Sealants."
H. Roofing Cement: ASTM D 4586, nonasbestos, fibrated asphalt cement designed for
   trowel application or other adhesive compatible with roofing system.

2.03 ROOF CURBS
A. Roof Curbs: Provide metal roof curbs, internally reinforced and capable of supporting
   superimposed live and dead loads, including equipment loads and other construction to
   be supported on roof curbs. Fabricate with welded or sealed mechanical corner joints,
   with stepped integral metal cant raised the thickness of roof insulation and integral
   formed mounting flange at perimeter bottom. Coordinate dimensions with rough-in
   information or Shop Drawings of equipment to be supported.
   1. Manufacturers:
      a. Colony Custom Curbs.
      b. Commodity Products Company, Inc.
2. Load Requirements: as indicated on Drawings.
3. Material: Galvanized steel sheet, thickness as required to support loads.
4. Liner: Same material as curb, of manufacturer’s standard thickness and finish.
5. Factory install wood nailers at tops of curbs.
6. On ribbed or fluted metal roofs, form flange at perimeter bottom to conform to roof profile.
7. Factory insulate curbs with 1-1/2-inch-thick, cellulosic-fiber board insulation.
8. Curb height may be determined by adding thickness of roof insulation and minimum base flashing height recommended by roofing membrane manufacturer. Fabricate units to minimum height of 12 inches, unless otherwise indicated.
9. Sloping Roofs: Where slope of roof deck exceeds 1:48, fabricate curb units with water diverter or cricket and with height tapered to match slope to level tops of units.

2.04 EQUIPMENT SUPPORTS

A. Equipment Supports: Provide metal equipment supports, internally reinforced and capable of supporting superimposed live and dead loads, including equipment loads and other construction to be supported. Fabricate with welded or sealed mechanical corner joints, with stepped integral metal cant raised the thickness of roof insulation and integral formed mounting flange at perimeter bottom. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

1. Manufacturers:
   a. Colony Custom Curbs.
   b. Commodity Products Company, Inc.
   c. Conn-Fab Sales, Inc.
   d. Curbs Plus Inc.
   e. Custom Curb, Inc.
   f. LM Curbs.
   g. Loren Cook Company.
   h. Metallic Products Corporation.
   i. Pate Company (The).
   k. Roof Products, Inc.
   l. Thaler Metal Industries Ltd.
   m. ThyCurb; Div. of Thybar Corporation.
   n. Uni-Curb, Inc.
   o. Vent Products Company, Inc.

2. Load Requirements: as indicated on Drawings.
3. Material: Galvanized steel sheet, thickness as required to support loads.

4. Factory-install continuous wood nailers 3-1/2 inches wide at tops of equipment supports.

5. Metal Counterflashing: Manufacturer's standard removable counterflashing, fabricated of same metal and finish as equipment support.

6. On ribbed or fluted metal roofs, form flange at perimeter bottom to conform to roof profile.

7. Fabricate units to minimum height of 12 inches, unless otherwise indicated.

8. Sloping Roofs: Where slope of roof deck exceeds 1:48, fabricate curb units with water diverter or cricket and with height tapered to match slope to level tops of units.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of work.

1. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored and is ready to receive roof accessories.

2. Verify dimensions of roof openings for roof accessories.

3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. General: Install roof accessories according to manufacturer's written instructions. Anchor roof accessories securely in place and capable of resisting forces specified. Use fasteners, separators, sealants, and other miscellaneous items as required for completing roof accessory installation. Install roof accessories to resist exposure to weather without failing, rattling, leaking, and fastener disengagement.

B. Install roof accessories to fit substrates and to result in watertight performance.

C. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.

1. Coat concealed side of roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.

2. Underlayment: Where installing exposed-to-view components of roof accessories directly on cementitous or wood substrates, install a course of felt underlayment and cover with a slip sheet, or install a course of polyethylene underlayment.


D. Install roof accessories level, plumb, true to line and elevation, and without warping, jogs in alignment, excessive oil canning, buckling, or tool marks.

E. Roof Curb Installation:

1. Set roof curb so top surface of roof curb is level.

F. Equipment Support Installation:

1. Set equipment support so top surface of equipment support is level.

G. Seal joints with elastomeric or butyl sealant as required by manufacturer of roof accessories.
3.03 TOUCH UP
   A. Touch up factory-primed surfaces with compatible primer ready for field painting in accordance with Division 09 painting Sections.
   B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

3.04 CLEANING
   A. Clean exposed surfaces according to manufacturer's written instructions.

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. This Section includes through-penetration firestop systems for penetrations through fire-resistance-rated constructions, including both empty openings and openings containing penetrating items.

B. Related Sections include the following:
   1. Division 07 Section "Fire-Resistive Joint Systems."
   2. Division 21 Sections specifying fire-suppression piping penetrations.
   3. Division 22 and 23 Sections specifying duct and piping penetrations.
   4. Division 26, 27, and 28 Sections specifying cable and conduit penetrations.

1.03 PERFORMANCE REQUIREMENTS

A. General: For penetrations through fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.

B. Rated Systems: Provide through-penetration firestop systems with the following ratings determined per ASTM International (ASTM) E 814, "Standard Test Method for Fire Tests of Through-Penetration Fire Stops" or Underwriters Laboratory (UL) 1479 "Fire Tests of Through-Penetration Firestops:"
   1. F-Rated Systems: Provide through-penetration firestop systems with F-ratings indicated, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.
   2. T-Rated Systems: For the following conditions, provide through-penetration firestop systems with T-ratings indicated, as well as F-ratings, where systems protect penetrating items exposed to potential contact with adjacent materials in occupiable floor areas:
      a. Penetrations located outside wall cavities.
      b. Penetrations located outside fire-resistance-rated shaft enclosures.

C. For through-penetration firestop systems exposed to view, traffic, moisture, and physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.
   1. For piping penetrations for plumbing and wet-pipe sprinkler systems, provide moisture-resistant through-penetration firestop systems.
   2. For floor penetrations with annular spaces exceeding 4 inches in width and exposed to possible loading and traffic, provide firestop systems capable of supporting floor loads involved, either by installing floor plates or by other means.
   3. For penetrations involving insulated piping, provide through-penetration firestop systems not requiring removal of insulation.

D. For through-penetration firestop systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as

1.04 SUBMITTALS

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

B. Shop Drawings: For each through-penetration firestop system, show each type of construction condition penetrated, relationships to adjoining construction, and type of penetrating item. Include firestop design designation of qualified testing and inspecting agency that evidences compliance with requirements for each condition indicated.
   1. Submit documentation, including illustrations, from a qualified testing and inspecting agency that is applicable to each through-penetration firestop system configuration for construction and penetrating items.
   2. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular through-penetration firestop condition, submit illustration, with modifications marked, approved by through-penetration firestop system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

C. Through-Penetration Firestop System Schedule: Indicate locations of each through-penetration firestop system, along with the following information:
   1. General: Prepare a schedule showing typical penetrations of each penetrating material type and other information as follows:
      a. Project Name.
      b. Construction Type.
      c. Occupancy.
      d. Firestop Applicator.
   2. Types of penetrating items.
   3. Types of constructions penetrated, including fire-resistance ratings and, where applicable, thicknesses of construction penetrated. Include:
      a. Hourly fire rating.
      b. "F" Rating.
      c. "T" Rating.
      d. Qualified testing agency Design Number.
      e. Minimum annular space.
      f. Maximum annular space.
      g. Shop drawing detail or sheet number.

D. LEED Submittals:
   1. Credit EQ 4.1: Submit product data and material safety data sheets (MSDS) for firestopping materials used on the interior of the building indicating chemical composition and VOC content of each product used.

E. Product Certificates: For through-penetration firestop system products, signed by product manufacturer.
   1. Submit manufacturer's certification that materials supplied are in accordance with the specifications and requirements of the authorities having jurisdiction.
   2. Submit certification that materials supplied are VOC compliant and are nontoxic to building occupants.

F. Product Test Reports: Submit product test reports from, and based on tests performed by, a qualified testing and inspecting agency who is acceptable to ICBO and the University of Colorado at Boulder Department of Environmental Health and Safety evidencing compliance of firestopping with requirements based on comprehensive testing of current products.
1.05 QUALITY ASSURANCE

A. Installer Qualifications: A firm that has been approved by Factory Mutual Group (FMG) according to FMG 4991, "Approval of Firestop Contractors."

B. Installation Responsibility: Assign installation of through-penetration firestop systems in Project to a single qualified installer.

C. Source Limitations: Obtain through-penetration firestop systems, for each kind of penetration and construction condition indicated, through one source from a single manufacturer.

D. Fire-Test-Response Characteristics: Provide through-penetration firestop systems that comply with the following requirements and those specified in Part 1 "Performance Requirements" Article:
   1. Firestopping tests are performed by a qualified testing and inspecting agency. A qualified testing and inspecting agency is UL, Omega Point Laboratories (OPL), Intertek Testing Services (ITS), or another agency performing testing and follow-up inspection services for firestop systems acceptable to authorities having jurisdiction.
   2. Through-penetration firestop systems are identical to those tested per testing standard referenced in "Part 1 Performance Requirements" Article. Provide rated systems complying with the following requirements:
      a. Through-penetration firestop system products bear classification marking of qualified testing and inspecting agency.
      b. Through-penetration firestop systems correspond to those indicated by reference to through-penetration firestop system designations listed by the following:
         1) UL in its "Fire Resistance Directory."
         2) OPL in its "Directory of Listed Building Products, Materials, & Assemblies."
         3) ITS in its "Directory of Listed Products."

E. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver through-penetration firestop system products to Project site in original, unopened containers or packages with intact and legible manufacturers' labels identifying product and manufacturer, date of manufacture, lot number, shelf life if applicable, qualified testing and inspecting agency's classification marking applicable to Project, curing time, and mixing instructions for multicomponent materials.

B. Store and handle materials for through-penetration firestop systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.07 PROJECT CONDITIONS

A. Environmental Limitations: Do not install through-penetration firestop systems when ambient or substrate temperatures are outside limits permitted by through-penetration firestop system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.

B. Ventilate through-penetration firestop systems per manufacturer's written instructions by natural means or, where this is inadequate, forced-air circulation.
1.08 COORDINATION
A. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.
B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.
C. Notify Owner’s inspecting agency at least seven days in advance of through-penetration firestop system installations; confirm dates and times on days preceding each series of installations.
D. Do not cover up through-penetration fire stop system installations that will become concealed behind other construction until each installation has been examined by Owner’s inspecting agency and building inspector, if required by authorities having jurisdiction.

1.09 WARRANTY:
A. Submit 2 copies of written 2-year warranty agreeing to repair or replace firestopping which fails to perform as airtight and watertight joints; or fails in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, or general durability; or appears to deteriorate in any other manner not clearly specified by submitted manufacturer’s data as an inherent quality of the material for the exposure indicated.
B. Provide warranty signed by the Installer and Contractor.

PART 2 - PRODUCTS

2.01 GENERAL
A. The VOC content of adhesives and sealants used must be less than the current VOC content limits of South Coast Air Quality Management District (SCAQMD) Rule #1168, AND all sealants used as fillers must meet or exceed the requirements of the Bay Area Air Quality Management District Regulation 8, Rule 51.
1. Sealants:
   a. Architectural Sealants: 250 g/L.
   b. Other: 420 g/L.
2. Sealant Primers:
   a. Architectural (non-porous): 250 g/L.
   b. Architectural (porous): 775 g/L.

2.02 MANUFACTURERS
A. Products: Subject to compliance with requirements, provide one of the through-penetration firestop systems indicated for each application in the Through-Penetration Firestop System Schedule that are produced by one of the following manufacturers:
   1. BioFireshield, Inc.
   2. Hilti, Inc.
   4. 3M; Fire Protection Products Division.
   5. Tremco; Sealant/Weatherproofing Division.

2.03 FIRESTOPPING, GENERAL
A. Compatibility: Provide through-penetration firestop systems that are compatible with one another; with the substrates forming openings; and with the items, if any, penetrating through-penetration firestop systems, under conditions of service and application, as
demonstrated by through-penetration firestop system manufacturer based on testing and field experience.

B. Accessories: Provide components for each through-penetration firestop system that are needed to install fill materials and to comply with Part 1 "Performance Requirements" Article. Use only components specified by through-penetration firestop system manufacturer and approved by qualified testing and inspecting agency for firestop systems indicated.

2.04 MIXING
A. For those products requiring mixing before application, comply with through-penetration firestop system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.01 EXAMINATION
A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of work.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION
A. Surface Cleaning: Clean out openings immediately before installing through-penetration firestop systems to comply with firestop system manufacturer's written instructions and with the following requirements:
   1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of through-penetration firestop systems.
   2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with through-penetration firestop systems. Remove loose particles remaining from cleaning operation.
   3. Remove laitance and form-release agents from concrete.
B. Priming: Prime substrates where recommended in writing by through-penetration firestop system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.
C. Masking Tape: Use masking tape to prevent through-penetration firestop systems from contacting adjoining surfaces that will remain exposed on completion of Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove smears from firestop system materials. Remove tape as soon as possible without disturbing firestop system's seal with substrates.

3.03 THROUGH-PENETRATION FI RESTOP SYSTEM INSTALLATION
A. General: Install through-penetration firestop systems to comply with Part 1 "Performance Requirements" Article and with firestop system manufacturer's written installation instructions and published drawings for products and applications indicated.
B. Install forming/damming/backing materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestop systems.

C. Install fill materials for firestop systems by proven techniques to produce the following results:
   1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
   2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
   3. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.04 IDENTIFICATION
A. Identify through-penetration firestop systems with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of edge of the firestop systems so that labels will be visible to anyone seeking to remove penetrating items or firestop systems. Use mechanical fasteners for metal labels. For plastic labels, use self-adhering type with adhesives capable of permanently bonding labels to surfaces on which labels are placed and, in combination with label material, will result in partial destruction of label if removal is attempted. Include the following information on labels:
   1. The words "Warning - Through-Penetration Firestop System - Do Not Disturb. Notify Building Management of Any Damage."
   2. Contractor's name, address, and phone number.
   3. Through-penetration firestop system designation of applicable testing and inspecting agency.
   4. Date of installation.
   5. Through-penetration firestop system manufacturer's name.
   6. Installer's name.

3.05 FIELD QUALITY CONTROL
A. Inspecting Agency: Owner will engage a qualified, independent inspecting agency to inspect through-penetration firestops. Independent inspecting agency shall comply with ASTM E 2174 requirements including those related to qualifications, conducting inspections, and preparing test reports.

B. Where deficiencies are found, repair or replace through-penetration firestop systems so they comply with requirements.

C. Proceed with enclosing through-penetration firestop systems with other construction only after inspection reports are issued and firestop installations comply with requirements.

3.06 CLEANING AND PROTECTING
A. Clean off excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure that through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce systems complying with specified requirements.

END OF SECTION
SECTION 07 84 46
FIRE-RESISTIVE JOINT SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes fire-resistive joint systems for the following:
   1. Head-of-wall joints.
   2. Wall-to-wall joints.

B. Related Sections include the following:
   1. Division 07 Section "Penetration Firestopping" for systems installed in openings in walls and floors with and without penetrating items.
   2. Division 07 Section "Joint Sealants" for non-fire-resistive joint sealants.

1.03 PERFORMANCE REQUIREMENTS

A. General: Determine required locations for and provide fire-resistive joint systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of assembly in which fire-resistive joint systems are installed.

B. Joint Systems in and between Fire-Resistance-Rated Constructions: Provide systems with assembly ratings equaling or exceeding the fire-resistance ratings of construction that they join, and with movement capabilities indicated as determined by UL 2079.
   1. Load-bearing capabilities as determined by evaluation during the time of test.

C. For fire-resistive systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

1.04 SUBMITTALS

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

B. Shop Drawings: For each fire-resistive joint system, show each kind of construction condition and location in which joints are installed; also show relationships to adjoining construction. Include fire-resistive joint system design designation of testing and inspecting agency acceptable to authorities having jurisdiction that demonstrates compliance with requirements for each condition indicated.
   1. Submit documentation, including illustrations, from a qualified testing and inspecting agency that is applicable to each fire-resistive joint system configuration for construction and penetrating items.

C. Fire Resistant Joint System Schedule: Indicate locations of each fire resistive joint system, along with the following information:
   1. Types of construction joined, including fire-resistance ratings and, where applicable, thicknesses of construction materials and assemblies.
   2. Fire resistive joint systems for each location identified by design designation of qualified testing and inspecting agency.
1.05 QUALITY ASSURANCE

A. Installer Qualifications: A firm that has been approved by FMG according to FMG 4991, "Approval of Firestop Contractors."

B. Installation Responsibility: Assign installation of through-penetration firestop systems and fire-resistant joint systems in Project to a single qualified installer.

C. Source Limitations: Obtain fire-resistant joint systems, for each kind of joint and construction condition indicated, through one source from a single manufacturer.

D. Fire-Test-Response Characteristics: Provide fire-resistant joint systems that comply with the following requirements and those specified in Part 1 "Performance Requirements" Article:
   1. Fire-resistance tests are performed by a qualified testing and inspecting agency. A qualified testing and inspecting agency is UL or another agency performing testing and follow-up inspection services for fire-resistant joint systems acceptable to authorities having jurisdiction.
   2. Fire-resistant joint systems are identical to those tested per methods indicated in Part 1 "Performance Requirements" Article and comply with the following:
      a. Fire-resistant joint system products bear classification marking of qualified testing and inspecting agency.
      b. Fire-resistant joint systems correspond to those indicated by referencing system designations of the qualified testing and inspecting agency.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver fire-resistant joint system products to Project site in original, unopened containers or packages with qualified testing and inspecting agency's classification marking applicable to Project and with intact and legible manufacturers' labels identifying product and manufacturer, date of manufacture, lot number, shelf life, curing time, and mixing instructions for multicomponent materials.

B. Store and handle materials for fire-resistant joint systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.07 PROJECT CONDITIONS

A. Environmental Limitations: Do not install fire-resistant joint systems when ambient or substrate temperatures are outside limits permitted by fire-resistant joint system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.

B. Ventilate fire-resistant joint systems per manufacturer's written instructions by natural means or, if this is inadequate, forced-air circulation.

1.08 COORDINATION

A. Coordinate construction of joints to ensure that fire-resistant joint systems are installed according to specified requirements.

B. Coordinate sizing of joints to accommodate fire-resistant joint systems.

C. Notify Owner's inspecting agency at least seven days in advance of fire-resistant joint system installations; confirm dates and times on days preceding each series of installations.

D. Do not cover up fire-resistant joint system installations that will become concealed behind other construction until Owner's inspecting agency and building inspector of authorities having jurisdiction have examined each installation.
PART 2 - PRODUCTS

2.01 MANUFACTURERS
A. Products: Subject to compliance with requirements, provide one of the fire resistive joint systems indicated for each application in the Fire Resistive Joint System Schedule that are produced by one of the following manufacturers:
   1. BioFireshield, Inc.
   2. Hilti, Inc.
   4. 3M; Fire Protection Products Division.
   5. Tremco; Sealant/Weatherproofing Division.

2.02 FIRE-RESISTIVE JOINT SYSTEMS
A. Compatibility: Provide fire-resistive joint systems that are compatible with joint substrates, under conditions of service and application, as demonstrated by fire-resistive joint system manufacturer based on testing and field experience.
B. Accessories: Provide components of fire-resistive joint systems, including primers and forming materials, that are needed to install fill materials and to comply with Part 1 "Performance Requirements" Article. Use only components specified by fire-resistive joint system manufacturer and approved by the qualified testing and inspecting agency for systems indicated.

PART 3 - EXECUTION

3.01 EXAMINATION
A. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, substrates, and other conditions affecting performance of work.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION
A. Surface Cleaning: Clean joints immediately before installing fire-resistive joint systems to comply with fire-resistive joint system manufacturer's written instructions and the following requirements:
   1. Remove from surfaces of joint substrates foreign materials that could interfere with adhesion of fill materials.
   2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with fill materials. Remove loose particles remaining from cleaning operation.
   3. Remove laitance and form-release agents from concrete.
B. Priming: Prime substrates where recommended in writing by fire-resistive joint system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.
C. Masking Tape: Use masking tape to prevent fill materials of fire-resistive joint system from contacting adjoining surfaces that will remain exposed on completion of Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove smears from fire-resistive joint system materials. Remove tape as soon as possible without disturbing fire-resistive joint system's seal with substrates or damaging adjoining surfaces.
3.03 INSTALLATION
A. General: Install fire-resistive joint systems to comply with Part 1 "Performance Requirements" Article and fire-resistive joint system manufacturer's written installation instructions for products and applications indicated.
B. Install forming/packing/backing materials and other accessories of types required to support fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
C. Install fill materials for fire-resistive joint systems by proven techniques to produce the following results:
   1. Fill voids and cavities formed by openings and forming/packing/backing materials as required to achieve fire-resistance ratings indicated.
   2. Apply fill materials so they contact and adhere to substrates formed by joints.
   3. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.04 FIELD QUALITY CONTROL
A. Inspecting Agency: Owner will engage a qualified independent inspecting agency to inspect fire-resistive joint systems and prepare inspection reports.
B. Testing Services: Inspecting of completed installations of fire-resistive joint systems shall take place in successive stages as installation of fire-resistive joint systems proceeds. Do not proceed with installation of joint systems for the next area until inspecting agency determines completed work shows compliance with requirements.
   1. Inspecting agency shall state in each report whether inspected fire-resistive joint systems comply with or deviate from requirements.
C. Remove and replace fire-resistive joint systems where inspections indicate that they do not comply with specified requirements.
D. Additional inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
E. Proceed with enclosing fire-resistive joint systems with other construction only after inspection reports are issued and fire-resistive joint systems comply with requirements.

3.05 CLEANING AND PROTECTING
A. Clean off excess fill materials adjacent to joints as Work progresses by methods and with cleaning materials that are approved in writing by fire-resistive joint system manufacturers and that do not damage materials in which openings occur.
B. Provide final protection and maintain conditions during and after installation that ensure fire-resistive joint systems are without damage or deterioration at time of Substantial Completion. If damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated fire-resistant joint systems immediately and install new materials to produce fire-resistive joint systems complying with specified requirements.

END OF SECTION
SECTION 07 92 00
JOINT SEALANTS

PART 1 - GENERAL

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

1.02 SUMMARY
A. This Section is general in nature. Sealants are specified for various applications that may or may not be encountered in the Work.
B. This Section includes joint sealants for the following applications, including those specified by reference to this Section:
   1. Exterior joints in the following vertical surfaces and horizontal nontraffic surfaces:
      b. Control and expansion joints in unit masonry.
      c. Joints between metal components.
      d. Joints between different materials listed above.
      e. Perimeter joints between materials listed above and frames of doors windows and louvers.
      f. Other joints as indicated.
   2. Exterior joints in the following horizontal traffic surfaces:
      a. Isolation and contraction joints in cast-in-place concrete slabs.
      b. Joints between different materials listed above.
      c. Other joints as indicated.
   3. Interior joints in the following vertical surfaces and horizontal nontraffic surfaces:
      a. Control and expansion joints on exposed interior surfaces of exterior walls.
      b. Perimeter joints of exterior openings where indicated.
      c. Vertical joints on exposed surfaces of interior unit masonry and concrete walls and partitions.
      d. Perimeter joints between interior wall surfaces and frames of interior doors, windows, and elevator entrances.
      e. Joints between plumbing fixtures and adjoining walls, floors, and counters.
      f. Other joints as indicated.
   4. Interior joints in the following horizontal traffic surfaces:
      b. Other joints as indicated.
C. Related Sections include the following:
   1. Division 01 Section "Sustainable Design Requirements" for additional LEED requirements.
   2. Division 04 Section "Unit Masonry" for masonry control and expansion joint fillers and gaskets.
   3. Division 07 Section "Fire-Resistive Joint Systems" for sealing joints in fire-resistance-rated construction.
   4. Division 08 Section "Glazing" for glazing sealants.
   5. Division 32 Section "Concrete Paving Joint Sealants" for sealing joints in pavements, walkways, and curbing.
1.03 PERFORMANCE REQUIREMENTS
A. Provide elastomeric joint sealants that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.
B. Provide joint sealants for interior applications that establish and maintain airtight and water-resistant continuous joint seals without staining or deteriorating joint substrates.

1.04 SUBMITTALS
A. Product Data: For each joint-sealant product indicated.
B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.
C. Samples for Verification: For each type and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- wide joints formed between two 6-inch- long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
D. LEED Submittals:
   1. Credit EQ.4.1: Low Emitting Materials: Manufacturers' product data and material safety data sheets (MSDS) for interior sealants, including printed statement of VOC content.
E. Preconstruction Field Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on preconstruction testing specified in "Quality Assurance" Article.
F. Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:
   1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
   2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.
G. Field Test Report Log: For each elastomeric sealant application.

1.05 QUALITY ASSURANCE
A. Installer Qualifications: Manufacturer's authorized Installer who is approved or licensed for installation of elastomeric sealants required for this Project.
B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.
C. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.
   1. Use manufacturer's standard test method to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
   2. Submit not fewer than nine pieces of each type of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
   3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
   4. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.
   5. Testing will not be required if joint-sealant manufacturers submit joint preparation data that are based on previous testing of current sealant products for adhesion.

JOINT SEALANTS
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to, and compatibility with, joint substrates and other materials matching those submitted.

D. Preconstruction Field-Adhesion Testing: Before installing elastomeric sealants, field test their adhesion to Project joint substrates as follows:
   1. Locate test joints where indicated on Project or, if not indicated, as directed by Architect.
   2. Conduct field tests for each application indicated below:
      a. Each type of elastomeric sealant and joint substrate indicated.
      b. Each type of nonelastomeric sealant and joint substrate indicated.
   3. Notify Architect seven days in advance of dates and times when test joints will be erected.
   4. Arrange for tests to take place with joint-sealant manufacturer's technical representative present.
         1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
   5. Report whether sealant in joint connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each type of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
   6. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

E. Mockups: Build mockups incorporating sealant joints, as follows, to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution:
   1. Joints in mockups of assemblies specified in other Sections that are indicated to receive elastomeric joint sealants, which are specified by reference to this Section.

F. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.06 PROJECT CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:
   1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
   2. When joint substrates are wet.
   3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
   4. Contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.07 WARRANTY

A. Special Installer's Warranty: Installer's standard form in which Installer agrees to repair or replace elastomeric joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
   1. Warranty Period: Two years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer's standard form in which elastomeric sealant manufacturer agrees to furnish elastomeric joint sealants to repair or replace
those that do not comply with performance and other requirements specified in this Section within specified warranty period.
1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer, based on testing and field experience.

B. VOC Content of Interior Sealants: Provide interior sealants and sealant primers that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
   1. Sealants:
      a. Architectural sealants: 250 g/L.
      b. Other: 420 g/L.
   2. Sealant Primers:
      a. For Nonporous Substrates: 250 g/L.
      b. For Porous Substrates: 775 g/L.
      c. Other: 750 g/L.

C. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.02 ELASTOMERIC JOINT SEALANTS

A. Elastomeric Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.

B. Stain-Test-Response Characteristics: Where elastomeric sealants are specified to be non-staining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.

C. Single-Component Neutral- and Basic-Curing Silicone Sealant:
   1. Products:
      a. Dow Corning Corporation; 790.
      b. GE Silicones; SilPruf LM SCS2700.
      c. Tremco; Spectrem 1 (Basic).
   2. Type and Grade: S (single component) and NS (nonsag).
   3. Class: 100/50.
   4. Use Related to Exposure: NT (nontraffic).
   5. Uses Related to Joint Substrates: M, G, A, and, as applicable to joint substrates indicated, O.
   7. Use for:
      b. Exterior vertical and horizontal nontraffic joints between plant-precast architectural concrete units.
c. Exterior vertical control and expansion joints and horizontal relief joints in unit masonry.
d. Exterior joints in dimension stone cladding.
e. Interior and exterior sealant-pointed mortar joints in glass unit masonry assemblies.
f. Exterior butt joints between metal components.
g. Exterior vertical joints between different materials listed above.

D. Single-Component Mildew-Resistant Acid-Curing Silicone Sealant:
1. Products:
   a. Dow Corning Corporation; 786 Mildew Resistant.
   b. GE Silicones; Sanitary SCS1700.
   c. Tremco; Tremsil 200 Clear.
2. Type and Grade: S (single component) and NS (nonsag).
4. Use Related to Exposure: NT (nontraffic).
5. Uses Related to Joint Substrates: G, A, and, as applicable to joint substrates indicated, O.
6. Use for:
   a. Interior joints between plumbing fixtures and adjoining walls, floors, and counters.
   b. Interior joints at intersections of tile wall surfaces.

E. Multicomponent Pourable Urethane Sealant:
1. Products:
   b. Tremco; THC-901.
   c. Tremco; THC-900.
   d. Tremco; Vulkem 245.
2. Type and Grade: M (multicomponent) and P (pourable).
4. Use Related to Exposure: T (traffic).
5. Uses Related to Joint Substrates: M, A, and, as applicable to joint substrates indicated, O.
6. Use for:
   a. Exterior horizontal nontraffic and traffic isolation and contraction joints in cast-in-place concrete slabs.

F. Single-Component Nonsag Urethane Sealant:
1. Products:
   b. Sonneborn, Division of ChemRex Inc.; Ultra.
   c. Sonneborn, Division of ChemRex Inc.; NP 1.
   d. Tremco; Vulkem 116.
2. Type and Grade: S (single component) and NS (nonsag).
4. Uses Related to Exposure: T (traffic) and NT (nontraffic).
5. Uses Related to Joint Substrates: M, A, and, as applicable to joint substrates indicated, O.
6. Use for:
   a. Metal panel seams, metal flashings and reglet joints.

G. Single-Component Pourable Urethane Sealant:
1. Products:
   a. Pecora Corporation; Urexpan NR-201.
   b. Tremco; Tremflex S/L.
c. Tremco; Vulkem 45.

2. Type and Grade: S (single component) and P (pourable).
4. Use Related to Exposure: T (traffic).
5. Uses Related to Joint Substrates: M, A, and, as applicable to joint substrates indicated, O.
6. Use for: Interior ceramic tile expansion, control, contraction, and isolation joints in horizontal traffic surfaces.

2.03 SOLVENT-RELEASE JOINT SEALANTS
A. Butyl-Rubber-Based Solvent-Release Joint Sealant: Comply with ASTM C 1085.
   1. Products:
      a. Pecora Corporation; BC-158.
      b. Sonneborn, Division of ChemRex Inc.; Sonneborn Multi-Purpose Sealant.
      c. Tremco; Tremco Butyl Sealant.
   2. Use for:
      a. Concealed joints in exterior sheet metal work.
      b. Under exterior door thresholds.

2.04 LATEX JOINT SEALANTS
A. Latex Sealant: Comply with ASTM C 834, Type P, Grade NF.
   B. Products:
      1. Pecora Corporation; AC-20+.
      2. Sonneborn, Division of ChemRex Inc.; Sonolac.
      3. Tremco; Tremflex 834.
   C. Use for:
      1. Vertical control and expansion joints on exposed interior surfaces of exterior walls.
      2. Interior perimeter joints of exterior openings.
      3. Vertical joints on exposed surfaces of interior unit masonry and concrete walls and partitions.
      4. Perimeter joints between interior wall surfaces and frames of interior doors, windows, and elevator entrances.

2.05 ACOUSTICAL JOINT SEALANTS
A. Acoustical Sealant for Exposed and Concealed Joints: Manufacturer’s standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834 and the following:
   1. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
   2. Products:
      a. Pecora Corporation; AC-20 FTR Acoustical and Insulation Sealant.
   3. Use for: Joints for acoustical partitions.

2.06 JOINT-SEALANT BACKING
A. General: Provide sealant backings of material and type that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin), O (open-cell material), B (bicellular material with a surface skin), or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance:

C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

2.07 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer’s written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.

2. Clean porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:

   a. Concrete.
   b. Masonry.
   c. Unglazed surfaces of ceramic tile.

3. Remove laitance and form-release agents from concrete.

4. Clean nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
a. Metal.
b. Glass.
c. Porcelain enamel.
d. Glazed surfaces of ceramic tile.

B. Joint Priming: Prime joint substrates based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.03 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Acoustical Sealant Application Standard: Comply with recommendations in ASTM C 919 for use of joint sealants in acoustical applications as applicable to materials, applications, and conditions indicated.

D. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
   1. Do not leave gaps between ends of sealant backings.
   2. Do not stretch, twist, puncture, or tear sealant backings.
   3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

E. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

F. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
   1. Place sealants so they directly contact and fully wet joint substrates.
   2. Completely fill recesses in each joint configuration.
   3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

G. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
   1. Remove excess sealant from surfaces adjacent to joints.
   2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
   3. Provide concave joint configuration per Figure 5A in ASTM C 1193, unless otherwise indicated.

3.04 FIELD QUALITY CONTROL

A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:
   1. Extent of Testing: Test completed elastomeric sealant joints as follows:
      a. Perform 1 test for each 1000 feet of joint length thereafter or 1 test per each floor per elevation.
2. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab in Appendix X1 in ASTM C 1193, as appropriate for type of joint-sealant application indicated.
   a. For joints with dissimilar substrates, verify adhesion to each substrate separately; do this by extending cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.

3. Inspect joints for complete fill, for absence of voids, and for joint configuration complying with specified requirements. Record results in a field-adhesion-test log.

4. Inspect tested joints and report on the following:
   a. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each type of product and joint substrate. Compare these results to determine if adhesion passes sealant manufacturer’s field-adhesion hand-pull test criteria.
   b. Whether sealants filled joint cavities and are free of voids.
   c. Whether sealant dimensions and configurations comply with specified requirements.

5. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.

6. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.

B. Evaluation of Field Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.05 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.06 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

END OF SECTION
SECTION 08 11 13
CUSTOM HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

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

1.02 SUMMARY
A. This Section includes:
   1. Custom hollow metal doors and frames.
B. Related Sections include the following:
   1. Division 01 Section "Sustainable Design Requirements" for additional LEED requirements.
   2. Division 04 Section "Unit Masonry" for embedding anchors for hollow metal work into masonry construction.
   3. Division 08 Section "Door Hardware" for door hardware for hollow metal doors.
   4. Division 09 Sections "Exterior Painting" and "Interior Painting" for field painting hollow metal doors and frames.
   5. Division 26 Sections for electrical connections including conduit and wiring for door controls and operators.

1.03 DEFINITIONS
A. Minimum Thickness: Minimum thickness of base metal without coatings.
B. Custom Hollow Metal Work: Hollow metal work fabricated according to ANSI/NAAMM-HMMA 861.

1.04 SUBMITTALS
A. Product Data: For each type of product indicated. Include construction details, material descriptions, core descriptions, fire-resistance rating, temperature-rise ratings, and finishes.
B. Shop Drawings: Include the following:
   1. Elevations of each door design.
   2. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
   3. Locations of reinforcement and preparations for hardware.
   4. Details of each different wall opening condition.
   5. Details of anchorages, joints, field splices, and connections.
   6. Details of accessories.
   7. Details of moldings, removable stops, and glazing.
   8. Details of conduit and preparations for power, signal, and control systems.
C. Schedule: Provide a schedule of hollow metal work prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with door hardware schedule.
D. LEED Submittals:
   1. Credits MR 4.1 and 4.2: Recycled Content:
a. Submit documentation from manufacturer indicating separate percentages, by weight, of pre-consumer and post-consumer recycled content per unit of product. Also include material costs, excluding cost of installation.

2. Credits MR 5.1 and 5.2: Regionally Extracted, Harvested, or Recovered and Manufactured Materials:
   a. Indicate location of manufacturing facility, including name, address, and distance between manufacturing facility and the project site. Provide manufacturer’s documentation indication location where the base materials were extracted, mined, quarried, harvested, etc., and the distance between this location and the project site. Also include material costs, excluding cost of installation.

E. Oversize Construction Certification: For assemblies required to be fire rated and exceeding limitations of labeled assemblies.

1.05 QUALITY ASSURANCE

A. Source Limitations: Obtain hollow metal work from single source from single manufacturer.

B. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.
   1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.

C. Fire-Rated, Borrowed-Light Frame Assemblies: Assemblies complying with NFPA 80 that are listed and labeled, by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 257 or UL 9. Label each individual glazed lite.

D. Smoke-Control Door Assemblies: Comply with NFPA 105 or UL 1784.

E. Preinstallation Conference: Conduct conference at Project site.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver hollow metal work palletized, wrapped, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.
   1. Provide additional protection to prevent damage to finish of factory-finished units.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store hollow metal work under cover at Project site. Place in stacks of five units maximum in a vertical position with heads up, spaced by blocking, on minimum 4-inch-high wood blocking. Do not store in a manner that traps excess humidity.
   1. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

1.07 PROJECT CONDITIONS

A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.
   1. Where filed measurements cannot be made without delaying the Work, establish opening dimensions and proceed with fabricating custom steel frames without
field measurements. Coordinate wall construction to ensure that actual opening dimensions correspond to established dimensions.

1.08 COORDINATION
A. Coordinate installation of anchorages for hollow metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.01 GENERAL
A. Recycled Content: Materials/products shall contain the maximum amount of recycled content allowed that retains material integrity.
B. Regionally Extracted, Harvested, or Recovered and Manufactured Materials:
   1. Preference shall be given to manufacturer's whose facilities are within a 500 mile radius of the project site.
   2. Preference shall also be given to materials that are harvested, extracted, mined, quarried, etc. within a 500 mile radius of the project site.

2.02 MANUFACTURERS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Gateway Metal Products, Inc.
   2. Rocky Mountain Metals, Inc.
   3. Southwest Hollow Metal.
   4. West Central Manufacturing.

2.03 MATERIALS
A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 or A60 metallic coating.
D. Frame Anchors: ASTM A 591/A 591M, Commercial Steel (CS), 40Z coating designation; mill phosphatized.
   1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.
E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.
F. Powder-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow metal frames of type indicated.
G. Grout: ASTM C 476, except with a maximum slump of 4 inches, as measured according to ASTM C 143/C 143M.
H. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool with 6- to 12-lb/cu. ft. density;
with maximum flame-spread and smoke-development indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.

I. Glazing: Comply with requirements in Division 08 Section "Glazing."

J. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.04 CUSTOM HOLLOW METAL DOORS

A. General: Provide doors not less than 1-3/4 inches thick, of seamless hollow construction unless otherwise indicated. Construct doors with smooth surfaces without visible joints or seams on exposed faces. Comply with ANSI/NAAMM-HMMA 861.

B. Exterior Door Face Sheets: Fabricated from metallic-coated steel sheet, minimum 0.053 inch thick.

C. Interior Door Face Sheets: Fabricated from cold-rolled steel sheet, minimum 0.042 inch thick.

D. Core Construction: Provide thermal-resistance-rated cores for exterior doors.
   1. Steel-Stiffened Core: 0.026-inch-thick, steel vertical stiffeners of same material as face sheets extending full-door height, with vertical webs spaced not more than 6 inches apart, spot welded to face sheets a maximum of 5 inches o.c. Spaces filled between stiffeners with glass- or mineral-fiber insulation.
      a. Fire Door Core: As required to provide fire-protection ratings indicated.
      b. Thermal-Rated (Insulated) Doors: Where indicated, provide doors fabricated with thermal-resistance value (R-value) of not less than 4.0 deg F x h x sq. ft./Btu when tested according to ASTM C 1363.


F. Vertical Edges for Double-Acting Doors: Round vertical edges with 2-1/8-inch radius.

G. Top and Bottom Channels: Closed with continuous channels, minimum 0.053 inch thick, of same material as face sheets and spot welded to both face sheets.

H. Hardware Reinforcement: Fabricate according to ANSI/NAAMM-HMMA 861 with reinforcing plates from same material as door face sheets.

2.05 CUSTOM HOLLOW METAL FRAMES

   1. Door Frames for Openings 48 inches Wide or Less: Fabricated from 0.053-inch-thick steel sheet.
   2. Door Frames for Openings More Than 48 Inches Wide: Fabricated from 0.067-inch-thick steel sheet.
   3. Sidelight and Transom Frames: Fabricated from same thickness material as adjacent door frame.


C. Interior Frames: Fabricated from cold-rolled steel sheet.

D. Hardware Reinforcement: Fabricate according to ANSI/NAAMM-HMMA 861 with reinforcing plates from same material as frame.

E. Head Reinforcement: Provide minimum 0.093-inch-thick, steel channel or angle stiffener for opening widths more than 48 inches.
2.06 FRAME ANCHORS
A. Jamb Anchors:
   1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.042 inch thick, with corrugated or perforated straps not less than 2 inches wide by 10 inches long; or wire anchors not less than 0.177 inch thick.
   2. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.042 inch thick.
   3. Compression Type for Drywall Slip-on Frames: Adjustable compression anchors.
   4. Postinstalled Expansion Type for In-Place Concrete or Masonry: Minimum 3/8-inch diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.
B. Floor Anchors: Formed from same material as frames, not less than 0.042 inch thick, and as follows:
   1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.
   2. Separate Topping Concrete Slabs: Adjustable-type anchors with extension clips, allowing not less than 2-inch height adjustment. Terminate bottom of frames at finish floor surface.

2.07 STOPS AND MOLDINGS
A. Moldings for Glazed Lites in Doors: Minimum 0.032 inch thick, fabricated from same material as door face sheet in which they are installed.
B. Fixed Frame Moldings: Formed integral with hollow metal frames, a minimum of 5/8 inch high unless otherwise indicated.
C. Loose Stops for Glazed Lites in Frames: Minimum 0.032 inch thick, fabricated from same material as frames in which they are installed.

2.08 ACCESSORIES
A. Mullions and Transom Bars: Join to adjacent members by welding or rigid mechanical anchors.
B. Ceiling Struts: Minimum 1/4-inch-thick by 1-inch wide steel.
C. Grout Guards: Formed from same material as frames, not less than 0.016 inch thick.

2.09 FABRICATION
A. Fabricate hollow metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.
B. Tolerances: Fabricate hollow metal work to tolerances indicated in ANSI/NAAMM-HMMA 861.
C. Hollow Metal Doors:
   1. Exterior Doors: Provide weep-hole openings in bottom of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.
   2. Glazed Lites: Factory cut openings in doors.
CUSTOM HOLLOW METAL DOORS AND FRAMES
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3. Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch beyond edge of door on which astragal is mounted.

D. Hollow Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
   1. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.
   2. Sidelight and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by butt welding.
   3. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
   4. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
   5. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
   6. Jamb Anchors: Provide number and spacing of anchors as follows:
      a. Masonry Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:
         1) Two anchors per jamb up to 60 inches high.
         2) Three anchors per jamb from 60 to 90 inches high.
         3) Four anchors per jamb from 90 to 120 inches high.
         4) Four anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 120 inches high.
      b. Stud-Wall Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:
         1) Three anchors per jamb up to 60 inches high.
         2) Four anchors per jamb from 60 to 90 inches high.
         3) Five anchors per jamb from 90 to 96 inches high.
         4) Five anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 96 inches high.
         5) Two anchors per head for frames above 42 inches wide and mounted in metal-stud partitions.
      c. Compression Type: Not less than two anchors in each jamb.
      d. Postinstalled Expansion Type: Locate anchors not more than 6 inches from top and bottom of frame. Space anchors not more than 26 inches o.c.
   7. Door Silencers: Except on weather-stripped doors, drill stops to receive door silencers as follows. Keep holes clear during construction.
      a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
      b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

E. Fabricate concealed stiffeners, edge channels, and hardware reinforcement from either cold- or hot-rolled steel sheet.

F. Hardware Preparation: Factory prepare hollow metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to the Door Hardware Schedule and templates furnished as specified in Division 08 Section "Door Hardware."
1. Locate hardware as indicated, or if not indicated, according to ANSI/NAAMM-HMMA 861.
2. Reinforce doors and frames to receive nontemplated, mortised and surface-mounted door hardware.
3. Comply with applicable requirements in ANSI/SDIA250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.
4. Coordinate locations of conduit and wiring boxes for electrical connections with Division 26 Sections.

G. Stops and Moldings: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints.
   1. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of hollow metal work.
   2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
   3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.
   4. Provide loose stops and moldings on inside of hollow metal work.
   5. Coordinate rabbet width between fixed and removable stops with type of glazing and type of installation indicated.

2.10 STEEL FINISHES
A. Prime Finish: Apply manufacturer's standard primer immediately after cleaning and pretreating.
   1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDIA250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

PART 3 - EXECUTION
3.01 EXAMINATION
A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
B. Examine roughing-in for embedded and built-in anchors to verify actual locations before frame installation.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION
A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.
B. Prior to installation, adjust and securely brace welded hollow metal frames for squareness, alignment, twist, and plumbness to the following tolerances:
   1. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
   2. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
   3. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
4. Plumbness: Plus or minus 1/16 inch, measured at jambs on a perpendicular line from head to floor.

C. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.03 INSTALLATION

A. General: Install hollow metal work plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.

B. Hollow Metal Frames: Install hollow metal frames of size and profile indicated. Comply with HMMA 840.

1. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
   a. At fire-protection-rated openings, install frames according to NFPA 80.
   b. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
   c. Install frames with removable glazing stops located on secure side of opening.
   d. Install door silencers in frames before grouting.
   e. Remove temporary braces necessary for installation only after frames have been properly set and secured.
   f. Check plumbness, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
   g. Field apply bituminous coating to backs of frames that are filled with grout containing antifreezing agents.

2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors.
   a. Floor anchors may be set with powder-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.


4. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.

5. Concrete Walls: Solidly fill space between frames and concrete with grout. Take precautions, including bracing frames, to ensure that frames are not deformed or damaged by grout forces.

6. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.

7. In-Place Gypsum Board Partitions: Secure frames in place with postinstalled expansion anchors through floor anchors at each jamb. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.

8. Ceiling Struts: Extend struts vertically from top of frame at each jamb to overhead structural supports or substrates above frame unless frame is anchored to masonry or to other structural support at each jamb. Bend top of struts to provide flush contact for securing to supporting construction. Provide adjustable wedged or bolted anchorage to frame jamb members.

9. Installation Tolerances: Adjust hollow metal door frames for squareness, alignment, twist, and plumb to the following tolerances:
a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.

C. Hollow Metal Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.
   1. Non-Fire-Rated Steel Doors:
      a. Jambs and Head: 1/8 inch plus or minus 1/16 inch.
      b. Between Edges of Pairs of Doors: 1/8 inch plus or minus 1/16 inch.
      c. Between Bottom of Door and Top of Threshold: Maximum 3/8 inch.
   2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
   3. Smoke-Control Doors: Install doors according to NFPA 105.

D. Glazing: Comply with installation requirements in Division 08 Section “Glazing” and with hollow metal manufacturer's written instructions.
   1. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.

3.04 ADJUSTING AND CLEANING

A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow metal work that is warped, bowed, or otherwise unacceptable.

B. Remove grout and other bonding material from hollow metal work immediately after installation.

C. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

D. Metallic-Coated Surfaces: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

END OF SECTION
SECTION 08 14 16
FLUSH WOOD DOORS

PART 1 - GENERAL

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

1.02 SUMMARY
A. This Section includes:
1. Solid-core doors with wood-veneer faces.
2. Factory finishing flush wood doors.

B. Related Sections include the following:
1. Division 01 Section "Sustainable Design Requirements" for additional LEED requirements.
2. Division 08 Section "Glazing" for glass view panels in flush wood doors.

1.03 SUBMITTALS
A. Product Data: For each type of door indicated. Include details of core and edge construction and trim for openings. Include factory-finishing specifications.

B. LEED Submittals:
1. Certificates for Credit MR 7: Chain-of-custody certificates certifying that flush wood doors comply with forest certification requirements.

C. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; location and extent of hardware blocking; and other pertinent data.
1. Indicate dimensions and locations of mortises and holes for hardware.
2. Indicate dimensions and locations of cutouts.
3. Indicate requirements for veneer matching.
4. Indicate doors to be factory finished and finish requirements.
5. Indicate fire-protection ratings for fire-rated doors.

D. Samples:
1. Factory finishes applied to actual door face materials, approximately 8 by 10 inches, for each material and finish. For each wood species and transparent finish, provide set of three samples showing typical range of color and grain to be expected in the finished work.
2. Frames for light openings, 6 inches long, for each material, type, and finish required.

E. LEED Submittals:
1. Credit MR 5.1 and 5.2: Regionally Extracted, Harvested, or Recovered and Manufactured Materials:
a. Indicate location of manufacturing facility, including name, address, and distance between manufacturing facility and the project site. Provide manufacturer’s documentation indication location where the base materials were extracted, mined, quarried, harvested, etc., and the distance between this location and the project site. Also include material costs, excluding cost of installation.
2. Certificates for Credit MR 7: Chain-of-custody certificates certifying that flush wood doors comply with forest certification requirements. Include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body.

3. Credit EQ 4.4:
   a. Composite wood manufacturer's product data for each composite wood product used indicating that the bonding agent contains no urea formaldehyde.
   b. Adhesive manufacturer's product data for each adhesive used indicating that the adhesive contains no urea formaldehyde.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

B. Source Limitations: Obtain flush wood doors from single manufacturer.

C. Quality Standard: In addition to requirements specified, comply with WDMA I.S.1-A, "Architectural Wood Flush Doors."

D. Destructive Testing: One solid core wood door may be randomly selected by the Architect for destructive testing to determine if the manufacturer has complied with the specifications. The cost of the door will be borne by the manufacturer, provided there are at least 50 doors on the Project.

E. Forest Certification: Provide doors made with [cores] [veneers] [not less than 70 percent of wood products] [all wood products] obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."

F. Fire-Rated Wood Doors: Doors complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to UL 10C.
   1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.

G. Preinstallation Conference: Conduct conference at Project site.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Comply with requirements of referenced standard and manufacturer's written instructions.

B. Package doors individually in plastic bags or cardboard cartons.

C. Mark each door on top and bottom rail with opening number used on Shop Drawings.

1.06 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.07 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
a. Warping (bow, cup, or twist) more than 1/4 inch in a 42-by-84-inch section.
b. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch span.

2. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.

PART 2 - PRODUCTS

2.01 GENERAL
A. Regionally Extracted, Harvested, or Recovered, and Manufactured Materials:
1. Preference shall be given to manufacturer’s whose facilities are within a 500 mile radius of the project site.
2. Preference shall also be given to materials that are harvested, extracted, mined, quarried, etc. within a 500 mile radius of the project site.

2.02 MANUFACTURERS
A. Subject to compliance with requirements, provide products by one of the following:
1. Algoma Hardwoods, Inc.
2. Eggers Industries.

2.03 DOOR CONSTRUCTION, GENERAL
A. Low-Emitting Materials: Provide doors made with adhesives and composite wood products that do not contain urea formaldehyde.
B. WDMA I.S.1-A Performance Grade: Extra Heavy Duty.
C. Fire-Protection-Rated Doors: Provide core specified or mineral core as needed to provide fire-protection rating indicated.
1. Edge Construction: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed edges.
2. Pairs: Provide fire-retardant stiles that are listed and labeled for applications indicated without formed-steel edges and astragals. Provide stiles with concealed intumescent seals. Comply with specified requirements for exposed edges.
D. Mineral-Core Doors:
1. Core: Noncombustible mineral product complying with requirements of referenced quality standard and testing and inspecting agency for fire-protection rating indicated.
2. Blocking: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated as needed to eliminate through-bolting hardware.
3. Edge Construction: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.

2.04 VENEERED-FACED DOORS FOR TRANSPARENT FINISH
A. Interior Solid-Core Doors:
1. Grade: Premium, with Grade A faces.
2. Species: White birch.
3. Cut: Plain sliced (flat sliced).
5. Assembly of Veneer Leaves on Door Faces: Balance match.
6. Pair and Set Match: Provide for doors hung in same opening or separated only by mullions.
7. Transom Match: Continuous match.
8. Exposed Vertical and Top Edges: Same species as faces.
10. Construction: Five plies. Stiles and rails are bonded to core, then entire unit abrasive planed before veneering.

2.05 LIGHT FRAMES
A. Metal Frames for Light Openings in Fire-Rated Doors: Manufacturer's standard frame formed of 0.048-inch-thick, cold-rolled steel sheet; with baked-enamel- or powder-coated finish; and approved for use in doors of fire-protection rating indicated.

2.06 FABRICATION
A. Factory fit doors to suit frame-opening sizes indicated. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
   1. Comply with requirements in NFPA 80 for fire-rated doors.
B. Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings, DHI A115-W series standards, and hardware templates.
   1. Coordinate with hardware mortises in metal frames to verify dimensions and alignment before factory machining.
   2. Metal Astragals: Factory machine astragals and formed-steel edges for hardware for pairs of fire-rated doors.
C. Transom and Side Panels: Fabricate matching panels with same construction, exposed surfaces, and finish as specified for associated doors. Finish bottom edges of transoms and top edges of rabbeted doors same as door stiles.
   1. Fabricate door and transom panels with full-width, solid-lumber meeting rails. Provide factory-installed spring bolts for concealed attachment into jambs of metal door frames.
D. Openings: Cut and trim openings through doors in factory.
   1. Light Openings: Trim openings with moldings of material and profile indicated.
   2. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in Division 08 Section "Glazing."

2.07 FACTORY FINISHING
A. General: Comply with referenced quality standard for factory finishing. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
   1. Finish faces, all four edges, edges of cutouts, and mortises. Stains and fillers may be omitted on bottom edges, edges of cutouts, and mortises.
B. Finish doors at factory.
C. Transparent Finish:
   1. Grade: Premium.
   2. Finish: WDMA TR-6 catalyzed polyurethane.
   3. Effect: Open-grain finish.
PART 3 - EXECUTION

3.01 EXAMINATION
A. Examine doors and installed door frames before hanging doors.
   1. Verify that frames comply with indicated requirements for type, size, location, and
      swing characteristics and have been installed with level heads and plumb jambs.
   2. Reject doors with defects.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION
A. Hardware: For installation, see Division 08 Section "Door Hardware."
B. Installation Instructions: Install doors to comply with manufacturer's written instructions
   and the referenced quality standard, and as indicated.
   1. Install fire-rated doors in corresponding fire-rated frames according to NFPA 80.
C. Job-Fitted Doors: Align and fit doors in frames with uniform clearances and bevels as
   indicated below; do not trim stiles and rails in excess of limits set by manufacturer or
   permitted for fire-rated doors. Machine doors for hardware. Seal edges of doors, edges
   of cutouts, and mortises after fitting and machining.
   1. Clearances: Provide 1/8 inch at heads, jambs, and between pairs of doors.
      Provide 1/8 inch from bottom of door to top of decorative floor finish or covering
      unless otherwise indicated. Where threshold is shown or scheduled, provide 1/4
      inch from bottom of door to top of threshold unless otherwise indicated.
      a. Comply with NFPA 80 for fire-rated doors.
   2. Bevel non-fire-rated doors 1/8 inch in 2 inches at lock and hinge edges.
   3. Bevel fire-rated doors 1/8 inch in 2 inches at lock edge; trim stiles and rails only
      to extent permitted by labeling agency.
D. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.
E. Factory-Finished Doors: Restore finish before installation if fitting or machining is
   required at Project site.

3.03 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL
A. Construction waste shall be managed in accordance with provisions of Division 01
   Section - Construction Waste Management and Disposal, and as follows. Documentation
   shall be submitted to satisfy the requirements of that section.
   1. Do not send materials treated with pentachlorophenol, CCA, or ACA to co-
      generation facilities or “waste-to-energy” facilities.
   2. Do not leave any wood, shavings, sawdust, etc. on the ground or buried in fill
B. Prevent sawdust and wood shavings from entering the storm drainage system.

3.04 ADJUSTING
A. Operation: Rehang or replace doors that do not swing or operate freely.
B. Finished Doors: Replace doors that are damaged or that do not comply with
   requirements. Doors may be repaired or refinshed if work complies with requirements
   and shows no evidence of repair or refinishing.

END OF SECTION
SECTION 08 31 13
ACCESS DOORS AND FRAMES

PART 1 - GENERAL

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

1.02 SUMMARY
A. This Section includes:
1. Access doors and frames for walls and ceilings.
2. Floor access doors and frames.
B. Related Sections include the following:
1. Division 01 Section "Sustainable Design Requirements" for additional LEED requirements.
2. Division 03 Section "Cast-in-Place Concrete" for blocking out openings for access doors and frames in concrete.
3. Division 04 Section "Unit Masonry" for anchoring and grouting access door frames set in masonry construction.
4. Division 07 Section "Roof Accessories" for roof hatches.
5. Division 09 Section "Acoustical Tile Ceilings" for suspended acoustical tile ceilings.

1.03 PERFORMANCE REQUIREMENTS
A. Provide suitable access to every chase, valve, control, or other item of equipment requiring adjustment and maintenance that would otherwise be inaccessible.

1.04 SUBMITTALS
A. Product Data: For each type of access door and frame indicated. Include construction details, fire ratings, materials, individual components and profiles, and finishes.
B. Shop Drawings: Show fabrication and installation details of access doors and frames for each type of substrate. Include plans, elevations, sections, details, and attachments to other work.
C. Ceiling Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted items including access doors and frames, lighting fixtures, diffusers, grilles, speakers, sprinklers, and special trim are shown and coordinated with each other.
D. LEED Submittals:
1. Credits MR 4.1 and 4.2: Recycled Content:
a. Submit documentation from manufacturer indicating separate percentages, by weight, of pre-consumer and post-consumer recycled content per unit of product. Also include material costs, excluding cost of installation.
2. Credits MR 5.1 and 5.2: Regionally Extracted, Harvested, or Recovered and Manufactured Materials:
a. Indicate location of manufacturing facility, including name, address, and distance between manufacturing facility and the project site. Provide manufacturer’s documentation indication location where the base materials were extracted, mined, quarried, harvested, etc., and the
distance between this location and the project site. Also include material costs, excluding cost of installation.

1.05 QUALITY ASSURANCE
A. Source Limitations: Obtain access door(s) and frame(s) through one source from a single manufacturer.
B. Fire-Rated Access Doors and Frames: Units complying with NFPA 80 that are identical to access door and frame assemblies tested for fire-test-response characteristics per the following test method and that are listed and labeled by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
   1. NFPA 252 or UL 10B for vertical access doors and frames.
   2. ASTM E 119 or UL 263 for horizontal access doors and frames.

1.06 COORDINATION
A. Verification: Determine specific locations and sizes for access doors needed to gain access to concealed plumbing, mechanical, or other concealed work.

PART 2 - PRODUCTS

2.01 GENERAL
A. Recycled Content: Materials/products shall contain the maximum amount of recycled content allowed that retains material integrity.
B. Regionally Extracted, Harvested, or Recovered and Manufactured Materials:
   1. Preference shall be given to manufacturer's whose facilities are within a 500 mile radius of the project site.
   2. Preference shall also be given to materials that are harvested, extracted, mined, quarried, etc. within a 500 mile radius of the project site.

2.02 STEEL MATERIALS
A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
   1. ASTM A 123/A 123M, for galvanizing steel and iron products.
   2. ASTM A 153/A 153M, for galvanizing steel and iron hardware.
B. Steel Sheet: cold-rolled steel sheet substrate complying with ASTM A 1008/A 1008M, Commercial Steel (CS), exposed.
C. Steel Finishes: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
   1. Surface Preparation for Steel Sheet: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, or other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
   2. Factory-Primed Finish: Apply shop primer immediately after cleaning and pretreating.
D. Drywall Beads: Edge trim formed from 0.0299-inch zinc-coated steel sheet formed to receive joint compound and in size to suit thickness of gypsum board.
E. Plaster Beads: Casing bead formed from 0.0299-inch zinc-coated steel sheet with flange formed out of expanded metal lath and in size to suit thickness of plaster.
2.03 ACCESS DOORS AND FRAMES FOR WALLS AND CEILINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   2. J. L. Industries, Inc.
   4. Milcor Inc.
   5. Nystrom, Inc.

   1. Locations: Wall surfaces.
   2. Door: Minimum 0.060-inch-thick sheet metal, set flush with exposed face flange of frame.
   3. Frame: Minimum 0.060-inch-thick sheet metal with 1-inch-wide, surface-mounted trim.
   5. Latch: Cam latch operated by screwdriver with interior release.
   6. Use for: Non-fire-rated access doors in concrete or masonry walls.

C. Flush Access Doors and Trimless Frames: Fabricated from steel sheet.
   1. Locations: Wall and ceiling surfaces.
   2. Door: Minimum 0.060-inch-thick sheet metal, set flush with surrounding finish surfaces.
   3. Frame: Minimum 0.060-inch-thick sheet metal with drywall bead flange.
   5. Latch: Cam latch operated by screwdriver with interior release.
   6. Use for: Non-fire-rated access doors in gypsum board and plaster partitions.

   1. Locations: Wall and ceiling surfaces.
   2. Door: Minimum 0.040-inch-thick, metallic-coated steel sheet; flush panel construction with manufacturer's standard 2-inch-thick fiberglass insulation.
   3. Frame: Minimum 0.060-inch-thick extruded aluminum.
   5. Lock: Dual-action handles with key lock.
      a. Lock Preparation: Prepare door panel to accept cylinder specified in Division 08 Section "Door Hardware."

   1. Locations: Wall surfaces.
   2. Fire-Resistance Rating: As required by Building Code for type and rating of construction in which door is installed.
   3. Temperature Rise Rating: 250 deg F at the end of 30 minutes.
   4. Door: Flush panel with a core of mineral-fiber insulation enclosed in sheet metal with a minimum thickness of 0.036 inch.
   5. Frame: Minimum 0.060-inch-thick sheet metal with 1-inch-wide, surface-mounted trim.
   9. Use for: Fire-rated access doors in concrete or masonry walls.

1. Locations: Wall surfaces.
2. Fire-Resistance Rating: As required by Building Code for type and rating of construction in which door is installed.
3. Temperature Rise Rating: 250 deg F at the end of 30 minutes.
4. Door: Flush panel with a core of mineral-fiber insulation enclosed in sheet metal with a minimum thickness of 0.036 inch.
5. Frame: Minimum 0.060-inch-thick sheet metal with drywall bead.
8. Lock: Self-latching device with cylinder lock.
   a. Lock Preparation: Prepare door panel to accept cylinder specified in Division 08 Section "Door Hardware."

2.04 FABRICATION
A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.
B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access panels to types of supports indicated.
   1. For trimless frames with drywall bead, provide edge trim for gypsum board securely attached to perimeter of frames.
   2. For trimless frames with plaster bead for full-bed plaster applications, provide zinc-coated expanded metal lath and exposed casing bead welded to perimeter of frames.
   3. Provide mounting holes in frames for attachment of units to metal or wood framing.
   4. Provide mounting holes in frame for attachment of masonry anchors.
D. Latching Mechanisms: Furnish number required to hold doors in flush, smooth plane when closed.
   1. For cylinder lock, furnish two keys per lock and key all locks alike.

PART 3 - EXECUTION
3.01 INSTALLATION
A. Comply with manufacturer's written instructions for installing access doors and frames.
B. Set frames accurately in position and attach securely to supports with plane of face panels aligned with adjacent finish surfaces.
C. Install doors flush with adjacent finish surfaces or recessed to receive finish material.

3.02 ADJUSTING AND CLEANING
A. Adjust doors and hardware after installation for proper operation.
B. Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

END OF SECTION
SECTION 08 41 13

ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

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. Exterior and interior storefront framing.
   2. Storefront framing for punched openings.
   3. Vents.
   4. Exterior and interior manual-swing entrance doors and door-frame units.
B. Related Sections:
   1. Division 01 Section "Sustainable Design Requirements" for additional LEED requirements.
   2. Division 08 Section "Glazed Aluminum Curtain Walls" for curtain-wall systems that mechanically retain glazing on four sides.
   3. Division 08 Section "Louvers And Vents" for units installed with aluminum-framed systems.

1.03 DEFINITIONS
A. ADA/ABA Accessibility Guidelines: U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disability Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities."

1.04 PERFORMANCE REQUIREMENTS
A. General Performance: Aluminum-framed systems shall withstand the effects of the following performance requirements without exceeding performance criteria or failure due to defective manufacture, fabrication, installation, or other defects in construction:
   1. Movements of supporting structure indicated on Drawings including, but not limited to, story drift and deflection from uniformly distributed and concentrated live loads.
   2. Dimensional tolerances of building frame and other adjacent construction.
   3. Failure includes the following:
      a. Deflection exceeding specified limits.
      b. Thermal stresses transferring to building structure.
      c. Framing members transferring stresses, including those caused by thermal and structural movements to glazing.
      d. Glazing-to-glazing contact.
      e. Noise or vibration created by wind and by thermal and structural movements.
      f. Loosening or weakening of fasteners, attachments, and other components.
      g. Sealant failure.
      h. Failure of operating units.
B. Delegated Design: Design aluminum-framed systems, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

C. Structural Loads:
   1. Wind Loads: As indicated on Drawings.
   2. Seismic Loads: As indicated on Drawings.
   3. Blast Loads: As indicated on Drawings.

D. Deflection of Framing Members:
   1. Deflection Normal to Wall Plane: Limited to 1/175 of clear span for spans up to 13 feet 6 inches and to 1/240 of clear span plus 1/4 inch for spans greater than 13 feet 6 inches or an amount that restricts edge deflection of individual glazing lites to 3/4 inch, whichever is less.
   2. Deflection Parallel to Glazing Plane: Limited to amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that reduces edge clearance between framing members and glazing or other fixed components directly below them to less than 1/8 inch and clearance between members and operable units directly below them to less than 1/16 inch.

E. Structural-Test Performance: Provide aluminum-framed systems tested according to ASTM E 330 as follows:
   1. When tested at positive and negative wind-load design pressures, systems do not evidence deflection exceeding specified limits.
   2. When tested at 150 percent of positive and negative wind-load design pressures, systems, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 percent of span.
   3. Test Durations: As required by design wind velocity, but not fewer than 10 seconds.

F. Story Drift: Provide aluminum-framed systems that accommodate design displacement of adjacent stories indicated.
   1. Design Displacement: Building height divided by 400.
   2. Test Performance: Meet criteria for passing, based on building occupancy type, when tested according to AAMA 501.4 at design displacement and 1.5 times design displacement.

G. Air Infiltration: Provide aluminum-framed systems with maximum air leakage through fixed glazing and framing areas of 0.06 cfm/sq. ft. of fixed wall area when tested according to ASTM E 283 at a minimum static-air-pressure difference of 1.57 lbf/sq. ft.

H. Water Penetration under Static Pressure: Provide aluminum-framed systems that do not evidence water penetration through fixed glazing and framing areas when tested according to ASTM E 331 at a minimum static-air-pressure difference of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft.

I. Water Penetration under Dynamic Pressure: Provide aluminum-framed systems that do not evidence water leakage through fixed glazing and framing areas when tested according to AAMA 501.1 under dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft.
   1. Maximum Water Leakage: No uncontrolled water penetrating aluminum-framed systems or water appearing on systems' normally exposed interior surfaces from sources other than condensation. Water leakage does not include water controlled by flashing and gutters that is drained to exterior and water that cannot damage adjacent materials or finishes.

J. Thermal Movements: Provide aluminum-framed systems that allow for thermal movements resulting from the following maximum change (range) in ambient and surface
temperatures. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
2. Interior Ambient-Air Temperature: 75 deg F.

K. Condensation Resistance: Provide aluminum-framed systems with fixed glazing and framing areas having condensation-resistance factor (CRF) of not less than 53 when tested according to AAMA 1503.

L. Thermal Conductance: Provide aluminum-framed systems with fixed glazing and framing areas having an average U-factor of not more than 0.57 Btu/sq. ft. x h x deg F when tested according to AAMA 1503.

M. Sound Transmission: Provide aluminum-framed systems with fixed glazing and framing areas having the following sound-transmission characteristics:

1. Sound Transmission Class (STC): Minimum 35 STC when tested for laboratory sound transmission loss according to ASTM E 90 and determined by ASTM E 413.

N. Structural Sealant: Capable of withstanding tensile and shear stresses imposed by aluminum-framed systems without failing adhesively or cohesively. When tested for preconstruction adhesion and compatibility, cohesive failure of sealant shall occur before adhesive failure.

1. Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind.
2. Cohesive failure occurs when sealant breaks or tears within itself but does not separate from each substrate because sealant-to-substrate bond strength exceeds sealant’s internal strength.

O. Structural-Sealant Joints: Designed to produce tensile or shear stress of less than 20 psi.

1.05 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for aluminum-framed systems.

B. LEED Submittals:

1. Credits MR 5.1 and 5.2: Regionally Extracted, Harvested, or Recovered and Manufactured Materials:
   a. Indicate location of manufacturing facility, including name, address, and distance between manufacturing facility and the project site. Provide manufacturer’s documentation indicating location where the base materials were extracted, mined, quarried, harvested, etc., and the distance between this location and the project site. Also include material costs, excluding cost of installation.

2. Product Data for Credit EQ 4.1: For sealants, including printed statement of VOC content.

C. Shop Drawings: For aluminum-framed systems. Include plans, elevations, sections, details, and attachments to other work.

1. Include details of provisions for system expansion and contraction and for drainage of moisture in the system to the exterior.

D. Samples: For each type of exposed finish required, in manufacturer’s standard sizes.
E. Other Action Submittals:
   1. Entrance Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams. Coordinate final entrance door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of entrance door hardware.

F. Delegated-Design Submittal: For aluminum-framed systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Detail fabrication and assembly of aluminum-framed systems.
   2. Include design calculations.

G. Certificates: Submit certificates showing system performance regarding withstanding thermal movements, deflections, air infiltration per ASTM E283, water penetration per ASTM E331, and condensation resistance factor (CRF) per AAMA 1503.

H. Field quality-control reports.

I. Maintenance Data: For aluminum-framed systems to include in maintenance manuals.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
   1. Minimum five years experience in the installation of aluminum storefront framing systems of type specified for the project.

B. Manufacturer's Qualifications: Minimum five years experience in the manufacture of aluminum storefront framing systems of type specified for the project.

C. Testing Agency Qualifications: Qualified according to ASTM E 699 for testing indicated.

D. Engineering Responsibility: Prepare data for aluminum-framed systems, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in systems similar to those indicated for this Project.

E. Product Options: Information on Drawings and in Specifications establishes requirements for systems' aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.
   1. Do not revise intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If revisions are proposed, submit comprehensive explanatory data to Architect for review.


G. Source Limitations for Aluminum-Framed Systems: Obtain from single source from single manufacturer.

H. Welding Qualifications: Qualify procedures and personnel according to AWS D1.2, "Structural Welding Code - Aluminum."

I. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
   1. Build mockup of typical wall area as shown on Drawings.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

J. Preinstallation Conference: Conduct conference at Project site.

1.07 PROJECT CONDITIONS
A. Field Measurements: Verify actual locations of structural supports for aluminum-framed systems by field measurements before fabrication and indicate measurements on Shop Drawings.

1.08 WARRANTY
A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of aluminum-framed systems that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures including, but not limited to, excessive deflection.
      b. Noise or vibration caused by thermal movements.
      c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
      d. Adhesive or cohesive sealant failures.
      e. Water leakage through fixed glazing and framing areas.
      f. Failure of operating components.
   2. Warranty Period: Two years from date of Substantial Completion.

1.09 MAINTENANCE SERVICE
A. Entrance Door Hardware:
   1. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of entrance door hardware.

PART 2 - PRODUCTS

2.01 GENERAL
A. Regionally Extracted, Harvested, or Recovered and Manufactured Materials:
   1. Preference shall be given to manufacturer's whose facilities are within a 500 mile radius of the project site.
   2. Preference shall also be given to materials that are harvested, extracted, mined, quarried, etc. within a 500 mile radius of the project site.

2.02 MANUFACTURERS
A. Basis-of-Design Product: Subject to compliance with requirements, provide "Trifab II 451T" by Kawneer North America or comparable product by one of the following. Plans, elevations, details, characteristics, and other requirements indicated are based upon standards of the Basis of Design Product. Other manufacturers listed may be acceptable, provided their details and characteristics comply with size and profile requirements, and material and performance standards.
   1. Tubelite.

2.03 MATERIALS
A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
2. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221.
4. Structural Profiles: ASTM B 308/B 308M.
5. Welding Rods and Bare Electrodes: AWS A5.10/A5.10M.

B. Steel Reinforcement: Manufacturer's standard zinc-rich, corrosion-resistant primer, complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.
1. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
2. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
3. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.

2.04 FRAMING SYSTEMS

A. Framing Members: Manufacturer's standard extruded-aluminum framing members of thickness required and reinforced as required to support imposed loads.
   1. Construction: Thermally broken [Structurally glazed].
      a. Extruded sill flashing members to be thermally broken.
   2. Glazing System: [Retained mechanically with gaskets on four sides] [Retained by structural sealant at vertical edges and mechanically with gaskets at horizontal edges].
   3. Glazing Plane: [Front] [Center] [Back] [Multiplane].

B. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

C. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
   1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
   2. Reinforce members as required to receive fastener threads.
   3. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system.

D. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts, complying with ASTM A 123/A 123M or ASTM A 153/A 153M.

E. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.

F. Framing System Gaskets and Sealants: Manufacturer's standard, recommended by manufacturer for joint type.

2.05 GLAZING SYSTEMS

A. Glazing: As specified in Division 08 Section "Glazing."

B. Glazing Gaskets: Manufacturer's standard compression types; replaceable, molded or extruded, of profile and hardness required to maintain watertight seal.

C. Spacers and Setting Blocks: Manufacturer's standard elastomeric type.

D. Bond-Breaker Tape: Manufacturer's standard TFE-fluorocarbon or polyethylene material to which sealants will not develop adhesion.

E. Glazing Sealants: For structural-sealant-glazed systems, as recommended by manufacturer for joint type, and as follows:
   1. Structural Sealant: ASTM C 1184, single-component neutral-curing silicone formulation that is compatible with system components with which it comes in
contact, specifically formulated and tested for use as structural sealant and approved by a structural-sealant manufacturer for use in aluminum-framed systems indicated.

a. Color: [Black] [As selected by Architect from manufacturer's full range of colors].

2. Weatherseal Sealant: ASTM C 920 for Type S, Grade NS, Class 25, Uses NT, G, A, and O; single-component neutral-curing formulation that is compatible with structural sealant and other system components with which it comes in contact; recommended by structural-sealant, weatherseal-sealant, and aluminum-framed-system manufacturers for this use.


2.06 VENTS

A. General: Provide ventilating units designed for integration into storefront framing system.

B. Projected Vents: Provide the following operating hardware:

1. Hinge: Concealed four- or six-bar friction hinge with adjustable-slide friction shoe; two per ventilator.
2. Lock: Cam-action, sweep lock handle with strike; [one] [two] <Insert number> per ventilator.
3. Lock: Pole-operated, [spring-catch lock and keeper] [cam-action, sweep lock handle and strike].
4. Limit Device: Concealed support arms with adjustable, limited, hold-open limit device; located on jamb of each ventilator.

C. Projected Awning Vents: Provide the following operating hardware:

1. Operator: Gear-type rotary operator located on jamb at sill.
   a. Handle: [Standard crank] [Folding crank] [Removable crank].
2. Hinge: Concealed four- or six-bar friction hinge located on each jamb near top rail; two per ventilator.
3. Lock: Lift-type throw, cam-action lock with keeper; [one] [two] <Insert number> per ventilator.
4. Lock: Pole-operated, [combination handle and cam-action lock] [face-mounted transom latch] and keeper.
5. Limit Device: Concealed support arms with adjustable, limited, hold-open limit device; located on jamb of each ventilator.

2.07 ENTRANCE DOOR SYSTEMS

A. Basis of Design: "350 TUFFLINE" by Kawneer Company, Inc.

1. Door Construction: 2-inch overall thickness, with minimum 0.188-inch thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.
2. Door Design: Medium stile; 3-1/2-inch nominal width.
   a. Framing members shall provide for flush glazing on all sides with through sight lines, with no projecting stops or face joints.
   b. Design Wind Load: Capable of withstanding a positive or negative pressure of 30 psf when tested in accordance with ASTM E330.
   c. Accessible Doors: Smooth surfaced for width of door in area within 10 inches above floor or ground plane.
   a. Provide nonremovable glazing stops on outside of door.

B. Entrance Door Hardware: As scheduled in Division 08 Section "Door Hardware."
2.08 ENTRANCE DOOR HARDWARE

A. General: Provide entrance door hardware for each entrance door to comply with requirements in this Section.

B. Removable Mullion Fittings: Manufacturer's standard device or frame preparation for attachment of removable mullion to be provided by others.

C. Astragals: Manufacturer's standard.

D. Weather Stripping: Manufacturer's standard replaceable components.
   1. Compression Type: Made of ASTM D 2000, molded neoprene, or ASTM D 2287, molded PVC.
   2. Sliding Type: AAMA 701, made of wool, polypropylene, or nylon woven pile with nylon-fabric or aluminum-strip backing.

E. Weather Sweeps: Manufacturer's standard exterior-door bottom sweep with concealed fasteners on mounting strip.

F. Thresholds: BHMA A156.21, raised thresholds beveled with a slope of not more than 1:2, with maximum height of 1/2 inch.

2.09 ACCESSORY MATERIALS

A. Joint Sealants: For installation at perimeter of aluminum-framed systems, as specified in Division 07 Section "Joint Sealants."

B. Bituminous Paint: Cold-applied, asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos; formulated for 30-mil thickness per coat.

2.10 FABRICATION

A. Form or extrude aluminum shapes before finishing.

B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

C. Framing Members, General: Fabricate components that, when assembled, have the following characteristics:
   1. Profiles that are sharp, straight, and free of defects or deformations.
   2. Accurately fitted joints with ends coped or mitered.
   3. Means to drain water passing joints, condensation within framing members, and moisture migrating within the system to exterior.
   4. Physical and thermal isolation of glazing from framing members.
   5. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
   6. Provisions for field replacement of glazing from [exterior] [interior] [interior for vision glass and exterior for spandrel glazing or metal panels].
   7. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.

E. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.
   1. At exterior doors, provide compression weather stripping at fixed stops.
   2. At interior doors, provide silencers at stops to prevent metal-to-metal contact. Install three silencers on strike jamb of single-door frames and two silencers on head of frames for pairs of doors.
F. Entrance Doors: Reinforce doors as required for installing entrance door hardware.  
   1. At pairs of exterior doors, provide sliding-type weather stripping retained in 
      adjustable strip and mortised into door edge.  
   2. At exterior doors, provide weather sweeps applied to door bottoms.  

G. Entrance Door Hardware Installation: Factory install entrance door hardware to the 
   greatest extent possible. Cut, drill, and tap for factory-installed entrance door hardware 
   before applying finishes.  

H. After fabrication, clearly mark components to identify their locations in Project according 
   to Shop Drawings.  

2.11 ALUMINUM FINISHES  
A. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker. 
   1. Color: Dark bronze.  

PART 3 - EXECUTION  
3.01 EXAMINATION  
A. Examine areas and conditions, with Installer present, for compliance with requirements 
   for installation tolerances and other conditions affecting performance of the Work.  
B. Proceed with installation only after unsatisfactory conditions have been corrected.  

3.02 INSTALLATION  
A. General:  
   1. Comply with manufacturer's written instructions.  
   2. Do not install damaged components.  
   3. Fit joints to produce hairline joints free of burrs and distortion.  
   4. Rigidly secure non-movement joints.  
   5. Install anchors with separators and isolators to prevent metal corrosion and 
      electrolytic deterioration.  
   6. Seal joints watertight unless otherwise indicated.  
B. Metal Protection:  
   1. Where aluminum will contact dissimilar metals, protect against galvanic action by 
      painting contact surfaces with primer or applying sealant or tape, or by installing 
      nonconductive spacers as recommended by manufacturer for this purpose.  
   2. Where aluminum will contact concrete or masonry, protect against corrosion by 
      painting contact surfaces with bituminous paint.  
C. Install components to drain water passing joints, condensation occurring within framing 
   members, and moisture migrating within the system to exterior.  
D. Set continuous sill members and flashing in full sealant bed as specified in Division 07 
   Section "Joint Sealants" to produce weathertight installation.  
E. Install components plumb and true in alignment with established lines and grades, and 
   without warp or rack.  
F. Install glazing as specified in Division 08 Section "Glazing."
G. Entrance Doors: Install doors to produce smooth operation and tight fit at contact points.  
   1. Exterior Doors: Install to produce weathertight enclosure and tight fit at weather 
      stripping.  
   2. Field-Installed Entrance Door Hardware: Install surface-mounted entrance door 
      hardware according to entrance door hardware manufacturers' written 
      instructions using concealed fasteners to greatest extent possible.
H. Install perimeter joint sealants as specified in Division 07 Section "Joint Sealants" to produce weathertight installation.

3.03 ERECTION TOLERANCES

A. Install aluminum-framed systems to comply with the following maximum erection tolerances:
   1. Location and Plane: Limit variation from true location and plane to 1/8 inch in 12 feet; 1/4 inch over total length.
   2. Alignment:
      a. Where surfaces abut in line, limit offset from true alignment to 1/16 inch.
      b. Where surfaces meet at corners, limit offset from true alignment to 1/32 inch.

B. Diagonal Measurements: Limit difference between diagonal measurements to 1/8 inch.

3.04 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections.

B. Testing Services: Testing and inspecting of representative areas to determine compliance of installed systems with specified requirements shall take place as follows. Do not proceed with installation of the next area until test results for previously completed areas show compliance with requirements.
   1. Water Spray Test: Before installation of interior finishes has begun, areas designated by Architect shall be tested according to AAMA 501.2 and shall not evidence water penetration.
      a. Test Area: 3 punched-opening assemblies, to include operable vent.

C. Repair or remove work if test results and inspections 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.

E. Aluminum-framed assemblies will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.05 ADJUSTING

A. Adjust operating entrance door hardware to function smoothly as recommended by manufacturer.
   1. For entrance doors accessible to people with disabilities, adjust closers to provide a 3-second closer sweep period for doors to move from a 70-degree open position to 3 inches from the latch, measured to the leading door edge.

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. This Section includes
1. Conventionally glazed aluminum curtain walls installed as stick systems.
B. Related Sections include the following:
1. Division 01 Section "Sustainable Design Requirements" for additional LEED requirements.
2. Division 07 Section "Thermal Insulation" for insulation materials field installed with glazed aluminum curtain-wall systems.
3. Division 07 Section "Joint Sealants" for installation of joint sealants installed with glazed aluminum curtain-wall systems and for sealants to the extent not specified in this Section.
4. Division 08 Section "Aluminum-Framed Entrances and Storefronts" for entrance systems installed with glazed aluminum curtain-wall systems.
5. Division 08 Section "Glazing" for insulating-glass requirements.
6. Division 08 Section "Louvers and Vents" for units installed with glazed aluminum curtain-wall systems.

1.03 PERFORMANCE REQUIREMENTS
A. General: Provide glazed aluminum curtain-wall systems, including anchorage, capable of withstanding, without failure, the effects of the following:
1. Structural loads.
2. Thermal movements.
3. Movements of supporting structure indicated on Drawings including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
4. Dimensional tolerances of building frame and other adjacent construction.
5. Failure includes the following:
   a. Deflection exceeding specified limits.
   b. Thermal stresses transferred to building structure.
   c. Framing members transferring stresses, including those caused by thermal and structural movements, to glazing.
   d. Noise or vibration created by wind and thermal and structural movements.
   e. Loosening or weakening of fasteners, attachments, and other components.
   f. Sealant failure.
B. Delegated Design: Design glazed aluminum curtain wall assembly, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
C. Structural Loads:
   1. Wind Loads: As indicated on Drawings.
2. Seismic Loads: As indicated on Drawings.
4. Building Super-Structure: Framing members have not been designed to accept gravity loads from curtain wall assemblies. Notify Architect if design imposes gravity loads on building structure.

D. Structural-Test Performance: Provide glazed aluminum curtain-wall systems tested according to ASTM E 330 as follows:
1. When tested at positive and negative wind-load design pressures, systems do not evidence deflection exceeding specified limits.
2. When tested at 150 percent of positive and negative wind-load design pressures, systems, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 percent of span.
3. Test Duration: As required by design wind velocity but not less than 60 seconds.

E. Deflection of Framing Members:
1. Deflection Normal to Wall Plane: Limited to 1/175 of clear span for spans up to 13 feet 6 inches and to 1/240 of clear span plus 1/4 inch for spans greater than 13 feet 6 inches or an amount that restricts edge deflection of individual glazing lites to 3/4 inch, whichever is less.
2. Deflection Parallel to Glazing Plane: Limited to amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and which reduces edge clearance between framing members and glazing or other fixed components to less than 1/8 inch.
   a. Operable Units: Provide a minimum 1/16-inch clearance between framing members and operable units.
3. Cantilever Deflection: Where framing members overhang an anchor point, limited to 2 times the length of cantilevered member, divided by 175.

F. Story Drift: Provide glazed aluminum curtain-wall systems that accommodate design displacement of adjacent stories indicated.
1. Design Displacement: Building height divided by 400.
2. Test Performance: No glass breakage, anchor failures, or structural damage when tested according to AAMA 501.4.

G. Thermal Movements: Provide glazed aluminum curtain-wall systems that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
2. Test Performance: No buckling, stress on glass, glazing-edge seal failure, sealant failure, excess stress on curtain-wall framing, anchors and fasteners, or reduction of performance when tested according to AAMA 501.5.
   a. Test High Exterior Ambient Air Temperature: That which produces an exterior metal surface temperature of 180 deg F.
   b. Test Low Exterior Ambient Air Temperature: 0 deg F.
   c. Test Interior Ambient Air Temperature: 75 deg F.

H. Air Infiltration: Provide glazed aluminum curtain-wall systems with maximum air leakage of 0.06 cfm/sq. ft. of fixed wall area when tested according to ASTM E 283 at a minimum static-air-pressure differential of 1.57 lbf/sq. ft.

I. Water Penetration Under Static Pressure: Provide aluminum glazed curtain-wall systems that do not evidence water penetration when tested according to ASTM E 331 at a
minimum differential static pressure of 20 percent of positive design wind load, but not less than 10 lb/sq. ft.

J. Water Penetration Under Dynamic Pressure: Provide glazed aluminum curtain-wall systems that do not evidence water leakage when tested according to AAMA 501.1 under dynamic pressure equal to 20 percent of positive design wind load, but not less than 10 lb/sq. ft.
   1. Maximum Water Leakage: No uncontrolled water penetrating systems or appearing on systems' normally exposed interior surfaces from sources other than condensation. Water controlled by flashing and gutters that is drained to exterior and cannot damage adjacent materials or finishes is not considered water leakage.

K. Condensation Resistance: Provide glazed aluminum curtain-wall systems with condensation-resistance factor (CRF) of not less than 55 when tested according to AAMA 1503.

L. Average Thermal Conductance: Provide glazed aluminum curtain-wall systems with average U-factor of not more than 0.66 Btu/sq. ft. x h x deg F when tested according to AAMA 1503.

M. Sound Transmission: Provide glazed aluminum curtain-wall systems with minimum STC 32 according to ASTM E 413 and an OITC 26 according to ASTM E 1332, as determined by testing according to ASTM E 90.

1.04 SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of product indicated.

B. Shop Drawings: Prepared by or under the supervision of a qualified professional engineer detailing fabrication and assembly of glazed aluminum curtain-wall systems.
   1. Include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Samples: For each type of exposed finish required, in manufacturer's standard sizes.

D. LEED Submittals:
   1. Credits MR 5.1 and 5.2: Regionally Extracted, Harvested, or Recovered and Manufactured Materials:
      a. Indicate location of manufacturing facility, including name, address, and distance between manufacturing facility and the project site. Provide manufacturer's documentation indication location where the base materials were extracted, mined, quarried, harvested, etc., and the distance between this location and the project site. Also include material costs, excluding cost of installation.
   2. Product Data for Credit EQ 4.1: For sealants, including printed statement of VOC content.

E. Field quality-control test reports.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Capable of assuming engineering responsibility and performing Work of this Section and who is acceptable to manufacturer.
   1. Engineering Responsibility: Preparation of data for glazed aluminum curtain-wall systems including the following:
      a. Shop Drawings based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for
B. Testing Agency Qualifications: An independent agency qualified according to ASTM E 699 for testing indicated.

C. Product Options: Information on Drawings and in Specifications establishes requirements for systems’ aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.

1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.

D. Welding: Qualify procedures and personnel according to AWS D1.2, "Structural Welding Code—Aluminum."

E. Mockups: Build mockups to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1. Build mockup of typical wall area as shown on Drawings.

F. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." Review methods and procedures related to glazed aluminum curtain-wall systems including, but not limited to, the following:

1. Review structural load limitations.
2. Review and finalize construction schedule and verify availability of materials, Installer’s personnel, equipment, and facilities needed to make progress and avoid delays.
3. Review required testing, inspecting, and certifying procedures.

1.06 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of structural supports for glazed aluminum curtain-wall systems by field measurements before fabrication and indicate measurements on Shop Drawings.

1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating glazed aluminum curtain-wall systems without field measurements. Coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.07 WARRANTY

A. Special Assembly Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components of glazed aluminum curtain-wall systems that do not comply with requirements or that deteriorate as defined in this Section within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Structural failures including, but not limited to, excessive deflection.
   b. Noise or vibration caused by thermal movements.
   c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
   d. Water leakage.
   e. Failure of operating components to function normally.

2. Warranty Period: Five years from date of Substantial Completion.
B. Special Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components on which finishes fail within specified warranty period. Warranty does not include normal weathering.
   1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 GENERAL
   A. Regionally Extracted, Harvested, or Recovered and Manufactured Materials:
      1. Preference shall be given to manufacturer's whose facilities are within a 500 mile radius of the project site.
      2. Preference shall also be given to materials that are harvested, extracted, mined, quarried, etc. within a 500 mile radius of the project site.

2.02 BASIS OF DESIGN PRODUCT
   A. The design for glazed aluminum curtain-wall systems is based on 1600 Wall by Kawneer Company, Inc. Subject to compliance with requirements, provide the named product or a comparable product by one of the following. Plans, elevations, details, characteristics, and other requirements indicated are based upon standards of the Basis of Design Product. Other manufacturers listed may be acceptable, provided their details and characteristics comply with size and profile requirements, and material and performance standards.
      1. Tubelite, Inc.
      2. Wausau Window and Wall Systems.

2.03 FRAMING SYSTEMS
   A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
      2. Extruded Bars, Rods, Shapes, and Tubes: ASTM B 221.
      4. Welding Rods and Bare Electrodes: AWS A5.10/A5.10M.
   B. Steel Reinforcement: With manufacturer's standard corrosion-resistant primer complying with SSPC-PS Guide No. 12.00 applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.
      1. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
      2. Cold-Rolled Sheet and Strip: ASTM A 611.
      3. Hot-Rolled Sheet and Strip: ASTM A 570/A 570M.
   C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.
   D. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
      1. Where fasteners are subject to loosening or turn out from thermal and structural movements, wind loads, or vibration, use self-locking devices.
      2. Reinforce members as required to receive fastener threads.
      3. Use exposed fasteners with countersunk Phillips screw heads.
      4. Finish exposed portions to match framing system.
      5. At movement joints, use slip-joint linings, spacers, and sleeves of material and type recommended by manufacturer.
E. Anchors: Three-way adjustable anchors that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.
   1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123/A 123M or ASTM A 153/A 153M requirements.
F. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.
G. Framing Gaskets: As recommended by manufacturer for joint type.
H. Framing Sealants: As recommended by manufacturer for joint type.

2.04 GLAZING SYSTEMS
A. Glazing: As specified in Division 08 Section "Glazing."
B. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.
C. Glazing Sealants: As recommended by manufacturer for joint type.

2.05 OPERABLE UNITS
A. Doors: As specified in Division 08 Section "Aluminum-Framed Entrances and Storefronts."

2.06 ACCESSORY MATERIALS
B. Insulating Materials: Specified in Division 07 Section "Thermal Insulation."
C. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil thickness per coat.

2.07 FABRICATION
A. Form aluminum shapes before finishing.
B. Fabricate components that, when assembled, have the following characteristics:
   1. Sharp profiles, straight and free of defects or deformations.
   2. Accurately fitted joints with ends coped or mitered.
   3. Internal guttering systems or other means to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.
   4. Physical and thermal isolation of glazing from framing members.
   5. Accommodations for thermal and mechanical movements of glazing and framing to prevent glazing-to-glazing contact and to maintain required glazing edge clearances.
   6. Provisions for reglazing from interior for vision glass and exterior for spandrel glazing or panels.
C. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
D. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.
2.08 ALUMINUM FINISHES

A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

C. Class I, Color Anodic Finish: AA-M12C22A42/A44 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.
   1. Color: Dark bronze.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. General:
   1. Comply with manufacturer's written instructions.
   2. Do not install damaged components.
   3. Fit joints to produce hairline joints free of burrs and distortion.
   4. Rigidly secure nonmovement joints.
   5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
   6. Weld components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.
   7. Seal joints watertight, unless otherwise indicated.

B. Metal Protection:
   1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape or installing nonconductive spacers as recommended by manufacturer for this purpose.
   2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

C. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.

D. Install components plumb and true in alignment with established lines and grades.

E. Install operable units level and plumb, securely anchored, and without distortion. Adjust weather-stripping contact and hardware movement to produce proper operation.

F. Install glazing as specified Division 08 Section "Glazing."

G. Install sealants as specified in Division 07 Section "Joint Sealants."

H. Install insulation materials as specified in Division 07 Section "Thermal Insulation."

I. Install perimeter fire-containment systems (saflng insulation) as specified in Division 07 Section "Fire-Resistive Joint Systems."

J. Erection Tolerances: Install glazed aluminum curtain-wall systems to comply with the following maximum tolerances:
1. Plumb: 1/8 inch in 10 feet; 1/4 inch in 40 feet.
2. Level: 1/8 inch in 20 feet; 1/4 inch in 40 feet.
3. Alignment:
   a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch wide, limit offset from true alignment to 1/16 inch.
   b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch wide, limit offset from true alignment to 1/8 inch.
   c. Where surfaces are separated by reveal or protruding element of 1 inch wide or greater, limit offset from true alignment to 1/4 inch.
4. Location: Limit variation from plane to 1/8 inch in 12 feet; 1/2 inch over total length.

3.03 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Testing Services: Testing and inspecting of representative areas to determine compliance of installed system with specified requirements shall take place as follows and in successive stages as indicated on Drawings. Do not proceed with installation of the next area until test results for previously completed areas show compliance with requirements.

1. Water Spray Test: After the installation glazed aluminum curtain-wall system has been completed but before installation of interior finishes has begun, a portion of system designated by Architect shall be tested according to AAMA 501.2 and shall not evidence water penetration.

C. Repair or remove work where test results and inspections 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 08 63 00
METAL-FRAMED SKYLIGHTS

PART 1 - GENERAL

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

1.02 SUMMARY
A. This Section includes:
   1. Aluminum-framed skylights with the following characteristics:
      a. Glazing is glass.
      b. Glazing is retained by field-installed structural silicone at horizontal joints and pressure caps above rafters.
   2. Delegated Designs services by an Engineer licensed in the State in which the Project is to be constructed for the Work specified in this Section.

B. Related Sections include the following:
   1. Division 05 Section "Structural Steel Framing" for steel framing that supports skin-system assemblies.
   2. Division 07 Section "Thermal Insulation" for insulation materials field installed with metal-framed skylights.
   3. Division 07 Section "Sheet Metal Flashing and Trim" for metal flashings installed at perimeters of assemblies.
   4. Division 07 Section "Joint Sealants" for sealants installed at perimeters of metal-framed skylights.
   5. Division 08 Section "Glazing" for glass units installed in metal-framed skylights.

1.03 PERFORMANCE REQUIREMENTS
A. Provide metal-framed skylights, including anchorage, capable of withstanding, without failure, the effects of the following:
   1. Structural loads.
   2. Thermal movements.
   3. Movements of supporting structure.
   4. Dimensional tolerances of building frame and other adjacent construction.

B. Failure includes the following:
   1. Deflection exceeding specified limits.
   2. Water leakage.
   3. Thermal stresses transferred to building structure.
   4. Noise or vibration created by wind and thermal and structural movements.
   5. Framing members transferring stresses, including those caused by thermal and structural movements, to glazing.
   6. Loosening or weakening of fasteners, attachments, and other components.
   7. Sealant failure.

C. Structural Loads:
   1. Wind Loads: As indicated by structural design data on Drawings.
   2. Snow Loads: As indicated by structural design data on Drawings.
   3. Concentrated Live Loads: 250 lbf applied to framing members at locations that will produce greatest stress or deflection.
   4. Load Combinations: Calculate according to requirements of applicable code indicated on Drawings.
D. Deflection of Framing Members:
1. Deflection Normal to Glazing Plane:
   a. Spans Up to 20 Feet: Limited to 1/175 of clear span or 1 inch, whichever is smaller.
   b. Spans Exceeding 20 Feet: Limited to 1/240 of clear span.
   c. Glass Edge Deflection: Limit edge deflection of individual glass lites to 3/4 inch.
2. Deflection Parallel to Glazing Plane: Limited to 1/360 of clear span or 1/8 inch, whichever is smaller.

E. Lateral Bracing of Framing Members: Compression flanges of flexural members are laterally braced by cross members with minimum depth equal to 50 percent of flexural member that is braced. Glazing does not provide lateral support.

F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

1.04 PERFORMANCE TESTING

A. Provide metal-framed skylights that comply with test-performance requirements indicated, as evidenced by reports of tests performed on manufacturer's standard assemblies at a pitch equal to or less than that required for this project by a qualified independent testing agency.

B. Structural-Performance Test: ASTM E 330.
1. Performance at Design Load: When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
2. Performance at Maximum Test Load: When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main supporting members exceeding 0.2 percent of span.
3. Test Durations: As required by design wind velocity but not less than 10 seconds.

C. Air-Infiltration Test: ASTM E 283.
2. Maximum Air Leakage: 0.06 cfm/sq. ft.

D. Test for Water Penetration under Static Pressure: ASTM E 331.
1. Minimum Static-Air-Pressure Difference: 20 percent of positive wind-load design pressure, but not less than 15 lbf/sq. ft.
2. Water Leakage: None.

E. Test for Water Penetration under Dynamic Pressure: AAMA 501.1.
1. Dynamic Pressure: 20 percent of positive wind-load design pressure, but not less than 15 lbf/sq. ft.
2. Water Leakage: No uncontrolled water penetrating systems or appearing on systems' normally exposed interior surfaces from sources other than condensation. Water controlled by flashing and gutters that is drained to exterior and cannot damage adjacent materials or finishes is not considered water leakage.
1.05 SUBMITTALS
A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for metal-framed skylights.
B. Shop Drawings: For metal-framed skylights. Include plans, elevations, sections, details, and attachments to other work.
   1. Include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
C. Samples: For each type of exposed finish required, in manufacturer's standard sizes.
D. Field quality-control test and inspection reports.
E. Maintenance Data: For metal-framed skylights to include in maintenance manuals.

1.06 QUALITY ASSURANCE
A. Installer Qualifications: Entity capable of assuming engineering responsibility and performing work of this Section and who is acceptable to manufacturer.
B. Testing Agency Qualifications: An independent agency qualified according to ASTM E 699 for testing indicated.
C. Product Options: Information on Drawings and in Specifications establishes requirements for skylights' aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including testing conducted by an independent testing agency and in-service performance.
   1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.
D. Welding: Qualify procedures and personnel according to AWS D1.2, "Structural Welding Code - Aluminum."
E. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.07 PROJECT CONDITIONS
A. Field Measurements: Indicate measurements on Shop Drawings.

1.08 WARRANTY
A. Special Assembly Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal-framed skylights that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures including, but not limited to, excessive deflection.
      b. Noise or vibration caused by thermal movements.
      c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
      d. Adhesive or cohesive sealant failures.
      e. Water leakage.
   2. Warranty Period: Five years from date of Substantial Completion.
PART 2 - PRODUCTS

2.01 MANUFACTURERS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product: The design for metal-framed skylights is based on Structural Ridge by Skyline Sky-Lites, LLC. Subject to compliance with requirements, provide the named product or a comparable product by one of the following:
   1. Architectural Skylights
   2. Naturalite Skylight Systems; Vistawall Group (The).

2.02 FRAMING SYSTEMS
A. Aluminum: Alloy and temper recommended in writing by manufacturer for type of use and finish indicated.
   2. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221.

B. Pressure Caps: Manufacturer's standard aluminum components that mechanically retain glazing.
   1. Include snap-on aluminum trim that conceals fasteners.

C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning skylight components.

D. Anchors, Fasteners, and Accessories: Manufacturer's standard, corrosion-resistant, nonstaining, and nonbleeding; compatible with adjacent materials.
   1. At pressure caps, use ASTM A 193/A 193M, 300 series stainless-steel screws.
   2. Where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration, use self-locking devices.
   3. Exposed Fasteners:
      a. Use exposed fasteners with countersunk Phillips screw heads.
      b. Finish exposed portions to match framing system.
   4. At movement joints, use slip-joint linings, spacers, and sleeves of material and type recommended in writing by manufacturer.

E. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123/A 123M or ASTM A 153/A 153M requirements.


G. Concealed Flashing: Manufacturer's standard, corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.

H. Exposed Flashing and Closures: Manufacturer's standard aluminum components not less than 0.040 inch thick.

I. Framing Gaskets: Manufacturer's standard.

J. Framing Sealants: As recommended in writing by manufacturer.

2.03 GLAZING SYSTEMS
A. Glazing: As specified in Division 08 Section "Glazing."

B. Spacers, Setting Blocks, and Gaskets: Manufacturer's standard elastomeric types.

C. Glazing Sealants: As recommended in writing by manufacturer.
2.04 ACCESSORY MATERIALS

A. Insulating Materials: Specified in Division 07 Section "Thermal Insulation."

B. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil thickness per coat.

2.05 FABRICATION

A. Fabricate aluminum components before finishing.

B. Fabricate aluminum components that, when assembled, have the following characteristics:
   1. Profiles that are sharp, straight, and free of defects or deformations.
   2. Accurately fitted joints with ends coped or mitered.
   3. Internal guttering systems or other means to drain water passing joints, condensation occurring within framing members, and moisture migrating within skylight to exterior.
   4. Physical and thermal isolation of glazing from framing members.
   5. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.

C. Fabricate aluminum sill closures with weep holes and for installation as continuous component.

D. Reinforce aluminum components as required to receive fastener threads.

E. Weld aluminum components in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

F. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.06 ALUMINUM FINISHES

A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

C. Class I, Color Anodic Finish: AA-M12C22A42/A44 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. General:
   1. Comply with manufacturer's written instructions.
2. Do not install damaged components.
3. Fit joints between aluminum components to produce hairline joints free of burrs and distortion.
4. Rigidly secure nonmovement joints.
5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
6. Weld components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.
7. Seal joints watertight, unless otherwise indicated.

B. Metal Protection: Where aluminum will contact dissimilar materials, protect against galvanic action by painting contact surfaces with bituminous paint or by installing nonconductive spacers as recommended in writing by manufacturer for this purpose.

C. Install continuous aluminum sill closure with weatherproof expansion joints and locked and sealed or welded corners. Locate weep holes at rafters.

D. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within skylight to exterior.

E. Install components plumb and true in alignment with established lines and elevations.

F. Install glazing as specified in Division 08 Section "Glazing."

G. Install insulation materials as specified in Division 07 Section "Thermal Insulation."

H. Erection Tolerances: Install metal-framed skylights to comply with the following maximum tolerances:
   1. Alignment: Limit offset from true alignment to 1/32 inch where surfaces abut in line, edge to edge, at corners, or where a reveal or protruding element separates aligned surfaces by less than 3 inches; otherwise, limit offset to 1/8 inch.
   2. Location and Plane: Limit variation from true location and plane to 1/8 inch in 12 feet but no greater than 1/2 inch over total length.

3.03 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test and inspection reports.

B. Testing Services: Testing and inspecting of representative areas to determine compliance of installed skylights with specified requirements shall take place as follows and in successive stages as indicated on Drawings. Do not proceed with installation of the next area until test results for previously completed areas show compliance with requirements.
   1. Water-Spray Test: Before installation of interior finishes has begun, skylights shall be tested according to AAMA 501.2 and shall not evidence water penetration.

C. Repair or remove work where test results and inspections 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 08 71 00
DOOR HARDWARE

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. Furnish and install all commercial door hardware and electrified door hardware as shown on the Drawings or specified herein, or as required to complete the Work.

B. Intent of Hardware Groups:
1. The following schedule of hardware sets shall be considered a guide only, and the supplier is cautioned to refer to general conditions, special conditions, and the preamble of this section. It shall be the hardware supplier's responsibility to furnish all required hardware.

2. Where items of hardware aren't definitely or correctly specified and are required for completion of the Work, a written statement of such omission, error, or other discrepancy shall be sent to the Architect, prior to date specified for receipt of bids for clarification by addendum; or, furnish such items in the type and quality established by this specification, and appropriate to the service intended.

3. Adjustments to the Contract Sum will not be allowed for omissions or items of hardware not clarified prior to bid opening.

C. Related sections:
1. Division 08 Section "Flush Wood Doors" for integral intumescent seals provided as part of fire-rated labeled assemblies.

2. Division 08 Section "Access Doors and Frames" for access door hardware, including cylinders.

3. Division 08 Section "Aluminum-Framed Entrances and Storefronts" for entrance door hardware, except cylinders.

4. Division 26 Sections for connections to electrical power system and for low-voltage wiring work.

5. Division 28 Section "Access Control" for access control devices installed at door openings and provided as part of a security access system.

6. Division 28 Section "Fire Detection and Alarm" for connections to building fire alarm system.

7. Products furnished, but not installed, under this Section include the following.
   Coordinating, purchasing, delivering, and scheduling remain requirements of this Section.
   a. Pivots thresholds weather stripping and cylinders for locks specified in other Sections.
   b. Permanent cores to be installed by Owner.
      1) The Owner or Owner's Security Agent in conjunction with the supplying distributor will remove construction cores and install final cores.

1.03 REFERENCES
A. Use date of standard or code in effect as of Bid date.

B. State and Local Codes including Authority Having Jurisdiction.
C. ANSI/BHMA A156 – Builders Hardware Manufacturers Association Builders Hardware Standards.

D. NFPA – National Fire Protection Association:
   2. NFPA 105 – Smoke and Draft Control Door Assemblies.

E. UL – Underwriters Laboratories:
   1. UL10C – Fire Tests of Door Assemblies (Positive Pressure).
   2. UL 1784 - Air Leakage Tests of Door Assemblies.

F. ANSI A117.1 – Accessible and Usable Buildings and Facilities.

G. ADA – Americans with Disabilities Act.

H. DHI – Door and Hardware Institute.

I. SDI – Steel Door Institute.

J. WDMA – Window and Door Manufacturers Association.


1.04 SUBMITTALS

A. Product Data: Submit manufacturer’s complete product literature for specified hardware items, detailed installation diagrams and instructions, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Installation methods.

B. Door Hardware Schedule: Prepared by or under the supervision of the supplier’s Architectural Hardware Consultant, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
   1. Check specified hardware for suitability and adaptability to details and surrounding conditions. Indicate unsuitable items and proposed substitutions in hardware schedule.
   2. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
   3. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening.
   4. Organize door hardware sets in same order as in the Door Hardware Schedule at the end of Part 3.
   5. Content: Include the following information:
      a. Type, style, function, size, label, hand, degree of swing, and finish of each door hardware item.
      b. Manufacturer of each item.
      c. Fastenings and other pertinent information.
      d. Location of each door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
      e. Explanation of abbreviations, symbols, and codes contained in schedule.
      f. Mounting locations for door hardware.
      g. Door and frame sizes and materials.
   6. Electrified Hardware Drawings:
a. Submit elevation drawings showing relationship of all electrical hardware components to door and frame prior to electrical rough-in. Indicate number and gage of wires required.
b. Include wiring drawing showing point to point wire hook up for all components.
c. Detail interface between electrified door hardware and fire alarm, access control, security, and building control system.
d. Include system operations descriptions for each type of opening; describe each possible condition.
e. Cable Requirements
   1) Twisted, shielded, plenum-rated type cable must be used.
   2) All wiring shall run exposed above accessible ceiling or in cable troughs in riser closets.
   3) All exposed wiring shall be in containment.
   4) All cables must be fastened to the structure at least every 10 feet where not in conduit.

C. Samples:
   1. Upon request submit the following samples:
      a. Submit one sample of each type or item of hardware which will be exposed to view for Architect's approval of appearance, color, and finish if required. Samples will be returned to the Contractor upon request after completion of the Work.

D. Keying Schedule: Prepared by or under the supervision of Architectural Hardware Consultant, detailing Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations. Keying Schedule: Per DHI manual "Keying Procedures, Systems, and Nomenclature".

E. Qualification Data: For Installer, Supplier, and Architectural Hardware Consultant. Compliance with this Section shall include letters of certification Certifications shall be submitted for approval with and be incorporated with hardware schedule submittal. Submittals will not be considered without the certifications.

F. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.

G. Operations and maintenance manuals:
   1. Upon completion of construction and building turnover, furnish two (2) complete maintenance manuals to the owner. Manuals to include the following items:
      a. Approved hardware schedule, catalog cuts and keying schedule.
      b. Hardware installation and adjustment instructions.
      c. Manufacturer’s written warranty information.
      d. As installed "Wiring Diagrams" for each opening connected to power, both low voltage and 110 volts.
      e. One complete set of special tools required for maintenance and adjustment of hardware, including changing of cylinders.

H. LEED Submittals:
   1. Local/Regional Materials: Provide a statement from the manufacturer stating that materials provided were manufactured within a 500 mile radius of the project. Include location of the manufacturing facility including name, address and distance between manufacturing facility and the project site. Provide manufacturer’s documentation indicating location where the base materials were extracted, mined, harvested, etc. and distance between manufacturing facility and the project site (Applies to LEED MRc5.1 and MRc5.2: Regional Materials).
a. Include material costs (excluding cost of installation).

2. Recycled Content: Provide a statement from the manufacturer including the recycled content percentage, by weight, and whether the recycled content is post-consumer or post-industrial (applies to LEED MRc4.1 and MRc4.2: Recycled Content).

3. Credit EQ 4.1: Manufacturers' product data and material safety data sheets (MSDS) for construction adhesive and sealants used on the interior of the building, including printed statement of VOC content in g/L.

4. Credit EQ 4.2: Manufacturers' product data and material safety data sheets (MSDS) for construction painting and coatings used on the interior of the building, including printed statement of VOC content in g/L.

1.05 QUALITY ASSURANCE

A. Substitutions:
1. All substitution requests must be submitted within the procedures and time frame as outlined in Division 01 Section, Product Requirements. Approval of products is at the discretion of the architect and their consultant.
2. Items listed with no substitute manufacturers have been requested by Owner to meet existing standards.

B. Requirements of Regulatory Agencies:
1. Furnish finish hardware to comply with the requirements of laws, codes, ordinances, and regulations of the governmental authorities having jurisdiction where such requirements exceed the requirements of the Specifications. Furnish finish hardware to comply with the requirements of the American National Standards for Making Buildings and Facilities Accessible to and Usable by Physically Handicapped People (CABO/ANSI A117.1) and to comply with Americans with Disabilities Act (ADA).
2. Doors to stairs (other than exit stairs), loading platforms, boiler rooms, stages and doors serving other hazardous locations shall have knurled or other similar approved marking of Building Code.

C. Installer Qualifications: An experienced installer with a minimum of 3 years experience who has completed door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

D. Supplier Qualifications: Company specializing in the supply of door hardware with 5 years documented experience and an Architectural Hardware Consultant (AHC) to properly handle, detail and service hardware in a satisfactory manner. Architectural Hardware Consultant shall be available during the course of the Work to consult with Contractor, Architect, Hardware Consultant, and Owner about door hardware and keying.
1. Scheduling Responsibility: Preparation of door hardware and keying schedules.
2. Engineering Responsibility: Preparation of data for electrified door hardware, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
3. Hardware supplier shall be a certified direct distributor and be a full sales and service organization for the manufacturer's listed.

E. Architectural Hardware Consultant Qualifications: A person who is currently certified by the Door and Hardware Institute as an Architectural Hardware Consultant and 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.
1. Electrified Door Hardware Consultant Qualifications: A qualified Architectural Hardware Consultant who is experienced in providing consulting services for electrified door hardware installations.
F. Source Limitations: Obtain each type and variety of door hardware from a single manufacturer, unless otherwise indicated.

G. Fire-Rated Door Assemblies: Provide door hardware for assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 252 and UL10C. Project requires door assemblies and components that are compliant with positive pressure and S-label requirements. Specifications must be cross-referenced and coordinated with door manufacturers to ensure that total opening engineering is compatible with UL10C Standard for Positive Pressure Fire Tests of Door Assemblies. Provide proper latching hardware, non-flaming door closers, approved-bearing hinges, plus resilient and required intumescent seals if not furnished with wood door.

H. Templates: Furnish a complete list and suitable templates, together with finish hardware schedule to contractor, for distribution to necessary trades supplying materials to be prepped for finish hardware.

I. Keying Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." In addition to Owner, Construction Manager, Contractor, and Architect, conference participants shall also include Suppliers Architectural Hardware Consultant and Owner's security consultant. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including, but not limited to, the following:
   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. Address for delivery of keys.

J. Pre-installation Meeting:
   1. Before hardware installation, General Contractor/Construction Manager will request seminar be conducted on the installation of hardware; specifically that of locksets, closers, and exit devices. The hardware supplier for the project shall present the seminar. Seminar to be held at job site and attended by installers of hardware for aluminum, hollow metal and wood doors. Seminar to address proper coordination and installation of hardware, per finish hardware schedule for this specific project, by using installation manuals, hardware schedule, templates, physical product samples and installation videos.
   2. When any electrical hardware is specified this meeting shall also include the following trades/installers: Electrical and Security Contractors.
   3. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
   4. Failure to hold the pre-installation conference may affect the product warranty.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Marking and packaging:
   1. Properly package and mark items according to the approved hardware schedule, complete with necessary screws and accessories, instructions and installation templates for spotting mortising tools.
   2. Packaging of door hardware is the responsibility of the supplier. As hardware supplier receives material from various manufacturers, sort and repack in containers clearly marked with appropriate hardware set and door numbers to match the approved hardware schedule. Two or more identical sets may be packed in same container.
B. Delivery:
1. The supplier shall deliver all hardware to the project site; direct factory shipments are not allowed unless agreed upon beforehand. Hardware supplier shall coordinate delivery times and schedules with the contractor. Inventory door hardware jointly with representatives of hardware supplier and hardware installer/contractor until each is satisfied that count is correct.
2. No keys, other than construction master keys and/or temporary keys are to be packed in boxes with the locks.
3. Contractor shall check deliveries against accepted list and provide receipt for them, after which he is responsible for storage and care. Any shortage or damaged good shall be made without cost to the owner.

C. Storage:
1. Provide secure lock-up for door hardware delivered to the Project, but not yet installed. Control handling and installation of hardware items that are not immediately replaceable so that completion of work will not be delayed by hardware losses both before and after installation.

1.07 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 absolute limits.

1.08 COORDINATION
A. Supplier shall coordinate the following items with the General Contractor and related trades.
B. Coordinate work of this Section with other directly affected Sections involving manufacture of any internal reinforcement for door hardware. Furnish hardware templates to door fabricators for factory preparation to receive hardware.
C. Furnish hardware items of proper design for use on doors and frames of thicknesses, profile, swing, security, and other indicated requirements as necessary for proper function.
D. Coordinate solid blocking between studs of frame construction to support wall mounted items such as stops.
E. Electrical System Roughing-in: Coordinate layout and installation of electrified door hardware with connections to power supplies, fire alarm system and detection devices and access control system.
F. A hardware and keying conference is mandatory within 30 days of contract award.
G. Use hardware consultant to check Shop Drawings for doors and entrances to confirm that adequate provisions will be made for proper hardware installation.

1.09 WARRANTY:
A. General Warranty: Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
B. Special Warranty: Written warranty, executed by manufacturer agreeing to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, the following:
  1. Structural failures including excessive deflection, cracking, or breakage.
2. Faulty operation of operators and door hardware.
3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

C. Warranty Period: 2 years from date of Substantial Completion, unless otherwise indicated.
   1. Warranty Period for Electromagnetic Locks: 5 years from date of Completion.
   2. Warranty Period for Manual Closers: 5 years from date of Completion.
   3. Warranty Period for Exit Devices: 2 years from date of Completion.
   4. Warranty period for Locksets: 5 years, blanket coverage, from date of Completion.

1.10 MAINTENANCE SERVICE
   A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

1.11 COMMISSIONING
   A. The General Contractor in conjunction with the lock manufacturer's representative, hardware installer and supplying distributor shall commission hardware as follows.
   B. Test door hardware operation with climate control system both at rest and while in full operation.
   C. Test electrical and electronic hardware systems for satisfactory operation.
   D. Test hardware interfaced with fire/life-safety system for proper operation and release.

PART 2 - PRODUCTS

2.01 MANUFACTURERS
   A. Furnish each category with the products of only one manufacturer unless specified otherwise; this requirement is mandatory whether various manufacturers are listed or not.
   B. Provide the products of manufacturer designated or if more than one manufacturer is listed, the comparable product of one of the other manufacturers listed. Where only one manufacturer or product is listed, it is understood that this is the owner’s Building Standard and "no substitution" is allowed.

2.02 GENERAL HARDWARE REQUIREMENTS
   A. Provide hardware materials and products of the best quality, free from imperfections and flaws in appearance, finish, or operational function.
   B. Refer to Hardware Schedule below for specific hardware items, designs, functions, sizes, and finishes.
   C. LEED Requirements:
      1. Recycled Content: Provide indication that materials/products contain the maximum amount of recycled content permitted in order for material or product to retain its integrity.
      2. Local/Regional Materials: Preference shall be given to products and materials which have been manufactured, harvested, extracted mined quarried, etc. within a 500 mile radius of the project site.
      3. VOC Content EQc 4.1: Adhesives and sealants used on the interior of the building shall comply with VOC limits indicated in Division 1 Section – “Sustainable Requirements.”
4. VOC Content EQc 4.2: Paintings and coatings used on the interior of the building shall comply with VOC limits indicated in Division 1 Section – "Sustainable Requirements."

2.03 HINGES

A. Manufacturers:
   1. Hager.
   2. Lawrence Brothers.
   4. Stanley.

B. General: Except for hinges and pivots to be installed entirely (both leaves) into wood doors and frames, provide only template-produced units.

C. Hinges shall be five-knuckle design, ball bearing as specified with NRP (non-removable pin) feature, at all reverse bevel doors with locksets.

D. Hinge Base Metal: Provide the following:
   1. Exterior Hinges: Stainless steel or brass/bronze, with stainless-steel non-removable pin.
   2. Interior Hinges: Steel, with steel pin
   3. Hinges for Fire-Rated Assemblies: Steel, with steel pin.

E. Quantity, regardless of quantities specified in the hardware schedule provide the following:
   1. Three Hinges: For doors up to 84 inches in height.
   2. Add one additional hinge for doors exceeding 84 inches in height for each marginal increment of 24 inches.

F. Size, provide the following:
   1. Doors up to 35 inches in width: 2 ball bearing, standard weight, 0.134 gage, 4-1/2 inches by 4-1/2 inches.
   2. Doors 36 inches in width and over: 4 ball bearing, heavy weight, 0.180 gage, 5 inches by 5 inches.

G. Hinge Options: Where indicated in door hardware sets or on Drawings:
   1. 5 knuckle button tip.
   2. Hospital Tips: Slope ends of hinge barrel.
   4. Nonremovable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for outswinging exterior doors and outswinging corridor doors with locks.
   5. Corners: Square.

H. Provide shims and shimming instructions for proper door adjustment.

I. Electric Power Transfer:
   1. Manufacturers:
      a. Securitron at electric locksets.
      b. Von Duprin at electric latch retraction exit devices.
   2. Transfer power from door frame to edge of door.

2.04 SPRING HINGES

A. Self-Closing Hinges: BHMA A156.17, listed under Category A in BHMA's "Certified Product Directory."

B. Manufacturers:
   1. Hager.
   2. Lawrence Brothers.
2.05 CONTINUOUS HINGES
A. Manufacturers:
   1. Hager.
B. Continuous, Gear-Type Hinges: Extruded-aluminum, pinless, geared hinge leaves; joined by a continuous extruded-aluminum channel cap; with concealed, self-lubricating thrust bearings.
C. Manufacture units for proper door thickness, height, custom screw patterns and electrical and pneumatic modifications.

2.06 DOOR BOLTS
A. Manufacturers:
   1. Ives.
   2. Rockwood.
   3. Trimco.
B. Bolt Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:
C. Manual Flush Bolts: designed for mortising into door edge.
D. Automatic and Self-Latching Flush Bolts: designed for mortising into door edge. At non rated wood doors use Ives FB31P automatic flush bolt for metal door.
E. Locate centerline of manual top bolt not more than 78 inches (1981 mm) from finished floor.
F. Dust Proof Strikes: Furnish with all flush bolts.

2.07 COORDINATORS
A. Manufacturers:
   1. Ives.
   2. Rockwood.
   3. Trimco.
B. Provide coordinator for labeled pairs of doors equipped with automatic flush bolts.
C. Provide filler bars for total opening width and closer mounting brackets.

2.08 LOCKSETS AND LATCHSETS
A. Manufacturers:
   1. Schlage L9000 series mortise locksets and latchsets.
B. Latches and Locks for Means of Egress Doors: Comply with NFPA 101. Latches shall not require more than 15 lbf to release the latch. Locks shall not require use of a key, tool, or special knowledge for operation.
C. Function numbers as listed in sets.
D. Mortise type:
   1. Provide mortise locksets that comply with ANSI A156.13, Series 1000, Operational Grade 1 and Security Grade 1 with all standard trims.
2. Provide mortise locksets that comply with UL10C and UBC 7-2 positive pressure requirements.
3. Latchbolts to have a standard 2 ¾" backset with a full ¾" throw.
4. Deadbolts to be 1 ¾" total length; have standard 1" throw with a minimum ¾" internal engagement when fully extended.
5. Thumbturn and back-plate to be manufactured from castings and comply with ANSI 117 accessibility standard.

E. Deadlock:
1. Adams-Rite MS1850S Series with Armor faceplate to suit door edge. Backset shall be 1 1/2" unless door stile width requires narrower backset.

F. Strikes:
1. Provide strikes with extended lips where required to protect trim from being marred by latch bolt. Provide strike lips that do not project more than 1/8" beyond doorframe trim at single doors and have 7/8" lip to center at pairs of 1-3/4" doors. Provide wrought box strikes on all locks.

G. Hardware supplier shall verify all lock functions with Owner prior to ordering material.

2.09 CYLINDERS AND KEYING
A. Manufacturer: Medeco.
B. Supply all locks and panic hardware with construction cylinders to secure the building until replaced by Owner with Medeco cylinders at job completion. All locksets and panic hardware shall accommodate the Medeco cylinders.
C. Final cylinders and keying shall be Medeco purchased by the Owner and installed by the General Contractor.
D. Key Control System:
1. Provide metal cabinet with baked-enamel finish; containing key gathering envelopes, hook labels, permanent key tags, temporary key tags, signature receipt forms, visible index and instruction book with key capacity of 150 percent of the number of locks.
2. Wall-Mounted Cabinet: Cabinet with hinged-panel door equipped with key-holding panels and pin-tumbler cylinder door lock.

2.10 EXIT DEVICES AND MULLIONS
A. Exit Devices for Means of Egress Doors: Comply with NFPA 101. Exit devices shall not require more than 15 lb to release the latch. Exit devices shall not require use of a key, tool, or special knowledge for operation.
B. Manufacturer: Von Duprin; 99 series.
C. Rim and Surface-Mounted Vertical Rod devices:
1. Exit devices shall be touchpad style plated to the standard architectural finishes to match the balance of the door hardware.
2. Trim: as specified in sets, function numbers as listed in sets. Levers to match lockset design where specified.
3. Exit devices shall be UL listed panic exit hardware. All exit devices for fire rated openings shall be UL labeled fire exit hardware.
4. Provide hex key dogging on panic exit hardware.
5. Furnish glass bead kits for exit devices as required.
6. Electrically Operated Devices: Single manufacturer source for electric latch retraction devices, electrically controlled trim, power transfers, power supplies, monitoring switches and controls.
7. Where RX and LX switches and used at exit devices hardware supplier shall confirm current draw with security contractor, low current (LC) option may be required.
8. Through Bolts: For exit devices and trim on metal doors, non-fire-rated wood doors, fire-rated wood doors and fire-rated metal doors.
9. Strikes: Provide appropriate strike according to frame construction.
10. After installation of all exit devices, General Contractor to have Manufacturer’s representative inspect installation. Representative shall submit a written report to the Architect with copies to the General Contractor and hardware supplier upon completion of service. This report shall include any installation errors, noting door.

D. Removable Mullion:
1. Interior/Exterior, hollow metal or wood, mullion is removable only through the use of building keys. Mullions shall self lock when re-installed without the use of the cylinder key.
2. Provide two-piece interlocking stabilizer set. One piece shall be installed on the mullion and the other piece installed on the door. Provide shims to adjust for door misalignment.
3. Provide angle plates where required at flush transom applications.
4. Fire-Exit Removable Mullions: Provide removable mullions for use with fire exit devices complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire and panic protection, based on testing according to UL 305 and NFPA 252. Mullions shall be used only with exit devices for which they have been tested.


2.11 PUSH AND PULL HARDWARE
A. Manufacturers:
   1. Ives.
   2. Rockwood.
   3. Trimco.
B. Push-Pull Design: As scheduled.

2.12 CLOSERS
A. Manufacturer: LCN; 4040 series.
B. Surface Closers:
   1. Provide door closers that comply with Grade 1 ANSI A156.4 2000, fire-rated to UBC 7.2 and UL 10C.
   2. Spring power shall be continuously adjustable over the full range of closer sizes, and allow for reduced opening force for the physically handicapped.
   3. Hydraulic regulation shall be by tamper-proof, non-critical valves, adjustable with a hex wrench. Closers shall have separate adjustment for latch speed, general speed, and backcheck. Backcheck shall be properly located for protection of the door, frame, and applied hardware.
   4. Closers at interior doors, provide a delayed action feature to delay closing up to one minute from maximum opening to approximately 75º.
   5. Refer to door, frame details, and furnish accessories such as drop plates, transom adapters, special templates, spacers and supports as required to correctly install door closers. Provide flush panel adapter where required at flush transom applications.
   6. Doors swinging into exit corridors should provide for corridor clear width as required by applicable codes.
7. Install closers on room side of corridor doors, inside of exterior doors, and stair side of stairway doors.
8. Through Bolts: For surface closers on metal doors, non-fire-rated wood doors, fire-rated wood doors and fire-rated metal doors.

2.13 ADA SPECIAL CLOSERS (PNEUMATIC)

A. Surface automatic operators
1. Where "Low Energy Power Operated Door" are indicated for doors required to be accessible to the disabled, provide pneumatically powered operators complying with the ADA and A156.19 requirements.
2. Full closing force shall be provided when the power or assist cycle ends.
3. Locate power unit, control box and exhaust away from door to minimize noise and vibration in pedestrian areas. Maximum distance from control box to operator is 50'-0". Control box shall be accessible to allow for adjustments in operator performance.
4. The operator will be designed to prevent damage to the mechanism if the system is actuated while the door is latched or if the door is forced closed during the opening cycle.
5. Provide complete with drop plates, brackets, or adapters for arms as required to suit details.
6. Provide plenum-rated type cable or tubing where required.
7. Hardware supplier shall provide point-to-point wiring diagrams for automatic operator(s) to general and electrical contractor prior to electrical rough in. Electrical contractor shall provide 120VAC power to control box and provide and install wiring from control box to actuators. General contractor shall install pneumatic tubing from control box to operator.
8. Furnish actuator, control box and tubing as shown in Hardware Sets.
9. Furnish and install a key switch operated by the building key system to cut off power to automatic operators, coordinate location of key switch with Owner.

2.14 STOPS AND HOLDERS

A. Manufacturers:
1. Ives.
2. Rockwood.
3. Trimco.

B. Provide wall stops for doors, unless other type stops are scheduled or indicated. Where wall stops are not appropriate, provide overhead stops.

C. Wrought, forged, or cast, approximately 2-1/2 inch diameter, convex or concave rubber center, concealed fasteners.

D. Silencers for Door Frames: Neoprene or rubber; fabricated for drilled-in application to frame.

2.15 MAGNETIC HOLDERS

A. Manufacturers:
1. LCN
2. Rixson
3. ABH

B. Electromagnetic Door Holders: Coordinate with fire detectors and interface with fire alarm system for labeled fire door assemblies. Tri-voltage design, 24VAC/DC and 120VAC, with a minimum of 35 pounds of holding force.
2.16 OVERHEAD HOLDERS AND STOPS
   A. Manufacturers:
      1. Glynn Johnson.
      2. Rixson.
      3. ABH.
   B. Type, function and fasteners shall be as specified. Size per manufacturer's selector chart. Plastic end caps, hold open mechanisms and shock blocks are not allowed. End caps must be finished same as balance of unit.

2.17 KICK PLATES
   A. Manufacturers:
      1. Hager.
      3. Rockwood.
      4. Trimco.
   B. Furnish .050 inches thick, 10" high by door width less 2" at single doors and less 1" at pairs on push side and 1" less door width on pull side, beveled top and 2 sides with counter sink holes for fasteners. Where glass or louvers prevent this height, supply with height equal to height of bottom rail less 2".
   C. Fasteners: Manufacturer's standard machine or self-tapping screws.

2.18 THRESHOLDS
   A. Manufacturers:
      1. Pemko.
      2. National Guard.
   B. Accessibility Requirements: Where thresholds are indicated to comply with accessibility requirements, comply with the Accessibility Guidelines for Buildings and Facilities ANSI A117.1
   C. Bevel raised thresholds with a slope of not more than 1:2.
   D. Type as listed in sets.
      1. Cope at jambs.
      2. Where thresholds occur at openings with one or more mullions, they shall be cut for the mullions and extended continuously for the entire opening.
      3. Furnish with non-ferrous Stainless Steel Screws and Lead Anchors.

2.19 DOOR SWEEPS
   A. Manufacturers:
      1. Pemko.
      2. National Guard.
   B. Type as listed in sets.

2.20 WEATHER-STRIPPING
   A. Manufacturers:
      1. Pemko.
      2. National Guard.
B. Door Gasketing: Provide continuous weather-strip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated or scheduled. Provide non-corrosive fasteners for exterior applications and elsewhere as indicated. Type as listed in sets.
   1. Apply to head and jamb stops.
C. Fire, Smoke and Draft Control Seals:
   1. Smoke-Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled based on testing according to UL 1784.
   2. Fire-Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled based on testing according to UL 10C.
   3. Gaskets must comply with UL10C.
D. Where rain drips are specified in hardware groups, provide Pemko 346C by full frame width, unless detailed otherwise.

2.21 LATCH PROTECTORS
A. Manufacturers:
   1. Ives
   2. Rockwood
   3. Trimco
B. Latch protectors shall be 12 gage steel with USP finish. USP latch protectors shall be field painted to match door and frame

2.22 KEY MANAGEMENT SOFTWARE
A. Manufacturer: Schlage
B. Software shall provide tracking, issuing, collecting and transferring information regarding keys, doors, and hardware.
C. Provide training for Owner's personnel on the proper operation and application of the key management software.

2.23 FIRE DEPARTMENT LOCK BOX:
A. Provide Knox Model No. 3200 Knox Vault (recessed or surface mount as required by Owner) or other lock box as required by local fire department, in quantity and location as directed by the fire department and approved by the Architect. Recessed mount shall be furnished with recessed mounting kit (RMK) for new concrete or masonry construction.

2.24 MISCELLANEOUS
A. Furnish items not categorized in the above descriptions but specified by manufacturer's names in Hardware Sets.
B. Boxed Power Supplies: Modular unit in NEMA enclosure; filtered and regulated; voltage rating and type matching requirements of door hardware served; and listed and labeled for use with fire alarm systems.
C. Supplier shall review Security/Electrical Plan for locations of security equipment provided by others, advise Architect prior to bid date for any discrepancies.
D. Supplier shall review Security Plan for locations of security equipment provided by others.

2.25 FABRICATION
A. Base Metals: Produce door hardware units of base metal, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units
and BHMA A156.18. Do not furnish manufacturer’s standard materials or forming methods if different from specified standard.

2.26 FASTENERS
   A. Including, but not limited to, wood or machine screws, bolts, nuts, anchors, etc. of proper type, material, and finish required for installation of hardware.
   B. Use phillips head for exposed screws. Do not use aluminum screws to attach hardware.
   C. Provide self-tapping (TEC) screws for attachment of sweeps and stop-applied weatherstripping only.
   D. Through Bolts: For exit devices and surface closers on non-rated metal doors, fire-rated metal doors non-fire-rated wood doors, and fire-rated wood doors unless door blocking is provided.

2.27 FINISHES
   B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
   C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.01 CONSTRUCTION WASTE MANAGEMENT AND RECYCLING
   A. All project construction waste and recycled materials shall be managed in accordance with Division 01 Section “Construction Waste Management and Disposal.” The Contractor shall submit documentation satisfying the requirements of that section.

3.02 ACCEPTABLE INSTALLERS
   A. Factory trained and certified by the lock, closer and panic hardware manufacturers. Alternative: can demonstrate suitably equivalent competence and experience.

3.03 EXAMINATION
   A. The General Contractor in conjunction with the hardware installer and supplying distributor shall examine doors and frames as follows.
      1. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance. Ensure that walls and frames are square and plumb before hardware installation.
      2. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.
      3. Proceed with installation only after unsatisfactory conditions have been corrected.
      4. Beginning of installation means acceptance of existing conditions.
3.04 PREPARATION

A. Wood Doors: Comply with DHI A115-W series.
B. Steel Doors and Frames: Comply with DHI A115 series.
   1. Surface-Applied Door Hardware: Drill and tap doors and frames according to
      ANSI/SDI A250.6-97.

3.05 INSTALLATION

A. Install hardware in accordance with manufacturer's instructions and applicable
   requirements of SDI, WDMA, NFPA 80, BHMA, and DHI.
B. Use the templates provided by hardware item manufacturer.
C. Mounting Heights: Mount door hardware units at heights indicated in following applicable
   publications, unless specifically indicated or required to comply with governing
   regulations:
      1. Standard Steel Doors and Frames: DHI's "Recommended Locations for
         Architectural Hardware for Standard Steel Doors and Frames."
      2. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural
         Hardware for Wood Flush Doors."
      3. Conform to ANSI A117.1 for positioning requirements for the handicapped.
      4. Where new hardware is to be installed near existing doors/hardware scheduled
         to remain, match locations of existing hardware.
D. Process hardware for aluminum doors in accordance with DHI handbook, Processing
   Hardware for Custom Aluminum Doors and Frames.
E. Wherever cutting and fitting are required to install hardware on surfaces which are to be
   painted or finished by others, coordinate removal, storage, and reinstallation or
   application of surface protections with finishing work specified in other Sections. Do not
   install surface-mounted items until finishes have been completed on the substrate.
   NOTE: NO POWER DRIVEN TOOLS SHALL BE USED FOR INSTALLATION OF
   LOCKSETS AND HARDWARE ON DOORS.
F. Set units level, plumb, and true to line and location. Adjust and reinforce the attachment
   substrate as required for proper installation and operation.
G. Drill and countersink units, which are not factory-prepared for anchorage fasteners.
   Space fasteners and anchors in accordance with referenced standards.
H. Drill pilot holes for fasteners in wood doors and/or frames.
I. Drawings typically depict doors at 90 degrees; doors will actually swing to maximum
   allowable. Template hardware for maximum allowable degree of swing.
J. Gaskets: install jamb-applied gaskets before closers, overhead stops, rim strikes, etc.
   Install sweeps across bottoms of doors before astragals, trim astragals to tops of sweeps.
   Door Jambs shall be cleaned of all dirt, grease, oil, solvents or solvent residue and dust
   before applying Pressure-Sensitive Adhesive backed Gasketing, Smoke Seal or
   Weatherstripping.
K. Door and Frame Manufacturer(s) shall prepare doors and frames for electronic hardware
   furnished by Security Contractor.
L. Boxed Power Supplies: Locate power supplies as indicated or, if not indicated, above
   accessible ceilings. Verify location with Architect.
   1. Configuration: Provide the least number of power supplies required to
      adequately serve doors with electrified door hardware.
3.06 ADJUSTING
A. Adjust and check each operating hardware item, and each door assembly to ensure proper operation and function. Lubricate moving parts with lubrication type recommended by manufacturer.
B. Replace units, which cannot be adjusted and lubricated to operate freely and smoothly.
C. Hardware damaged by improper installation or adjustment methods to be repaired or replaced to Owner’s satisfaction.
D. Make final adjustments and lubrication immediately prior to final acceptance. Adjust door control devices to compensate for final operation of heating and ventilation equipment.
   1. Door Closers: Adjust sweep period so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches from the latch, measured to the leading edge of the door.
   2. Backcheck shall be properly located for protection of the door, frame, and applied hardware.

3.07 CLEANING AND PROTECTION
A. Clean adjacent surfaces soiled by door hardware installation.
B. Clean operating items as necessary to restore proper function and finish.
C. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of Substantial Completion.

3.08 FINAL ADJUSTMENT
A. Wherever hardware installation is made more than one month prior to acceptance or occupancy of a space or area, return to the work during the week prior to acceptance or occupancy, and make final check and adjustment of all hardware items in such space or area. Clean operating items as necessary to restore proper function and finish of hardware and doors. Adjust door control devices to compensate for final operation of heating and ventilating equipment.

3.09 DEMONSTRATION
A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain door hardware and door hardware finishes.

3.10 CLEANUP
A. Remove protective material from hardware where present.
B. Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

3.11 CONTINUED MAINTENANCE SERVICE
A. Approximately six months after the acceptance of hardware in each area, the Installer, accompanied by the representative of the latch and lock manufacturer, shall return to the project and re-adjust every item of hardware to restore proper function of doors and hardware. Consult with and instruct Owner's personnel in recommended additions to the maintenance procedures. Replace hardware items that have deteriorated or failed due to faulty design, materials or installation of hardware units. Prepare a written report of current and predictable problems in the performance of the hardware.
3.12 ACCEPTANCE

A. Warranty shall not start until Owner Acceptance. Acceptance shall be withheld until the foli own have been successfully completed:
   1. Commissioning per paragraph 1.11.
   2. Delivery and Acceptance of all Operations and maintenance manuals.

3.13 DOOR HARDWARE SCHEDULE

A. The following schedule is furnished for whatever assistance it may afford the Contractor; do not consider it as entirely inclusive. Should any particular door or item be omitted in any scheduled hardware heading, provide door or item with hardware same as required for similar purposes. Hardware supplier is responsible for handing and sizing all products as listed in the hardware heading. Quantities listed are for each pair of doors, or for each single door.

B. Hardware schedule to be developed.

END OF SECTION
SECTION 08 80 00

GLAZING

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 glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:
   1. Windows.
   2. Doors.
   4. Glazed entrances.
   5. Interior borrowed lites.
   7. Skylights.

B. Related Sections include the following:
   1. Division 08 Section “Aluminum-Framed Entrances and Storefronts” for glazing gaskets and accessories for specified storefront systems.
   2. Division 08 Section “Glazed Aluminum Curtain Walls” for glazing gaskets and accessories for specified curtain wall systems.
   3. Division 09 Section "Gypsum Board" for trimless glazing tracks.

1.03 DEFINITIONS

A. Manufacturers of Glass Products: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.

B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.

C. Interspace: Space between lites of an insulating-glass unit that contains dehydrated air or a specified gas.

D. Deterioration of Coated Glass: Defects developed from normal use that are attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning coated glass contrary to manufacturer’s written instructions. Defects include peeling, cracking, and other indications of deterioration in metallic coating.

E. Deterioration of Insulating Glass: Failure of hermetic seal under normal use that is attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.

F. Deterioration of Laminated Glass: Defects developed from normal use that are attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision.
through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.

1.04 PERFORMANCE REQUIREMENTS

A. General: Provide glazing systems capable of withstanding normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, and installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

B. Glass Design: Glass thickness designations indicated are minimums and are for detailing only. Confirm glass thicknesses by analyzing Project loads and in-service conditions. Provide glass lites in the thickness designations indicated for various size openings, but not less than thicknesses and in strengths (annealed or heat treated) required to meet or exceed the following criteria:

1. Glass Thicknesses: Select minimum glass thicknesses to comply with ASTM E 1300, according to the following requirements:
   a. Specified Design Wind Loads: As indicated, but not less than 30 psf or wind loads applicable to Project as required by ASCE 7 "Minimum Design Loads for Buildings and Other Structures": Section 6.0 "Wind Loads" and the Boulder County Wind Map.
   b. Specified Design Snow Loads: As indicated, but not less than snow loads applicable to Project as required by ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 7.0, "Snow Loads."
   c. Probability of Breakage for Vertical Glazing: 8 lites per 1000 for lites set vertically or not more than 15 degrees off vertical and under wind action.
      1) Load Duration: 3 seconds.
   d. Probability of Breakage for Sloped Glazing: 1 lite per 1000 for lites set more than 15 degrees off vertical and under wind and snow action.
      1) Load Duration: 30 days.
   e. Maximum Lateral Deflection: For the following types of glass supported on all 4 edges, provide thickness required that limits center deflection at design wind pressure to 1/50 times the short side length or 1 inch, whichever is less.
      1) For monolithic-glass lites heat treated to resist wind loads.
      2) For insulating glass.
      3) For laminated-glass lites.
   f. Minimum Glass Thickness for Exterior Lites: Not less than 6.0 mm.
   g. Thickness of Tinted and Heat-Absorbing Glass: Provide the same thickness for each tint color indicated throughout Project.

C. Thermal Movements: Provide glazing that allows for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures acting on glass framing members and glazing components. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

D. Thermal and Optical Performance Properties: Provide glass with performance properties specified based on manufacturer's published test data, as determined according to procedures indicated below:

1. For monolithic-glass lites, properties are based on units with lites 6.0 mm thick.
2. For laminated-glass lites, properties are based on products of construction indicated.
3. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
4. Center-of-Glass Values: Based on using LBL-44789 WINDOW 5.0 computer program for the following methodologies:
   a. U-Factors: NFRC 100 expressed as Btu/ sq. ft. x h x deg F.

1.05 SUBMITTALS
A. Product Data: For each glass product and glazing material indicated.
B. Samples: For the following products, in the form of 12-inch- square Samples for glass.
   1. Each color of tinted float glass.
   2. Each type of patterned glass.
   3. Coated vision glass.
   5. Each pattern and color of ceramic-coated vision glass.
   7. Each type of laminated glass with colored interlayer.
   8. Insulating glass for each designation indicated.
   9. For each color (except black) of exposed glazing sealant indicated.
C. Glazing Schedule: Use same designations indicated on Drawings for glazed openings in preparing a schedule listing glass types and thicknesses for each size opening and location.
D. LEED Submittals:
   1. Credit MR 5.1 and 5.2: Regionally Extracted, Harvested, or Recovered and Manufactured Materials:
      a. Indicate location of manufacturing facility, including name, address, and distance between manufacturing facility and the project site. Provide manufacturer’s documentation indication location where the base materials were extracted, mined, quarried, harvested, etc., and the distance between this location and the project site. Also include material costs, excluding cost of installation.
   2. Credit EQ 4.1: Low Emitting Materials: Manufacturers' product data and material safety data sheets (MSDS) for interior sealants, including printed statement of VOC content.

1.06 QUALITY ASSURANCE
A. Installer Qualifications: An experienced installer who has completed glazing similar in material, design, and extent to that indicated for this Project; whose work has resulted in glass installations with a record of successful in-service performance; and who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.
B. Source Limitations for Glass: Obtain the following through one source from a single manufacturer for each glass type: clear float glass coated float glass laminated glass and insulating glass.
   1. Provide each type of glass and primary sealant/gasket from a single manufacturer with not less than 5 years of successful experience in the production of materials similar to those required.
C. Source Limitations for Glazing Accessories: Obtain glazing accessories through one source from a single manufacturer for each product and installation method indicated.
D. Glazing for Fire-Rated Door Assemblies: Glazing for assemblies that comply with NFPA 80 and that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 252.

1. Where glazing units, including Kind FT glass and laminated glass, are specified in Part 2 articles for glazing lites more than 9 sq. ft. in exposed surface area of one side, provide glazing products that comply with Category II materials, for lites 9 sq. ft. or less in exposed surface area of one side, provide glazing products that comply with Category I or II materials, except for hazardous locations where Category II materials are required by 16 CFR 1201 and regulations of authorities having jurisdiction.

F. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.

G. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
1. Build mockups in the location and of the size indicated or, if not indicated, as directed by Architect.

H. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.07 DELIVERY, STORAGE, AND HANDLING
A. Protect glazing materials according to manufacturer's written instructions and as needed to prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

B. For insulating-glass units that will be exposed to substantial altitude changes, comply with insulating-glass manufacturer's written recommendations for venting and sealing to avoid hermetic seal ruptures.

1.08 PROJECT CONDITIONS
A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.
1. Do not install liquid glazing sealants when ambient and substrate temperature conditions are outside limits permitted by glazing sealant manufacturer or below 40 deg F.

1.09 WARRANTY
A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer's standard form, made out to Owner and signed by coated-glass manufacturer agreeing to replace coated-glass units that deteriorate as defined in "Definitions" Article, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
1. Warranty Period: 10 years from date of Completion.
B. Manufacturer’s Special Warranty on Laminated Glass: Manufacturer’s standard form, made out to Owner and signed by laminated-glass manufacturer agreeing to replace laminated-glass units that deteriorate as defined in “Definitions” Article, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
   1. Warranty Period: 10 years from date of Completion.

C. Manufacturer’s Special Warranty on Insulating Glass: Manufacturer’s standard form, made out to Owner and signed by insulating-glass manufacturer agreeing to replace insulating-glass units that deteriorate as defined in “Definitions” Article, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
   1. Warranty Period: 10 years from date of Completion.

PART 2 - PRODUCTS

2.01 GENERAL
   A. Regionally Extracted, Harvested, or Recovered and Manufactured Materials:
      1. Preference shall be given to manufacturer’s whose facilities are within a 500 mile radius of the project site.
      2. Preference shall also be given to materials that are harvested, extracted, mined, quarried, etc. within a 500 mile radius of the project site.

2.02 MANUFACTURERS/FABRICATORS
   A. Subject to compliance with requirements, provide products by one of the following:
      1. AGC Flat Glass North America.
      2. Guardian Industries Corp.
      4. PPG Industries, Inc., including affiliated licensed fabricators.
      5. Oldcastle Glass.
      6. Viracon.

2.03 GLASS PRODUCTS
   A. Annealed Float Glass: ASTM C 1036, Type I (transparent flat glass), Quality-Q3; of class indicated.
   B. Heat-Treated Float Glass: ASTM C 1048; Type I (transparent flat glass); Quality-Q3; of class, kind, and condition indicated.
      1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed, unless otherwise indicated.
         a. Peak to valley roll ratio shall not exceed 0.003.
      2. Provide Kind HS (heat-strengthened) float glass in place of annealed float glass where needed to resist thermal stresses induced by differential shading of individual glass lites and to comply with glass design requirements specified in Part 1 “Performance Requirements” Article.
      3. For uncoated glass, comply with requirements for Condition A.
      4. For coated vision glass, comply with requirements for Condition C (other uncoated glass).
      5. Provide Kind FT (fully tempered) float glass in place of annealed or Kind HS (heat-strengthened) float glass where safety glass is indicated.
   C. Ceramic-Coated Vision Glass: Float glass with ceramic enamel applied by silk-screened process and complying with ASTM C 1048, Condition C (other coated glass), Type I
GLAZING
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D. Ceramic-Coated Spandrel Glass: ASTM C 1048, Condition B (spandrel glass, one surface ceramic coated), Type I (transparent flat glass), Quality-Q3, and complying with other requirements specified.

1. Fallout Resistance: Provide spandrel units identical to those passing the fallout-resistance test for spandrel glass specified in ASTM C 1048.

E. Pyrolytic-Coated Float Glass: ASTM C 1376, float glass with metallic-oxide coating applied by pyrolytic deposition process during initial manufacture, and complying with other requirements specified.

F. Sputter-Coated Float Glass: ASTM C 1376, float glass with metallic-oxide or -nitride coating deposited by vacuum deposition process after manufacture and heat treatment (if any), and complying with other requirements specified.

G. Coated Spandrel Float Glass: Float glass complying with other requirements specified and with the following:

1. Fallout Resistance: Provide spandrel units identical to those passing the fallout-resistance test for spandrel glass specified in ASTM C 1048.

2. Factory apply manufacturer's standard opacifier of the following material to coated second surface of lites, with resulting products complying with Specification No. 89-1-6 in GANA Tempering Division's "Engineering Standards Manual."
   a. Manufacturer's standard opacifier material.
   b. Polyester film laminated to glass with solvent-based adhesive.

H. Wired Glass: ASTM C 1036, Type II (patterned and wired flat glass), Class 1 (clear), Quality-Q-6; and of form and mesh pattern specified.

I. Laminated Glass: ASTM C 1172, and complying with other requirements specified and with the following:

1. Interlayer: Polyvinyl butyral or cured resin of thickness indicated with a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after laminating glass lites and installation.
   a. For polyvinyl butyral interlayers, laminate lites in autoclave with heat plus pressure.
   b. For cured-resin interlayers, laminate lites with laminated-glass manufacturer's standard cast-in-place and cured-transparent-resin interlayer.

2. Laminating Process: Fabricate laminated glass to produce glass free of foreign substances and air or glass pockets.

J. Insulating-Glass Units, General: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, and complying with ASTM E 774 for Class CBA units and with requirements specified in this Article and in Part 2 "Insulating-Glass Units" Article.

1. Provide Kind HS (heat-strengthened) float glass in place of annealed glass where needed to resist thermal stresses induced by differential shading of individual glass lites and to comply with glass design requirements specified in Part 1 "Performance Requirements" Article.

2. Provide Kind FT (fully tempered) glass lites where safety glass is indicated.

3. Overall Unit Thickness and Thickness of Each Lite: Dimensions indicated for insulating-glass units are nominal and the overall thicknesses of units are measured perpendicularly from outer surfaces of glass lites at unit's edge.

4. Sealing System: Dual seal, with primary and secondary sealants as follows:
   a. Manufacturer's standard sealants.
5. Spacer Specifications: Manufacturer's standard spacer material and construction.

2.04 GLAZING SEALANTS
   A. General: Provide products of type indicated, complying with the following requirements:
      1. Compatibility: Select glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
      2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
      3. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range.
   B. Single-component Acrylic Glazing Sealant:
      1. Water-based acrylic emulsionsealant: non-sag, mildew resistant, paintable.

2.05 GLAZING TAPES
   A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based elastomeric tape with a solids content of 100 percent; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; packaged on rolls with a release paper backing; and complying with ASTM C 1281 and AAMA 800 for products indicated below:
      1. AAMA 804.3 tape.

2.06 MISCELLANEOUS GLAZING MATERIALS
   A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
   B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
   C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
   D. Spacers: Elastomeric blocks or continuous extrusions with a Shore, Type A durometer hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
   E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).
   F. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.
   G. Perimeter Insulation for Fire-Resistive Glazing: Identical to product used in test assembly to obtain fire-resistance rating.

2.07 FABRICATION OF GLAZING UNITS
   A. Fabricate glazing units in sizes required to glaze openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written
instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.

B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites in a manner that produces square edges with slight kerfs at junctions with outdoor and indoor faces.

C. Grind smooth and polish exposed glass edges and corners.

2.08 MONOLITHIC FLOAT-GLASS UNITS

A. Uncoated Clear Float-Glass Units MG-#: Class 1 (clear) annealed or Kind HS (heat-strengthened) float glass where heat strengthening is required to resist thermal stresses induced by differential shading of individual glass lites and to comply with system performance requirements.
   1. Thickness: 6.0 mm.

2.09 MONOLITHIC CERAMIC-COATED VISION-GLASS UNITS

A. Ceramic-Coated Vision-Glass Units CVG-#: Class 1 (clear) float glass.
   1. Thickness: 6.0 mm.
   2. Ceramic Coating Color and Pattern: <Insert one manufacturer's color and pattern designation if matching is required; otherwise, insert color and pattern designation for each product named above>.
      a. Coating Location: Second surface.

2.10 MONOLITHIC CERAMIC-COATED SPANDREL-GLASS UNITS

A. Ceramic-Coated Spandrel-Glass Units CSG-#:
   1. Class 1 (clear) 2 (tinted) float glass.
   2. Kind [HS (heat strengthened)] [FT (fully tempered)].
   3. Thickness: 6.0 mm.
   4. Ceramic Coating Color: [As selected by Architect from manufacturer's full range] [Match] [Provide] <Insert one manufacturer's color designation if matching is required; otherwise, insert color designation for each product named above>.
   5. Coating Location: Second surface.

2.11 MONOLITHIC WIRED-GLASS UNITS

A. Polished Wired-Glass Units WG-#: Form 1 (wired glass, polished both sides), Quality-Q6, Mesh 2 (M2) (Square), 6.0 mm thick.
   1. Manufacturers:
      a. Asahi/AMA Glass Corp.; affiliated with AFG Industries, Inc.
      b. Central Glass Co., Ltd.; distributed by Northwestern Industries Inc.
      c. Pilkington Sales (North America) Ltd.

2.12 LAMINATED-GLASS UNITS

A. Heat-Treated Laminated-Glass Units LG-#:
   1. Basis-of-Design Product: <Insert manufacturer's name; product name or designation> or a comparable product by one of the following:
      a. <Insert, in separate subparagraphs, manufacturer's name.>
   2. [Available ]Products:
a. <Insert, in separate subparagraphs, manufacturer's name; product name or designation.>

3. Kind [LHS, consisting of two lites of heat-strengthened float glass] [LR, consisting of two lites of heat-treated float glass, one of which is reflective] [LT, consisting of two lites of fully tempered float glass] [LD, consisting of two lites of float glass, one of which is ceramic-coated vision glass].

4. Outer Lite: Class [1 clear] [2 tinted] float glass.
   a. Tint Color: 
      ["Azurlite" by PPG Industries, Inc.] [Blue-green] [Bronze]
      ["EverGreen" by Pilkington Building Products North America]
   b. Kind [HS (heat strengthened)] [FT (fully tempered)]
   c. Thickness: [3.0 mm] [5.0 mm] [6.0 mm] [As indicated] <Insert thickness designation>

5. Inner Lite: Class 1 (clear) float glass.
   a. Kind [HS (heat strengthened)] [FT (fully tempered)].
   b. Thickness: [3.0 mm] [5.0 mm] [6.0 mm] [As indicated] <Insert thickness designation>.

6. Silk-Screened Coating: Ceramic enamel on [second] [third] [fourth] surface.
   a. Color and Pattern: [As selected by Architect from manufacturer's full range] [Match] [Provide] <Insert one manufacturer's color and pattern designation if matching is required; otherwise, insert color and pattern designation for each product named above>.

7. Plastic Interlayer:
   a. Thickness: [0.060 inch] [0.090 inch] [, but not less than that required to comply as a Type II safety glass material].
   b. Interlayer Color: [Clear] [Blue-green] [Bronze light] [Gray] <Insert color>.
   c. Visible Light Transmittance of Interlayer: <Insert single percentage> percent minimum.

8. Visible Light Transmittance: <Insert single percentage> percent minimum.


10. Summer Daytime U-Factor: <Insert single value> maximum.


2.13 INSULATING-GLASS UNITS

A. Passive Solar Low-E Insulating-Glass Units IG-<#>:
   1. Basis-of-Design Product: <Insert manufacturer's name; product name or designation> or a comparable product by one of the firms listed under the "Manufacturers/Fabricators" article.
   2. Overall Unit Thickness and Thickness of Each Lite: 25 and 6.0 mm.
   3. Interspace Content: Air.
   4. Outdoor Lite: Class [1 (clear)] [2 (tinted)] float glass [complying with ceramic-coated vision-glass requirements].
      a. Tint Color: ["Azurlite" by PPG Industries, Inc.] [Blue-green] [Bronze]
         ["EverGreen" by Pilkington Building Products North America]
   5. Indoor Lite: Class 1 (clear) float glass.
6. Low-E Coating: Pyrolytic or sputtered on second or third surface.
7. Silk-Screened Coating: Ceramic enamel on second surface.
   a. Color and Pattern: Insert one manufacturer's color and pattern designation if matching is required; otherwise, insert color and pattern designation for each product named above.
8. Visible Light Transmittance: Insert single percentage percent minimum.
9. Winter Nighttime U-Factor: [0.35] Insert single value maximum.
10. Summer Daytime U-Factor: [0.38] Insert single value maximum.
11. Solar Heat Gain Coefficient: [0.61] Insert single value maximum.

2.14 INSULATING-GLASS UNITS FOR SLOPED GLAZING
A. Passive Solar Low-E Insulating-Glass Units for Sloped Glazing IG-#:
1. Basis-of-Design Product: Insert manufacturer's name; product name or designation or a comparable product by one of the following:
   a. Insert, in separate subparagraphs, manufacturer's name.
2. [Available] Products:
   a. Insert, in separate subparagraphs, manufacturer's name; product name or designation.
3. Thickness of Outdoor Lite: [6 mm] [As indicated] Insert thickness.
4. Thickness of Indoor Lite: [As indicated] Insert thickness.
5. Overall Unit Thickness: [As indicated] Insert thickness.
6. Interspace Content: [Air] [Argon].
7. Outdoor Lite: Class [1 (clear)] [1 ultra-clear (low-iron)] [2 (tinted)] float glass complying with ceramic-coated vision-glass requirements.
   b. Kind [HS (heat strengthened)] [FT (fully tempered)].
8. Indoor Lite: Complying with requirements specified for heat-treated laminated-glass units.
9. Low-E Coating: [Pyrolytic on second] [Pyrolytic on third] [Sputtered on second] [Sputtered on third] [Pyrolytic or sputtered on second or third] surface.
10. Silk-Screened Coating: Ceramic enamel on second surface.
   a. Color and Pattern: [As selected by Architect from manufacturer's full range] [Match] [Provide] <Insert one manufacturer's color and pattern designation if matching is required; otherwise, insert color and pattern designation for each product named above>.
12. Winter Nighttime U-Factor: [0.35] Insert single value maximum.
13. Summer Daytime U-Factor: [0.38] Insert single value maximum.
14. Solar Heat Gain Coefficient: [0.61] Insert single value maximum.
15. Outdoor Visible Reflectance: Insert single percentage percent maximum.

PART 3 - EXECUTION
3.01 EXAMINATION
A. Examine glazing framing, with Installer present, for compliance with the following:

GLAZING
08 80 00 - 10
1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
2. Presence and functioning of weep system.
3. Minimum required face or edge clearances.
4. Effective sealing between joints of glass-framing members.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION
A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

3.03 GLAZING, GENERAL
A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
B. Glazing channel dimensions: Provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances. Adjust as required by Project conditions during installation.
C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.
D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction sealant-substrate testing.
E. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
G. Provide spacers for glass lites where length plus width is larger than 50 inches as follows:
   1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
   2. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
H. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.
I. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

3.04 TAPE GLAZING
A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.
B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.
C. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.

D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.

E. Do not remove release paper from tape until just before each glazing unit is installed.

F. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

G. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.05 GASKET GLAZING (DRY)
A. Fabricate compression gaskets in lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.

C. Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

D. Install gaskets so they protrude past face of glazing stops.

3.06 SEALANT GLAZING (WET)
A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.

C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.07 CLEANING AND PROTECTION
A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels, and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations, including weld splatter. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended by glass manufacturer.

C. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains; remove as recommended in writing by glass manufacturer.

D. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.
E. Wash glass on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

END OF SECTION
SECTION 08 90 00
LOUVERS AND VENTS

PART 1 - GENERAL

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

1.02 SUMMARY
A. This Section includes the following:
  1. Fixed, extruded-aluminum louvers.
  2. Acoustical louvers.
B. Related Sections include the following:
  1. Division 01 Section "Sustainable Design Requirements" for additional LEED requirements.
  2. Division 07 Section "Joint Sealants" for sealants installed in perimeter joints between louver frames and adjoining construction.
  3. Division 23 Sections for louvers that are a part of mechanical equipment.

1.03 DEFINITIONS
A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.
B. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.

1.04 PERFORMANCE REQUIREMENTS
A. Structural Performance: Provide louvers capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act on vertical projection of louvers.
   1. Wind Loads: Determine loads based on pressures as indicated on Drawings.
B. Thermal Movements: Provide louvers that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
C. Air-Performance, Water-Penetration, Air-Leakage, and Wind-Driven Rain Ratings: Provide louvers complying with performance requirements indicated, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.
D. Airborne Sound Transmission Loss: Provide acoustical louvers complying with airborne sound transmission loss ratings indicated, as demonstrated by testing manufacturer's
stock units identical to those specified, except for length and width according to ASTM E 90.

1.05 SUBMITTALS
   A. Product Data: For each type of product indicated.
   B. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other Work. Show blade profiles, angles, and spacing. 
      1. For installed louvers and vents indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   C. Samples: For each type of metal finish required.
   D. LEED Submittals:
      1. Credit MR 5.1 and 5.2: Regionally Extracted, Harvested, or Recovered and Manufactured Materials: 
         a. Indicate location of manufacturing facility, including name, address, and distance between manufacturing facility and the project site. Provide manufacturer’s documentation indicating location where the base materials were extracted, mined, quarried, harvested, etc., and the distance between this location and the project site. Also include material costs, excluding cost of installation.
      2. Product Data for Credit EQ 4.1: For sealants, including printed statement of VOC content and chemical components.

1.06 QUALITY ASSURANCE
   A. Source Limitations: Obtain louvers and vents through one source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.
   B. Welding: Qualify procedures and personnel according to the following:

1.07 PROJECT CONDITIONS
   A. Field Measurements: Verify louver openings by field measurements before fabrication and indicate measurements on Shop Drawings.
      1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish opening dimensions and proceed with fabricating louvers without field measurements. Coordinate construction to ensure that actual opening dimensions correspond to established dimensions.

PART 2 - PRODUCTS

2.01 GENERAL
   A. Local/Regional Materials:
      1. Preference shall be given to manufacturer's whose facilities are within a 500 mile radius of the project site.
      2. Preference shall also be given to materials that are harvested, extracted, mined, quarried, etc. within a 500 mile radius of the project site.
2.02 MANUFACTURERS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Louvers:
      a. Airline Products Co.
      b. Airolite Company (The).
      c. American Warming and Ventilating, Inc.
      d. Arrow United Industries.
      e. Carnes Company, Inc.
      f. Cesco Products.
      g. Construction Specialties, Inc.
      h. Dowco Products Group; Safe-Air of Illinois, Inc.
      i. Greenheck.
      j. Industrial Louvers, Inc.
      k. Louvers & Dampers, Inc.
      l. Metal Form Manufacturing Company, Inc.
      m. NCA Manufacturing, Inc.
      n. Nystrom Building Products.
      o. Reliable Products; Hart & Cooley, Inc.
      p. Ruskin Company; Tomkins PLC.
      q. Vent Products Company, Inc.

2.03 MATERIALS
A. Aluminum Extrusions: ASTM B 221, alloy 6063-T5 or T-52.
B. Aluminum Sheet: ASTM B 209, alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by metal producer for required finish.
D. Fasteners: Of same basic metal and alloy as fastened metal or 300 Series stainless steel, unless otherwise indicated. Do not use metals that are incompatible with joined materials.
   1. Use types and sizes to suit unit installation conditions.
   2. Use hex-head or Phillips pan-head screws for exposed fasteners, unless otherwise indicated.
E. Postinstalled Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, made from stainless-steel components, with capability to sustain, without failure, a load equal to 4 times the loads imposed, for concrete, or 6 times the load imposed, for masonry, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.
F. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.04 FABRICATION, GENERAL
A. Assemble louvers in factory to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
B. Vertical Assemblies: Where height of louver units exceeds fabrication and handling limitations, fabricate units to permit field-bolted assembly with close-fitting joints in jambs and mullions, reinforced with splice plates.
   1. Continuous Vertical Assemblies: Fabricate units without interrupting blade-spacing pattern unless horizontal mullions are indicated.
   2. Horizontal Mullions: Provide horizontal mullions at joints unless continuous vertical assemblies are indicated.
C. Maintain equal louver blade spacing to produce uniform appearance.

D. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
   1. Frame Type: Channel, unless otherwise indicated.

E. Include supports, anchorages, and accessories required for complete assembly.

F. Provide vertical mullions of type and at spacings indicated, but not more than recommended by manufacturer, or 72 inches o.c., whichever is less.
   1. Semirecessed Mullions: Where indicated, provide mullions partly recessed behind louver blades so louver blades appear continuous. Where length of louver exceeds fabrication and handling limitations, fabricate with interlocking split mullions and close-fitting blade splices designed to permit expansion and contraction.
   2. Exposed Mullions: Where indicated, provide units with exposed mullions of same width and depth as louver frame. Where length of louver exceeds fabrication and handling limitations, provide interlocking split mullions designed to permit expansion and contraction.
   3. Exterior Corners: Prefabricated corner units with mitered blades with concealed close-fitting splices and with semirecessed mullions at corners.

G. Provide subsills made of same material as louvers or extended sills for recessed louvers.

H. Join frame members to each other and to fixed louver blades with fillet welds concealed from view, unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

I. Join frame members to each other and to fixed louver blades with fillet welds, threaded fasteners, or both, as standard with louver manufacturer, concealed from view, unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

2.05 FIXED, EXTRUDED-ALUMINUM LOUVERS

A. Horizontal Storm-Resistant Louver <Insert drawing designation, e.g., LV-1>:
   1. Louver Depth: [4 inches] [5 inches] [7 inches] [8 inches] [9 inches] <Insert depth>.
   2. Frame and Blade Nominal Thickness: As required to comply with structural performance requirements, but not less than 0.080 inch.
   3. Performance Requirements:
      a. Free Area: Not less than 7.0 sq. ft. for 48-inch- wide by 48-inch- high louver.
      b. Air Performance: Not more than 0.10-inch wg static pressure drop at 700-fpm free-area velocity.
      c. Wind-Driven Rain Performance: Not less than 95 percent effectiveness when subjected to a rain fall rate of 3 inches per hour and a wind speed of 29 mph at a core area intake velocity of 400 fpm.
   4. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

2.06 FIXED, ACOUSTICAL LOUVERS

A. Fixed, Formed-Metal Louver <Insert drawing designation, e.g., LV-1>: Extruded- or formed-metal frames and formed-metal blades filled on interior with mineral-fiber, rigid-board, acoustical insulation retained by perforated metal sheet.
   1. Louver Depth: [6 inches] [8 inches] [12 inches].
   2. Frame Material: Aluminum, of thickness required to comply with structural performance requirements, but not less than 0.080-inch nominal thickness.
3. Blade Material: Aluminum sheet, of thickness required to comply with structural performance requirements, but not less than 0.080-inch nominal thickness.

4. Blade Angle: 45 degrees, unless otherwise indicated.

5. Blade Spacing: 6 inches o.c. for 6-inch-deep louvers.


8. Free Area: Not less than 4 sq. ft. for 48-inch-wide by 48-inch-high louver.

9. Airborne Sound Transmission Loss: STC 10 per ASTM E 413, determined by testing per ASTM E 90.

2.07 LOUVER SCREENS

A. General: Provide screen at each exterior louver.
   1. Screen Location for Fixed Louvers: Interior face.
   2. Screening Type: Bird screening at exhaust louvers; insect screening at intake louvers.

B. Secure screens to louver frames with stainless-steel machine screws, spaced a maximum of 6 inches from each corner and at 12 inches o.c.

C. Louver Screen Frames: Fabricate with mitered corners to louver sizes indicated.
   1. Metal: Same kind and form of metal as indicated for louver to which screens are attached. Reinforce extruded-aluminum screen frames at corners with clips.
   2. Finish: Same finish as louver frames to which louver screens are attached.
   3. Type: Non-rewirable, U-shaped frames for permanently securing screen mesh.

D. Louver Screening for Aluminum Louvers:
   1. Bird Screening: Aluminum, 1/2-inch-square mesh, 0.063-inch wire.
   2. Insect Screening: Aluminum, 18-by-16 mesh, 0.012-inch wire.

2.08 BLANK-OFF PANELS

A. Insulated, Blank-off Panels: Laminated metal-faced panels consisting of insulating core surfaced on back and front with metal sheets.
   1. Thickness: 2 inches.
   2. Metal Facing Sheets: Aluminum sheet, not less than 0.032-inch nominal thickness.
   3. Insulating Core: Unfaced mineral-fiber or foamed-plastic rigid insulation board.
   4. Edge Treatment: Trim perimeter edges of blank-off panels with louver manufacturer's standard extruded-aluminum-channel frames, not less than 0.080-inch nominal thickness, with corners mitered and with same finish as panels.
   5. Seal perimeter joints between panel faces and louver frames with 1/8-by-l-inch PVC compression gaskets.
   6. Panel Finish: Same type of finish applied to louvers, but black color.
   7. Attach blank-off panels to back of louver frames with clips.

2.09 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish louvers after assembly.

2.10 ALUMINUM FINISHES

A. Finish designations prefixed by AA comply with system established by the Aluminum Association for designating aluminum finishes.
B. Class I, Color Anodic Finish: AA-M12C22A42/A44 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.

PART 3 - EXECUTION

3.01 EXAMINATION
A. Examine substrates and openings, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION
A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.03 INSTALLATION
A. Locate and place louvers and vents level, plumb, and at indicated alignment with adjacent work.
B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.
C. Form closely fitted joints with exposed connections accurately located and secured.
D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
E. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.
F. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.
G. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Division 07 Section "Joint Sealants" for sealants applied during louver installation.

3.04 ADJUSTING AND CLEANING
A. Test operation of adjustable louvers and adjust as needed to produce fully functioning units that comply with requirements.
B. Clean exposed surfaces of louvers and vents that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate until final cleaning.
C. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.
D. Restore louvers and vents damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.

1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION
SECTION 09 21 16
GYPSUM BOARD SHAFT WALL ASSEMBLIES

PART 1 - GENERAL

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

1.02 SUMMARY
   A. This Section includes gypsum board shaft-wall assemblies for the following:
      1. Shaft-wall enclosures.
      2. Chase enclosures.
      3. Horizontal enclosures.
   B. Related Sections include the following:
      1. Division 01 Section "Sustainable Design Requirements" for additional LEED requirements.
      2. Division 07 Section "Fire-Resistive Joint Systems" for head-of-wall assemblies that incorporate gypsum board shaft-wall assemblies.

1.03 SUBMITTALS
   A. Product Data: For each gypsum board shaft-wall assembly indicated.
   B. LEED Submittals:
      1. Credit EQ 4.1: Product Data for adhesives, including printed statement of VOC content.
      2. Credit MR 4.1 and 4.2: Product Data indicating percentages by weight of postconsumer and preconsumer recycled content for sound attenuation insulation.
         a. Include statement indicating costs for each product having recycled content.

1.04 QUALITY ASSURANCE
   A. Fire-Resistance Ratings: Provide materials and construction identical to those of assemblies with fire-resistance ratings determined according to ASTM E 119 by a testing and inspecting agency.
   B. STC-Rated Assemblies: Provide materials and construction identical to those of assemblies tested according to ASTM E 90 and classified according to ASTM E 413 by a testing and inspecting agency.
   C. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." Review methods and procedures for installing gypsum board shaft-wall assemblies including, but not limited to, the following:
      1. Fasteners proposed for anchoring nonstructural steel framing to building structure.
      2. Sprayed fire-resistive materials applied to structural steel framing.
      3. Elevator equipment, including hoistway doors, elevator call buttons, and elevator floor indicators.
      4. Wiring devices in shaft-wall assemblies.
      5. Doors and other items penetrating shaft-wall assemblies.
6. Items supported by shaft-wall-assembly framing.
7. Mechanical work enclosed within shaft-wall assemblies.

1.05 DELIVERY, STORAGE, AND HANDLING
A. Deliver materials in original packages, containers, and bundles bearing brand name and identification of manufacturer or supplier.
B. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes.
C. Stack panels flat on leveled supports off floor or slab to prevent sagging.

1.06 PROJECT CONDITIONS
A. Environmental Limitations: Comply with ASTM C 840 requirements or with gypsum board manufacturer's written recommendations, whichever are more stringent.
B. Do not install interior products until installation areas are enclosed and conditioned.
C. Do not install panels that are wet, moisture damaged, or mold damaged.
   1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and irregular shape.
   2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.01 MANUFACTURERS
A. Subject to compliance with requirements, provide products by one of the following:
   1. G-P Gypsum.
   3. USG Corporation.

2.02 GYPSUM BOARD SHAFT-WALL ASSEMBLIES, GENERAL
A. Provide materials and components complying with requirements of fire-resistance-rated assemblies indicated.
   1. Provide panels in maximum lengths available to eliminate or minimize end-to-end butt joints.
   2. Provide auxiliary materials complying with gypsum board shaft-wall assembly manufacturer's written recommendations.

2.03 PANEL PRODUCTS
A. Gypsum Liner Panels: Comply with ASTM C 442/C 442M.
   1. Type X: Manufacturer's proprietary liner panels with moisture-resistant paper faces.
      a. Core: 1 inch thick.
      b. Long Edges: Double bevel.
B. Gypsum Board: As specified in Division 09 Section "Gypsum Board."

2.04 NON-LOAD-BEARING STEEL FRAMING
A. Framing Members: Comply with ASTM C 754 for conditions indicated.
B. Steel Sheet Components: Comply with ASTM C 645 requirements for metal, unless otherwise indicated.

2.05 AUXILIARY MATERIALS
A. General: Provide auxiliary materials that comply with referenced product standards and manufacturer's written recommendations.

B. Trim Accessories: Corner bead, edge trim, and control joints of material and shapes specified in Division 09 Section "Gypsum Board" that comply with gypsum board shaft-wall assembly manufacturer's written recommendations for application indicated.

C. Gypsum Board Joint-Treatment Materials: As specified in Division 09 Section "Gypsum Board."

D. Laminating Adhesive: Adhesive or joint compound recommended by manufacturer for directly adhering gypsum face-layer panels to backing-layer panels in multilayer construction.
   1. Use adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
   1. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

F. Track Fasteners: Power-driven fasteners of size and material required to withstand loading conditions imposed on shaft-wall assemblies without exceeding allowable design stress of track, fasteners, or structural substrates in which anchors are embedded.
   1. Expansion Anchors: Fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 5 times design load, as determined by testing per ASTM E 488 conducted by a qualified testing agency.
   2. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 10 times design load, as determined by testing per ASTM E 1190 conducted by a qualified testing agency.

2.06 GYPSUM BOARD SHAFT-WALL ASSEMBLIES
A. Basis-of-Design Product: As indicated on Drawings by design designation of a qualified testing agency.

B. Fire-Resistance Rating: As indicated.

C. STC Rating: As indicated.

D. Studs: Manufacturer's standard profile for repetitive members, corner and end members, and fire-resistance-rated assembly indicated.
   1. Depth: As indicated.
      a. When approved by Architect, depth of members may be modified to comply with deflection limits.
   2. Minimum Base-Metal Thickness: As required to limit allowable deflection of framed assembly to L/360 for vertical span.

E. Runner Tracks: Manufacturer's standard J-profile track with long-leg length as standard with manufacturer, but at least 2 inches long and in depth matching studs.
   1. Minimum Base-Metal Thickness: 0.0179 inch.

F. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Dietrich Metal Framing; “The System” by Metal-Lite, Inc.
   b. Fire Trak Corp.; “Fire Trak” attached to studs with Fire Trak Slip Clip.

G. Jamb Struts: Manufacturer’s standard J-profile strut with long-leg length of 3 inches, in depth matching studs, and not less than 0.0329 inch thick.

H. Room-Side Finish: Gypsum board.

I. Shaft-Side Finish: As indicated by fire-resistance-rated assembly design designation.

J. Insulation: Sound attenuation blankets.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates to which gypsum board shaft-wall assemblies attach or abut, with Installer present, including hollow-metal frames, elevator hoistway door frames, cast-in anchors, and structural framing. Examine for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, or mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

3.03 INSTALLATION

A. General: Install gypsum board shaft-wall assemblies to comply with requirements of fire-resistance-rated assemblies indicated, manufacturer’s written installation instructions, and the following:
   1. ASTM C 754 for installing steel framing except comply with framing spacing indicated.
   2. Division 09 Section "Gypsum Board" for applying and finishing panels.
   3. Division 09 Section "Tiling" for cementitious backer units.

B. Do not bridge architectural or building expansion joints with shaft-wall assemblies; frame both sides of expansion joints with furring and other support.

C. Install supplementary framing in gypsum board shaft-wall assemblies around openings and as required for blocking, bracing, and support of gravity and pullout loads of fixtures, equipment, services, heavy trim, furnishings, and similar items that cannot be supported directly by shaft-wall assembly framing.
   1. At elevator hoistway entrance door frames, provide jamb struts on each side of door frame.
   2. Where handrails directly attach to gypsum board shaft-wall assemblies, provide galvanized steel reinforcing strip with 0.0312-inch minimum thickness of base (uncoated) metal, accurately positioned and secured behind at least 1 gypsum board face-layer panel.

D. At penetrations in shaft wall, maintain fire-resistance rating of shaft-wall assembly by installing supplementary steel framing around perimeter of penetration and fire protection behind boxes containing wiring devices, elevator call buttons, elevator floor indicators, and similar items.

E. Isolate perimeter of gypsum panels from building structure to prevent cracking of panels, while maintaining continuity of fire-rated construction.
F. Firestop Tracks: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.

G. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect, while maintaining fire-resistance rating of gypsum board shaft-wall assemblies.

H. Seal gypsum board shaft walls with acoustical sealant at perimeter of each assembly where it abuts other work and at joints and penetrations within each assembly. Install acoustical sealant to withstand dislocation by air-pressure differential between shaft and external spaces; maintain an airtight and smoke-tight seal; and comply with ASTM C 919 requirements or with manufacturer's written instructions, whichever are more stringent.

I. In elevator shafts where gypsum board shaft-wall assemblies cannot be positioned within 4 inches of the shaft face of structural beams, floor edges, and similar projections into shaft, install 1/2- or 5/8-inch- thick, gypsum board cants covering tops of projections. No recesses allowed (at steel beams especially).
   1. Slope cant panels at least 75 degrees from horizontal. Set base edge of panels in adhesive and secure top edges to shaft walls at 24 inches o.c. with screws fastened to shaft-wall framing.
   2. Where steel framing is required to support gypsum board cants, install framing at 24 inches o.c. and extend studs from the projection to shaft-wall framing.

J. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

3.04 PROTECTION

A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

B. Remove and replace panels that are wet, moisture damaged, or mold damaged.
   1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and irregular shape.
   2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION
SECTION 09 22 16
NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

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

1.02 SUMMARY
A. This Section includes non-load-bearing steel framing members for the following applications:
   1. Interior framing systems (e.g., supports for partition walls, framed soffits, furring, etc.).
   2. Interior suspension systems (e.g., supports for ceilings, suspended soffits, etc.).
B. Related Sections include the following:
   1. Division 01 Section "Sustainable Design Requirements" for additional LEED requirements.
   2. Division 05 Section "Cold-Formed Metal Framing" for exterior and interior load-bearing and exterior non-load-bearing wall studs; floor joists; roof rafters and ceiling joists; and roof trusses.
   3. Division 07 Section "Thermal Insulation" for insulation installed with Z-shaped furring members.
   5. Division 09 Section "Portland Cement Plastering" for metal lath supported by non-load-bearing steel framing.
   6. Division 09 Section "Gypsum Board Shaft Wall Assemblies" for non-load-bearing metal shaft-wall framing, gypsum panels, and other components of shaft-wall assemblies.

1.03 SUBMITTALS
A. Product Data: For each type of product indicated.
B. LEED Submittals:
   1. Credit MR 4.1 and 4.2: Recycled Content:
      a. Submit documentation from manufacturer indicating separate percentages, by weight, of pre-consumer and post-consumer recycled content per unit of product. Also include material costs, excluding cost of installation.
   2. Credit MR 5.1 and 5.2: Regionally Extracted, Harvested, or Recovered and Manufactured Materials:
      a. Indicate location of manufacturing facility, including name, address, and distance between manufacturing facility and the project site. Provide manufacturer’s documentation indication location where the base materials were extracted, mined, quarried, harvested, etc., and the distance between this location and the project site. Also include material costs, excluding cost of installation.
1.04 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

PART 2 - PRODUCTS

2.01 GENERAL

A. Recycled Content: Materials/products shall contain the maximum amount of recycled content allowed that retains material integrity.

B. Regionally Extracted, Harvested, or Recovered and Manufactured Materials:
   1. Preference shall be given to manufacturer’s whose facilities are within a 500 mile radius of the project site.
   2. Preference shall also be given to materials that are harvested, extracted, mined, quarried, etc. within a 500 mile radius of the project site.

2.02 NON-LOAD-BEARING STEEL FRAMING, GENERAL

A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.
   1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal, unless otherwise indicated.

2.03 SUSPENSION SYSTEM COMPONENTS

A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625-inch- diameter wire, or double strand of 0.0475-inch- diameter wire.

B. Hanger Attachments to Concrete:
   1. Anchors: Fabricated from corrosion-resistant materials with holes or loops for attaching wire hangers and capable of sustaining, without failure, a load equal to 5 times that imposed by construction as determined by testing according to ASTM E 488 by an independent testing agency.
      a. Type: Cast-in-place anchor, designed for attachment to concrete forms Postinstalled, expansion anchor.
   2. Powder-Actuated Fasteners: Suitable for application indicated, fabricated from corrosion-resistant materials with clips or other devices for attaching hangers of type indicated, and capable of sustaining, without failure, a load equal to 10 times that imposed by construction as determined by testing according to ASTM E 1190 by an independent testing agency.

C. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.162-inch diameter.

D. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.0538 inch and minimum 1/2-inch- wide flanges.
   1. Depth: 1-1/2 inches.

E. Furring Channels (Furring Members):
a. Minimum Base Metal Thickness: 0.0179 inch.

F. Grid Suspension System for Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.
   1. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
      b. USG Corporation; Drywall Suspension System.

2.04 STEEL FRAMING FOR FRAMED ASSEMBLIES

A. Steel Studs and Runners: ASTM C 645.
   1. Minimum Base-Metal Thickness: As required to limit allowable deflection of framed assembly to L/240 for vertical span.
   2. Depth: As indicated on Drawings.
      a. When approved by Architect, depth of members may be modified to comply with deflection limits.

B. Slip-Type Head Joints: Where indicated, provide one of the following:
   1. Single Long-Leg Runner System: ASTM C 645 top runner with 2-inch-deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top runner and with continuous bridging located within 12 inches of the top of studs to provide lateral bracing.
   2. Double-Runner System: ASTM C 645 top runners, inside runner with 2-inch-deep flanges in thickness not less than indicated for studs and fastened to studs, and outer runner sized to friction fit inside runner.
   3. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.
      a. Products: Subject to compliance with requirements, provide one of the following:
         1) Steel Network Inc. (The); VertiClip SLD/VertiTrack VTD Series.
         2) Superior Metal Trim; Superior Flex Track System (SFT).

C. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Fire Trak Corp.; Fire Trak attached to studs with Fire Trak Slip Clip.
      b. Metal-Lite, Inc.; The System.

D. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
   1. Minimum Base-Metal Thickness: 0.0179 inch.

E. Cold-Rolled Channel Bridging: 0.0538-inch bare-steel thickness, with minimum 1/2-inch-wide flanges.
   1. Depth: 1-1/2 inches.
   2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches, 0.068-inch-thick, galvanized steel.

F. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
   1. Minimum Base Metal Thickness: 0.0179 inch.
   2. Depth: 7/8 inch.

G. Resilient Furring Channels: 1/2-inch-deep, steel sheet members designed to reduce sound transmission.
   1. Configuration: Asymmetrical or hat shaped.
H. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches, wall attachment flange of 7/8 inch, minimum bare-metal thickness of 0.0179 inch, and depth required to fit insulation thickness indicated.

2.05 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards.
1. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

B. Isolation Strip at Exterior Walls: Provide one of the following:
1. Asphalt-Saturated Organic Felt: ASTM D 226, Type I (No. 15 asphalt felt), nonperforated.
2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch thick, in width to suit steel stud size.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance.
1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.
1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.

3.03 INSTALLATION, GENERAL

1. Portland Cement Plaster Assemblies: Also comply with requirements in ASTM C 1063 that apply to framing installation.
2. Gypsum Veneer Plaster Assemblies: Also comply with requirements in ASTM C 844 that apply to framing installation.
3. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.

B. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

C. Install bracing at terminations in assemblies.

D. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.
3.04 INSTALLING SUSPENSION SYSTEMS

A. Install suspension system components in sizes and spacings indicated on Drawings, but not less than those required by referenced installation standards for assembly types and other assembly components indicated.

B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.

C. Suspend hangers from building structure as follows:
   1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
      a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
   2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
      a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.
   3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
   4. Do not attach hangers to steel roof deck.
   5. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
   6. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
   7. Do not connect or suspend steel framing from ducts, pipes, or conduit.

D. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.

E. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

3.05 INSTALLING FRAMED ASSEMBLIES

A. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

B. Install studs so flanges within framing system point in same direction.
   1. Space studs as follows:
      a. Single-Layer Application: 16 inches o.c., unless otherwise indicated.
      b. Multilayer Application: 16 inches o.c., unless otherwise indicated.
      c. Tile backing panels: 16 inches o.c., unless otherwise indicated.

C. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.
   1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
   a. Install two studs at each jamb, unless otherwise indicated.
   b. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.

3. Other Framed Openings: Frame openings other than door openings the same as required for door openings, unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.

4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
   a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.

5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.

D. Direct Furring:
   1. Screw to wood framing.
   2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.

E. Z-Furring Members:
   1. Erect insulation (specified in Division 07 Section "Thermal Insulation") vertically and hold in place with Z-furring members spaced 24 inches o.c.
   2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
   3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches from corner and cut insulation to fit.

F. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

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. This Section includes the following:
   1. Interior gypsum board.
   2. Tile backing panels.
   3. Column covers.
   4. Extruded aluminum trim.
B. Related Sections include the following:
   1. Division 01 Section "Sustainable Design Requirements" for additional LEED requirements that affect gypsum board and related products.
   2. Division 05 Section "Cold-Formed Metal Framing" for load-bearing steel framing that supports gypsum board.
   3. Division 06 Section "Rough Carpentry" for wood framing and furring that supports gypsum board.
   4. Division 06 Section "Sheathing" for gypsum sheathing.
   5. Division 07 Section "Thermal Insulation" for insulation and vapor retarders installed in assemblies that incorporate gypsum board.
   6. Division 07 Section "Fire-Resistive Joint Systems" for head-of-wall assemblies that incorporate gypsum board.
   7. Division 09 Section "Non-Structural Metal Framing" for non-structural framing and suspension systems that support gypsum board.
   8. Division 09 Section "Gypsum Board Shaft-Wall Assemblies" for metal shaft-wall framing, gypsum shaft liners, and other components of shaft-wall assemblies.
   9. Division 09 Section "Tiling" for cementitious backer units installed as substrates for ceramic tile.
  10. Division 09 painting Sections for primers applied to gypsum board surfaces.

1.03 SUBMITTALS
A. Product Data: For each type of product indicated.
B. LEED Submittals:
   1. Credit MR 4.1 and 4.2: Recycled Content:
      a. Submit documentation from manufacturer indicating separate percentages, by weight, of pre-consumer and post-consumer recycled content per unit of product. Also include material costs, excluding cost of installation.
   2. Credit MR 5.1 and 5.2: Regionally Extracted, Harvested, or Recovered and Manufactured Materials:
      a. Indicate location of manufacturing facility, including name, address, and distance between manufacturing facility and the project site. Provide manufacturer's documentation indication location where the base materials were extracted, mined, quarried, harvested, etc., and the
distance between this location and the project site. Also include material costs, excluding cost of installation.

3. Credit EQ 4.1: Low Emitting Materials: Manufacturers' product data for adhesives used to laminate gypsum board panels to substrates, including printed statement of VOC content.

1.04 QUALITY ASSURANCE

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

C. Mockups: Before beginning gypsum board installation, install mockups of at least 100 sq. ft. in surface area to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Install mockups for the following:
      a. Each level of gypsum board finish indicated for use in exposed locations.
   2. Apply or install final decoration indicated, including painting and wallcoverings, on exposed surfaces for review of mockups.
   3. Simulate finished lighting conditions for review of mockups.
   4. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.05 STORAGE AND HANDLING

A. Store materials inside under cover and keep them dry and protected against damage from weather, condensation, direct sunlight, construction traffic, and other causes. Stack panels flat to prevent sagging.

1.06 PROJECT CONDITIONS

A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.

B. Do not install interior products until installation areas are enclosed and conditioned.

C. Do not install panels that are wet, those that are moisture damaged, and those that are mold damaged.
   1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
   2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.01 GENERAL

A. Recycled Content: Materials/products shall contain the maximum amount of recycled content allowed that retains material integrity.

B. Regionally Extracted, Harvested, or Recovered, and Manufactured Materials:
   1. Preference shall be given to manufacturer's whose facilities are within a 500 mile radius of the project site.
2. Preference shall also be given to materials that are harvested, extracted, mined, quarried, etc. within a 500 mile radius of the project site.

2.02 PANELS, GENERAL
A. Size: Provide in maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.03 INTERIOR GYPSUM BOARD
A. General: Complying with ASTM C 36/C 36M or ASTM C 1396/C 1396M, as applicable to type of gypsum board indicated and whichever is more stringent.
   1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. G-P Gypsum.
      c. USG Corporation.

B. Type X:
   1. Thickness: 1/2 inch and 5/8 inch.
   2. Long Edges: Tapered.

C. Abuse-Resistant Type: Manufactured to produce greater resistance to surface indentation, through-penetration (impact resistance), and abrasion than standard, regular-type and Type X gypsum board.
   1. Core: 5/8 inch, Type X.
   2. Long Edges: Tapered.

2.04 TILE BACKING PANELS
A. Water-Resistant Gypsum Backing Board: ASTM C 630/C 630M or ASTM C 1396/C 1396M.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. G-P Gypsum.
      c. USG Corporation.
   2. Core: 5/8 inch, Type X.

2.05 COLUMN COVERS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. ATAS International, Inc.
   2. Ceilings Plus, Inc.
   3. Firestone Metal Products.
   4. Fry Reglet Corporation.
   5. Industrial Louvers, Inc.
   7. Pittcon Industries.

B. Spackled-Seam Type: Form column covers from 0.125-inch aluminum, rolled to radii indicated. Taper edges of adjoining pieces of column covers, for taping and spackling, to 0.094-inch thickness in approximately 1 inch of width. Punch tapered edges for gypsum board screws at 1/2 inch o.c., and mill grooves in tapered edge to improve bond with joint compound.
   1. Trim: Provide reveal base and head trim.
2. Support Framing: At vertical joints, provide 1-1/2 by 3-5/8-inch steel channel support posts formed from 0.040-inch galvanized steel.

2.06 FILLER PANELS
A. Form filler panels for closing ends of partition systems and for other applications indicated. Form from two sheets of metal of type and thickness indicated below, separated by channels formed from the same material, producing a panel of same thickness as mullions, unless otherwise indicated. Incorporate reveals, trim, and concealed anchorages for attaching to adjacent surfaces.
   1. Steel Sheet: 0.053 inch.
   2. Filler panels may be fabricated from prefinished metal sheet in lieu of finishing after fabrication provided unfinished edges are concealed from view.
B. Fill interior of panel with sound-deadening insulation permanently attached to inside panel faces.
C. Adhesively attach gaskets to filler panel edges where they abut mullions or glazing. Use 1-inch- square material, unless otherwise indicated, set approximately 1/4 inch into channeled edge of filler panel.
D. Attach gaskets to all edges of panels that abut adjacent surfaces to form a continuous seal. Use compressible gaskets or mastic sealing tape, applied to center of panel edges to be concealed from view, unless otherwise indicated.
E. Do not mechanically fasten filler panels to mullions.

2.07 TRIM ACCESSORIES
A. Interior Trim: ASTM C 1047.
   1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.
   2. Shapes:
      a. Cornerbead.
      b. LC-Bead: J-shaped; exposed long flange receives joint compound.
      c. Expansion (control) joint.
      d. Curved-Edge Cornerbead: With notched or flexible flanges.
   1. Material: Hot-dip galvanized steel sheet, or rolled zinc.
   2. Shapes:
      a. Cornerbead.
      b. LC-Bead: J-shaped; exposed long flange receives joint compound.
      c. Expansion (Control) Joint: One-piece, rolled zinc with V-shaped slot and removable strip covering slot opening.
C. Aluminum Trim:
   1. Extruded accessories of profiles and dimensions indicated, including, but not limited to:
      a. Reveal moldings.
      b. Reveal picture hangers.
      c. Reveal base.
      d. Glazing tracks.
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Fry Reglet Corp.
      b. Gordon, Inc.
      c. Pittcon Industries.
3. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B 221, Alloy 6063-T5.
4. Finish: Corrosion-resistant primer compatible with joint compound and finish materials specified.

2.08 JOINT TREATMENT MATERIALS
A. General: Comply with ASTM C 475/C 475M.
B. Joint Tape:
   1. Interior Gypsum Wallboard: Paper.
   2. Tile Backing Panels: As recommended by panel manufacturer.
C. Joint Compound for Interior Gypsum Wallboard: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.
   1. Prefilling: At open joints and damaged surface areas, use setting-type taping compound.
   2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.
      a. Use setting-type compound for installing paper-faced metal trim accessories.
   3. Fill Coat: For second coat, use setting-type, sandable topping compound.
   4. Finish Coat: For third coat, use setting-type, sandable topping compound.
   5. Skim Coat: For final coat of Level 5 finish, use setting-type, sandable topping compound.
D. Joint Compound for Tile Backing Panels:
   1. Water-Resistant Gypsum Backing Board: Use setting-type taping compound and setting-type, sandable topping compound.

2.09 AUXILIARY MATERIALS
A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.
B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
   1. Use adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
C. Spot-Grout: ASTM C 475, setting type joint compound for spot-grouting hollow metal frames.
D. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
   1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
   2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
E. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
   1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
F. Acoustical Sealant: As specified in Division 07 Section "Joint Sealants."
G. Thermal Insulation: As specified in Division 07 Section "Thermal Insulation."
H. Vapor Retarder: As specified in Division 07 Section "Thermal Insulation."
PART 3 - EXECUTION

3.01 EXAMINATION
A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames and framing, for compliance with requirements and other conditions affecting performance.
B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 APPLYING AND FINISHING PANELS, GENERAL
A. Comply with ASTM C 840.
B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.
D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
E. Form control and expansion joints with space between edges of adjoining gypsum panels.
F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
   1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
   2. Fit gypsum panels around ducts, pipes, and conduits.
   3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- wide joints to install sealant.
G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch- wide spaces at these locations, and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
I. Wood Framing: Install gypsum panels over wood framing, with floating internal corner construction. Do not attach gypsum panels across the flat grain of wide-dimension lumber, including floor joists and headers. Float gypsum panels over these members, or provide control joints to counteract wood shrinkage.
J. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written recommendations for locating...
edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.

3.03 APPLYING INTERIOR GYPSUM BOARD
A. Install interior gypsum board in the following locations:
   1. Type X: Vertical surfaces, unless otherwise indicated.
   2. Ceiling Type: Ceiling surfaces.
   3. Abuse-Resistant Type: As indicated on Drawings.
B. Single-Layer Application:
   1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing, unless otherwise indicated.
   2. On partitions/walls, apply gypsum panels horizontally (perpendicular to framing), unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
      a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
      b. At stairwells and other high walls, install panels horizontally, unless otherwise indicated or required by fire-resistance-rated assembly.
   3. On Z-furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
   4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.
C. Multilayer Application:
   1. On ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints 1 framing member, 16 inches minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.
   2. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
   3. On Z-furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
   4. Fastening Methods: Fasten base layers and face layers separately to supports with screws.
D. Hollow Metal Frames: Spot-grout hollow metal door frames for solid-core wood doors, hollow metal doors and doors over 32 inches wide. Apply spot-grout at each jamb anchor clip just before inserting board into frame.
E. Laminating to Substrate: Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum board manufacturer’s written recommendations and temporarily brace or fasten gypsum panels until fastening adhesive has set.

3.04 APPLYING TILE BACKING PANELS
A. Water-Resistant Gypsum Backing Board: Install at surfaces receiving tile unless indicated otherwise. Install with 1/4-inch gap where panels abut other construction or penetrations.
B. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

3.05 INSTALLING TRIM ACCESSORIES

A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

B. Control Joints: Place control joints consistent with lines of building spaces and as follows:
   1. Control joints shall be installed where indicated on the Drawings. Full height door frames shall be considered equivalent to a control joint.
   2. A control joint shall be installed where a partition, wall, or ceiling traverses a joint (expansion, seismic, control, deflection-accommodating) in the base building structure.
   3. A control joint shall be installed in partitions or furred gypsum board at intervals not to exceed 30 feet.
   4. Control joints in interior ceilings with perimeter relief shall be installed so that linear dimensions between control joints do not exceed 50 feet and total area between control joints does not exceed 2500 sq ft.
   5. Control joints in interior ceilings without perimeter relief shall be installed so that linear dimensions between control joints do not exceed 30 feet and total area between control joints does not exceed 900 square feet.
   6. A control joint shall be installed between legs of "L", "U", or "T" shaped fields of gypsum board exceeding 50 square feet.
   7. A control joint or intermediate blocking shall be installed where ceiling framing members change direction.
   8. Where a control joint occurs in an acoustical or firerated system, blocking shall be provided behind the control joint by using a backing material such as 5/8 inch Type X gypsum board, mineral fiber, or other tested equivalent. See the Gypsum Association's Fire Resistance Design Manual (GA-600).
   9. If control joints are required at locations other than indicated, verify arrangement with Architect.

C. Interior Trim: Install in the following locations:
   1. Cornerbead: Use at outside corners.
   2. LC-Bead: Use at exposed panel edges.
   3. Curved-Edge Cornerbead: Use at curved openings.

D. Aluminum Trim: Install in locations indicated on Drawings.

3.06 FINISHING GYPSUM BOARD

A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.

B. Prefill open joints and damaged surface areas.

C. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.

D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:
   1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
   2. Level 2: Panels that are substrate for tile.
   3. Level 4: At panel surfaces that will be exposed to view, unless otherwise indicated.
a. Primer and its application to surfaces are specified in other Division 09 Sections.

4. Level 5: Where indicated on Drawings.
   a. Primer and its application to surfaces are specified in other Division 09 Sections.

3.07 PROTECTION

   A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

   B. Remove and replace panels that are wet, moisture damaged, and mold damaged.
      1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
      2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

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. This Section includes the following:
   1. Ceramic mosaic tile.
   2. Waterproof membrane for thin-set tile installations.
   3. Crack-suppression membrane for thin-set tile installations.
   4. Cementitious backer units installed as part of tile installations.
   5. Metal edge strips installed as part of tile installations.
B. Related Sections include the following:
   1. Division 01 Section "Sustainable Design Requirements" for additional LEED requirements.
   2. Division 03 Section "Cast-in-Place Concrete" for monolithic slab finishes specified for tile substrates.
   3. Division 07 Section "Joint Sealants" for sealing of expansion, contraction, control, and isolation joints in tile surfaces.

1.03 DEFINITIONS
A. Module Size: Actual tile size (minor facial dimension as measured per ASTM C 499) plus joint width indicated.
B. Facial Dimension: Actual tile size (minor facial dimension as measured per ASTM C 499).

1.04 PERFORMANCE REQUIREMENTS
A. Static Coefficient of Friction: For tile installed on walkway surfaces, provide products with the following values as determined by testing identical products per ASTM C 1028:
   1. Level Surfaces: Minimum 0.6.
   2. Step Treads: Minimum 0.6.
   3. Ramp Surfaces: Minimum 0.8.

1.05 SUBMITTALS
A. Product Data: For each type of product indicated.
B. Samples:
   1. Assembled samples with grouted joints for each type and composition of tile and for each color and finish required, at least 12 inches square and mounted on rigid panel. Use grout of type and in color or colors approved for completed work.
C. LEED Submittals:
   1. Credit MR 4.1 and 4.2: Recycled Content:
      a. Submit documentation from manufacturer indicating separate percentages, by weight, of pre-consumer and post-consumer recycled
content per unit of product. Also include material costs, excluding cost of installation.

2. Credit MR 5.1 and 5.2: Regionally Extracted, Harvested, or Recovered and Manufactured Materials:
   a. Indicate location of manufacturing facility, including name, address, and distance between manufacturing facility and the project site. Provide manufacturer’s documentation indication location where the base materials were extracted, mined, quarried, harvested, etc., and the distance between this location and the project site. Also include material costs, excluding cost of installation.

3. Credit EQ 4.1: Manufacturers’ product data for adhesives and sealants, including printed statement of VOC content.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Not less than 3 years experience in ceramic tile installations similar in size, scope, and installation procedures required for this project.

B. Source Limitations for Tile: Obtain all tile of same type and color or finish from one source or producer.
   1. Obtain tile from same production run and of consistent quality in appearance and physical properties for each contiguous area.

C. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from a single manufacturer and each aggregate from one source or producer.

D. Source Limitations for Other Products: Obtain each of the following products specified in this Section through one source from a single manufacturer for each product:
   1. Joint sealants.
   2. Metal edge strips.

E. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirement in ANSI A137.1 for labeling sealed tile packages.

B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Store liquid latexes and emulsion adhesives in unopened containers and protected from freezing.

E. Handle tile that has temporary protective coating on exposed surfaces to prevent coated surfaces from contacting backs or edges of other units. If coating does contact bonding surfaces of tile, remove coating from bonding surfaces before setting tile.

1.08 PROJECT CONDITIONS

A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer’s written instructions.
1.09 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Tile and Trim Units: Furnish quantity of full-size units equal to 5 percent of amount installed, but not less than 2 cortons, for each type, composition, color, pattern, and size indicated.

PART 2 - PRODUCTS

2.01 GENERAL

A. Regionally Extracted, Harvested, or Recovered and Manufactured Materials:
   1. Preference shall be given to manufacturer’s whose facilities are within a 500 mile radius of the project site.
   2. Preference shall also be given to materials that are harvested, extracted, mined, quarried, etc. within a 500 mile radius of the project site.

B. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1, "Specifications for Ceramic Tile," for types, compositions, and other characteristics indicated.
   1. Provide tile complying with Standard grade requirements, unless otherwise indicated.
   2. For facial dimensions of tile, comply with requirements relating to tile sizes specified in Part 1 "Definitions” Article.


D. Colors, Textures, and Patterns: Where manufacturer's standard products are indicated for tile, grout, and other products requiring selection of colors, surface textures, patterns, and other appearance characteristics, provide specific products or materials complying with the following requirements:
   1. Minimum 3 color/texture/pattern options, as selected by Architect from manufacturer’s full range, unless indicated otherwise.

E. Factory Blending: For tile exhibiting color variations within ranges selected during Sample submittals, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.

F. Mounting: For factory-mounted tile, provide back- or edge-mounted tile assemblies as standard with manufacturer, unless otherwise indicated.

2.02 BASIS OF DESIGN PRODUCTS

A. The design for each tile type is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified. Plans, elevations, details, characteristics, and other requirements indicated are based upon standards of the Basis of Design Product. Other manufacturers listed may be acceptable, provided their details and characteristics comply with size and profile requirements, and material and performance standards.

2.03 TILE PRODUCTS

A. Unglazed Ceramic Mosaic Tile [CT-<#>]: Factory-mounted flat tile as follows:
   1. Surface: Smooth, without abrasive admixture.
4. Face: Plain with cushion edges.
5. Basis-of-Design Product: <Insert manufacturer's name; product name or designation and possibly color or color group> or a comparable product of one of the following:
   a. American Olean; Div. of Dal-Tile International Corp.
   b. Daltile; Div. of Dal-Tile International Inc.
   c. Florida Tile Industries, Inc.

B. Ceramic Mosaic Trim Units: Matching characteristics of adjoining flat tile and coordinated with sizes and coursing of adjoining flat tile where applicable. Provide shapes as follows, selected from manufacturer's standard shapes:
   1. Base Cove: Cove, module size 2 by 1 inch.
   2. Base Cap for Thin-Set Mortar Installations: Surface bullnose, module size 2 by 2 inches.
   3. Wainscot Cap for Thin-Set Mortar Installations: Surface bullnose, module size 2 by 2 inches.
   4. External Corners for Thin-Set Mortar Installations: Surface bullnose, module size 2 by 2 inches.

2.04 WATERPROOFING AND CRACK-SUPPRESSION MEMBRANES FOR THIN-SET TILE INSTALLATIONS

A. Polyethylene-Sheet Product: Polyethylene faced on both sides with fleece webbing for adhering to latex-portland cement mortar; 39 inches wide by 0.008-inch nominal thickness.
   1. Product: Schluter Systems L.P.; KERDI.
      a. Use for setting wall tile in at showers.

B. Corrugated-Polyethylene Product: Corrugated polyethylene with dovetail-shaped corrugations for adhering to latex-portland cement mortar and with anchoring webbing on the underside; 39 inches wide by 3/16-inch nominal thickness.
   1. Product: Schluter Systems L.P.; DITRA.

2.05 SETTING AND GROUTING MATERIALS

A. Manufacturers:
   2. Boiardi Products Corporation.
   5. C-Cure.
   6. Custom Building Products.
   7. DAP, Inc.
   8. Jamo Inc.
   9. LATICRETE International Inc.
   10. MAPEI Corporation.
   11. Southern Grouts & Mortars, Inc.
   12. Summitville Tiles, Inc.
   13. TEC Specialty Products Inc.

   1. For wall applications, provide nonsagging mortar that complies with Paragraph C-4.6.1 in addition to the other requirements in ANSI A118.1.

C. Latex-Portland Cement Mortar (Thin Set): ANSI A118.4, consisting of the following:
   1. Prepackaged dry-mortar mix containing dry, redispersible, ethylene vinyl acetate additive to which only water must be added at Project site.
2. Prepackaged dry-mortar mix combined with acrylic resin or styrene-butadiene-rubber liquid-latex additive.
   a. For wall applications, provide nonsagging mortar that complies with Paragraph F-4.6.1 in addition to the other requirements in ANSI A118.4.

D. Standard Sanded Cement Grout: ANSI A118.6, color as indicated.
   1. Sanded grout mixture for joints 1/8 inch and wider.

E. Standard Unsanded Cement Grout: ANSI A118.6, color as indicated.
   1. Unsanded grout mixture for joints 1/8 inch and narrower.

2.06 ELASTOMERIC SEALANTS

A. General: Provide manufacturer's standard chemically curing, elastomeric sealants of base polymer and characteristics indicated that comply with applicable requirements in Division 07 Section "Joint Sealants."
   1. Use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Colors: Provide colors of exposed sealants to match colors of grout in tile adjoining sealed joints, unless otherwise indicated.

C. One-Part, Mildew-Resistant Silicone Sealant: As specified in Division 07 Section "Joint Sealants."

D. One-Part, Pourable Urethane Sealant for Use T: As specified in Division 07 Section "Joint Sealants."

2.07 CEMENTITIOUS BACKER UNITS

A. Provide cementitious backer units complying with ANSI A118.9 in maximum lengths available to minimize end-to-end butt joints.
   1. Thickness: 1/2 inch.
   2. Width: Manufacturer's standard width, but not less than 32 inches.

B. Products:
   1. C-Cure; C-Cure Board 990.
   2. Custom Building Products; Wonderboard.
   3. FinPan, Inc.; Util-A-Crete Concrete Backer Board.
   4. USG Corporation; DUROCK Cement Board.

2.08 MISCELLANEOUS MATERIALS

A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.

B. Metal Edge Strips: Angle or L-shape, height to match tile and setting-bed thickness, metallic or combination of metal and PVC or neoprene base, designed specifically for flooring applications, stainless steel; ASTM A 666, 300 Series exposed-edge material.

C. Temporary Protective Coating: Product indicated below that is formulated to protect exposed surfaces of tile against adherence of mortar and grout; compatible with tile, mortar, and grout products; and easily removable after grouting is completed without damaging grout or tile.
   1. Grout release in form of manufacturer's standard proprietary liquid coating that is specially formulated and recommended for use as temporary protective coating for tile.
D. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

E. Grout Sealer: Manufacturer's standard product for sealing grout joints that does not change color or appearance of grout.
   1. Products:
      b. Bostik; CeramaSeal Grout Sealer.
      c. C-Cure; Penetrating Sealer 978.
      d. Jamo Inc.; Penetrating Sealer.
      e. MAPEI Corporation; KER 004, Keraseal Penetrating Sealer for Unglazed Grout and Tile.
      f. Southern Grouts & Mortars, Inc.; Silicone Grout Sealer.
      h. TEC Specialty Products Inc.; TA-256 Penetrating Silicone Grout Sealer.

2.09 MIXING MORTARS AND GROUT
A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.
B. Add materials, water, and additives in accurate proportions.
C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

PART 3 - EXECUTION

3.01 EXAMINATION
A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile.
   1. Verify that substrates for setting tile are firm; dry; clean; free of oil, waxy films, and curing compounds; and within flatness tolerances required by referenced ANSI A108 Series of tile installation standards for installations indicated.
   2. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed before installing tile.
   3. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION
A. Remove coatings, including curing compounds and other substances that contain soap, wax, oil, or silicone, that are incompatible with tile-setting materials.
B. Provide concrete substrates for tile floors installed with thin-set mortar that comply with flatness tolerances specified in referenced ANSI A108 Series of tile installation standards.
   1. Fill cracks, holes, and depressions with trowelable leveling and patching compound according to tile-setting material manufacturer's written instructions. Use product specifically recommended by tile-setting material manufacturer.
   2. Remove protrusions, bumps, and ridges by sanding or grinding.
C. Blending: For tile exhibiting color variations within ranges selected during Sample submittals, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

D. Field-Applied Temporary Protective Coating: Where indicated under tile type or needed to prevent grout from staining or adhering to exposed tile surfaces, precoat them with continuous film of temporary protective coating, taking care not to coat unexposed tile surfaces.

3.03 INSTALLATION, GENERAL

A. ANSI Tile Installation Standards: Comply with parts of ANSI A108 Series "Specifications for Installation of Ceramic Tile" that apply to types of setting and grouting materials and to methods indicated in ceramic tile installation schedules.


C. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions, unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.

D. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.

E. Jointing Pattern: Lay tile in grid pattern, unless otherwise indicated. Align joints when adjoining tiles on floor, base, walls, and trim are same size. Lay out tile work and center tile fields in both directions in each space or on each wall area. Adjust to minimize tile cutting. Provide uniform joint widths, unless otherwise indicated.
   1. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets so joints between sheets are not apparent in finished work.

F. Lay out tile wainscots to next full tile beyond dimensions indicated.

G. Grout tile to comply with requirements of the following tile installation standards:
   1. For ceramic tile grouts (sand-portland cement; dry-set, commercial portland cement; and latex-portland cement grouts), comply with ANSI A108.10.
   2. For chemical-resistant epoxy grouts, comply with ANSI A108.6.
   3. For chemical-resistant furan grouts, comply with ANSI A108.8.

H. At restrooms with showers, install cementitious backer units and treat joints to comply with ANSI A108.11 and manufacturer's written instructions for type of application indicated.

3.04 WATERPROOFING AND CRACK-SUPPRESSION MEMBRANE INSTALLATION

A. Install waterproofing to comply with ANSI A108.13 and waterproofing manufacturer's written instructions to produce waterproof membrane of uniform thickness bonded securely to substrate.

B. Install crack-suppression membrane to comply with manufacturer's written instructions to produce membrane of uniform thickness bonded securely to substrate.

C. Do not install tile over waterproofing until waterproofing has cured and been tested to determine that it is watertight.
3.05 FLOOR TILE INSTALLATION
A. General: Install tile to comply with TCA installation method F-113 and ANSI A108 Series of tile installation standards.
B. Joint Widths: Install tile on floors with the following joint widths:
C. Metal Edge Strips: Install at locations indicated or where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with top of tile.
D. Grout Sealer: Apply grout sealer to grout joints according to grout-sealer manufacturer's written instructions. As soon as grout sealer has penetrated grout joints, remove excess sealer and sealer that has gotten on tile faces by wiping with soft cloth.

3.06 WALL TILE INSTALLATION
A. Install types of tile designated for wall installations to comply with TCA installation method W-243 and W-244 and ANSI setting-bed standards.
B. Install metal lath and scratch coat for walls to comply with ANSI A108.1A, Section 4.1.
C. Joint Widths: Install tile on walls with the following joint widths:

3.07 CLEANING AND PROTECTING
A. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
   1. Remove latex-portland cement grout residue from tile as soon as possible.
   2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions, but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.
   3. Remove temporary protective coating by method recommended by coating manufacturer that is acceptable to tile and grout manufacturer. Trap and remove coating to prevent it from clogging drains.
B. When recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear.
C. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.
D. Before final inspection, remove protective coverings and rinse neutral cleaner from tile surfaces.

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. This Section includes acoustical panels and exposed suspension systems for ceilings.
B. Related Sections include the following:
   1. Division 01 Section "Sustainable Design Requirements" for additional LEED requirements.
C. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete for ceilings.

1.03 DEFINITIONS
A. AC: Articulation Class.
B. CAC: Ceiling Attenuation Class.
C. LR: Light Reflectance coefficient.
D. NRC: Noise Reduction Coefficient.

1.04 SUBMITTALS
A. Product Data: For each type of product indicated.
B. Samples: For each component indicated and for each exposed finish required, prepared on Samples of size indicated below.
   1. Acoustical Panel: Set of 6-inch- square Samples of each type, color, pattern, and texture.
C. LEED Submittals:
   1. Credit MR 4.1 and 4.2: Recycled Content:
      a. Submit documentation from manufacturer indicating separate percentages, by weight, of pre-consumer and post-consumer recycled content per unit of product. Also include material costs, excluding cost of installation.
   2. Credit MR 5.1 and 5.2: Regionally Extracted, Harvested, or Recovered and Manufactured Materials:
      a. Indicate location of manufacturing facility, including name, address, and distance between manufacturing facility and the project site. Provide manufacturer’s documentation indication location where the base materials were extracted, mined, quarried, harvested, etc., and the distance between this location and the project site. Also include material costs, excluding cost of installation.
   3. Credit EQ 4.1: Manufacturers’ product data for sealants, including printed statement of VOC content and material safety data sheets.
D. Maintenance Data: For finishes to include in maintenance manuals.
1.05 QUALITY ASSURANCE
A. Source Limitations:
   1. Acoustical Ceiling Panel: Obtain each type through one source from a single manufacturer.
   2. Suspension System: Obtain each type through one source from a single manufacturer.
B. Fire-Test-Response Characteristics: Provide acoustical panel ceilings that comply with the following requirements:
   1. Surface-Burning Characteristics: Provide acoustical panels with the following surface-burning characteristics complying with ASTM E 1264 for Class A materials as determined by testing identical products per ASTM E 84:
      a. Smoke-Developed Index: 450 or less.
C. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
D. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.06 DELIVERY, STORAGE, AND HANDLING
A. Deliver acoustical panels, suspension system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.
C. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.

1.07 PROJECT CONDITIONS
A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

1.08 COORDINATION
A. Coordinate layout and installation of acoustical panels and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

1.09 EXTRA MATERIALS
A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Acoustical Ceiling Panels: Full-size panels equal to 2.0 percent of quantity installed, but not less than 10 panels, for each type installed.
   2. Suspension System Components: Quantity of each exposed component equal to 2.0 percent of quantity installed.
PART 2 - PRODUCTS

2.01 GENERAL

A. Recycled Content: Materials/products shall contain the maximum amount of recycled content allowed that retains material integrity.

B. Regionally Extracted, Harvested, or Recovered and Manufactured Materials:
   1. Preference shall be given to manufacturer's whose facilities are within a 500 mile radius of the project site.
   2. Preference shall also be given to materials that are harvested, extracted, mined, quarried, etc. within a 500 mile radius of the project site.

2.02 ACOUSTICAL PANELS, GENERAL

A. Acoustical Panel Standard: Provide manufacturer's standard panels of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances, unless otherwise indicated.
   1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches away from test surface per ASTM E 795.

B. Acoustical Panel Colors and Patterns: Match appearance characteristics indicated for each product type.
   1. Where appearance characteristics of acoustical panels are indicated by referencing pattern designations in ASTM E 1264 and not manufacturers’ proprietary product designations, provide products selected by Architect from each manufacturer's full range that comply with requirements indicated for type, pattern, color, light reflectance, acoustical performance, edge detail, and size.

C. Broad Spectrum Antimicrobial Fungicide and Bactericide Treatment: Provide acoustical panels treated with manufacturer's standard antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D 3273 and evaluated according to ASTM D 3274 or ASTM G 21.

2.03 ACOUSTICAL PANELS [FOR ACOUSTICAL PANEL CEILING] <Insert drawing designation>

A. Basis of Design Products: The design for each panel type is based on [name product] [products by] [name manufacturer]. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers listed below. Plans, elevations, details, characteristics, and other requirements indicated are based upon standards of the Basis of Design Product. Other manufacturers listed may be acceptable, provided their details and characteristics comply with size and profile requirements, and material and performance standards.
   1. Armstrong World Industries, Inc.; <Insert product name or designation>.
   2. Certainteed Corporation.
   3. USG Interiors, Inc.; <Insert product name or designation>.

B. Classification: Provide panels complying with ASTM E 1264 for type, form, and pattern as follows:
   1. Type and Form: Type III, mineral base with painted finish; Form [1, nodular] [2, water felted] [4, cast or molded].
   2. Type and Form: Type IV, mineral base with membrane-faced overlay; Form 1, nodular; with [glass-fiber cloth] [washable vinyl-film] overlay.
   3. Type and Form: Type IV, mineral base with membrane-faced overlay; Form 2, water felted; with [vinyl overlay on face] [vinyl overlay on face and back] [vinyl overlay on face, back, and sealed edges] [fiberglass-fabric overlay on face].
   4. Type and Form: Type XII, glass-fiber base with membrane-faced overlay; Form [1, plastic] [2, cloth] [3, other].

ACOUSTICAL PANEL CEILINGS
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5. Type and Form: Type XX, other types; described as high-density, ceramic- and mineral-base panels with scrubbable finish, resistant to heat, moisture, and corrosive fumes.

6. Type and Form: <Insert type and form.>

7. Pattern: [C (perforated, small holes)] [CD (perforated, small holes and fissured)] [CE (perforated, small holes and lightly textured)] [D (fissured)] [E (lightly textured)] [F (heavily textured)] [G (smooth)] [GH (smooth and printed)] [H (embossed)] [I (embossed in register)] [K (surface scored)] [Z (other patterns as described)] [As indicated by manufacturer's designation] [Insert pattern].

8. Color: [White] [As selected from manufacturer's full range] [Match Architect's sample] [As indicated by manufacturer's designation] [As indicated on Drawings] [As indicated in a schedule] [Insert color].

9. LR: Not less than [0.65] [0.70] [0.75] [0.80] [0.85] [0.90] <Insert LR>.

10. NRC: Not less than [0.10] [0.35] [0.40] [0.50] [0.55] [0.60] [0.65] [0.70] [0.75] [0.80] [0.85] [0.90] [0.95] [1.00] <Insert NRC>.

11. CAC: Not less than [20] [25] [30] [35] [40] <Insert CAC>.

12. AC: Not less than [170] [180] [190] [200] [210] <Insert AC>.

13. Edge/Joint Detail: [Square] [Reveal sized to fit flange of exposed suspension system members] [Flush reveal sized to fit flange of exposed suspension system members] [Beveled, kerfed and rabbeted long edges and square, butt-on short edges] [Insert manufacturer's special proprietary edge detail].

14. Thickness: [5/8 inch] [3/4 inch] [7/8 inch] [As indicated on Drawings] [As indicated in a schedule] [Insert thickness].

15. Modular Size: [24 by 24 inches] [24 by 48 inches] [600 by 600 mm] [600 by 1200 mm] [As indicated on Drawings] [As indicated in a schedule] [Insert size].

16. Antimicrobial Treatment: [Broad spectrum fungicide and bactericide] [Fungicide] based.

2.04 METAL SUSPENSION SYSTEMS, GENERAL

A. Metal Suspension System Standard: Provide manufacturer's standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635.

B. Finishes and Colors, General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Provide manufacturer's standard factory-applied finish for type of system indicated.

C. Attachment Devices: Size for five times the design load indicated in ASTM C 635, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.

1. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing per ASTM E 488 or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.
   a. Type: Cast-in-place or postinstalled bonded anchors.
   b. Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (0.005 mm) for Class SC 1 service condition.

2. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated, and with capability to sustain, without failure, a load equal to 10 times that imposed by
ceiling construction, as determined by testing per ASTM E 1190, conducted by a qualified testing and inspecting agency.

D. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
   2. Size: Select wire diameter so its stress at 3 times hanger design load (ASTM C 635, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.106-inch- diameter wire.

2.05 METAL SUSPENSION SYSTEM FOR ACOUSTICAL PANEL CEILINGS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Armstrong World Industries, Inc., "Prelude XL" or a comparable product by one of the following:
   1. Certainteed Corporation.
   2. USG Interiors, Inc.

B. Wide-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, not less than G30 coating designation, with prefinished 15/16-inch- wide metal caps on flanges.
   2. End Condition of Cross Runners: Override (stepped) or butt-edge type.
   3. Face Design: Flat, flush.

2.06 METAL EDGE MOLDINGS AND TRIM

A. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension system runners.
   1. Provide manufacturer's standard edge moldings that fit acoustical panel edge details and suspension systems indicated and that match width and configuration of exposed runners, unless otherwise indicated.
   2. For lay-in panels with reveal edge details, provide stepped edge molding that forms reveal of same depth and width as that formed between edge of panel and flange at exposed suspension member.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders, and comply with layout shown on reflected ceiling plans.
3.03 INSTALLATION
A. General: Install acoustical panel ceilings to comply with ASTM C 636, per manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."

B. Suspend ceiling hangers from building’s structural members and as follows:
   1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
   2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
   3. Splay hangers only where required and, if permitted with fire-resistance-rated ceilings, to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
   4. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
   5. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
   6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
   7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
   8. Do not attach hangers to steel deck tabs.
   9. Do not attach hangers to steel roof deck. Attach hangers to structural members.
   10. Space hangers not more than 48 inches o.c. along each member supported directly from hangers, unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.
   11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.

C. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
   1. Do not use exposed fasteners, including pop rivets, on moldings and trim.

D. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

E. Install acoustical panels with undamaged edges and fit accurately into suspension system runners and edge moldings. Scribe and cut panels at borders, penetrations, and where fixtures are surface-mounted to the grid, to provide a neat, precise fit.
   1. For reveal-edged panels on suspension system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
   2. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.

3.04 CLEANING
A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace ceiling components
that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION
SECTION 09 65 13
RESILIENT BASE AND ACCESSORIES

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. Resilient base.
2. Resilient molding accessories.
B. Related Sections:
1. Division 01 Section "Sustainable Design Requirements" for additional LEED requirements.
2. Division 09 Section "Linoleum Flooring" for linoleum floor coverings.

1.03 SUBMITTALS
A. Product Data: For each type of product indicated.
B. LEED Submittals:
1. Credit EQ 4.1: Low Emitting Materials:
2. Product Data for adhesives, including printed statement of VOC content.
C. Samples: For each type of product indicated, in manufacturer's standard-size Samples but not less than 12 inches long, of each resilient product color, texture, and pattern required.

1.04 QUALITY ASSURANCE
A. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.
B. Installer Qualifications: Minimum 3 years experience installing resilient floor covering material.
C. Mockups: Provide resilient products with mockups specified in other Sections.

1.05 DELIVERY, STORAGE, AND HANDLING
A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F.

1.06 PROJECT CONDITIONS
A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive resilient products during the following time periods:
1. 48 hours before installation.
2. During installation.
3. 48 hours after installation.
B. Until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.

C. Install resilient products after other finishing operations, including painting, have been completed.

1.07 EXTRA MATERIALS
A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Furnish materials at the rate of 120 lineal feet (one carton) for each color and type of base installed.

PART 2 - PRODUCTS

2.01 RESILIENT BASE
A. Resilient Base:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Burke Mercer Flooring Products; Division of Burke Industries, Inc.
   b. Flexco, Inc.
   c. Roppe Corporation, USA.

1. Material Requirement: Type TS (rubber, vulcanized thermoset).
3. Style:
   a. Carpeted Areas: Straight (flat or toeless).
   b. All Other Areas: Cove (base with toe).

C. Minimum Thickness: 0.125 inch.
D. Height: 4 inches.
E. Lengths: Cut lengths 48 inches long or coils in manufacturer's standard length.
F. Outside Corners: Job formed or preformed.
G. Inside Corners: Job formed or preformed.
H. Finish: As selected by Architect from manufacturer's full range.
I. Colors and Patterns: As selected by Architect from full range of industry colors.
1. Basis of Design is Roppe 114 "Lunar Dust."

2.02 RESILIENT MOLDING ACCESSORIES
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Burke Mercer Flooring Products; Division of Burke Industries, Inc.
2. Flexco, Inc.
3. Roppe Corporation, USA.

B. Description: Cap for cove resilient floor covering, carpet edge for glue-down applications, reducer strip for resilient floor covering, joiner for resilient flooring and carpet, and transition strips.
C. Material: Rubber.
D. Colors and Patterns: As selected by Architect from full range of industry colors.
1. Basis of Design is Roppe 114 "Lunar Dust."

RESILIENT BASE AND ACCESSORIES
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2.03 INSTALLATION MATERIALS
A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.
B. Adhesives: Water-resistant type recommended by manufacturer to suit resilient products and substrate conditions indicated.
   1. Use adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
      a. Cove Base Adhesives: Not more than 50 g/L.
      b. Rubber Floor Adhesives: Not more than 60 g/L.
C. Stair-Tread-Nose Filler: Two-part epoxy compound recommended by resilient tread manufacturer to fill nosing substrates that do not conform to tread contours.
D. Floor Polish: Provide protective liquid floor polish products as recommended by resilient stair tread manufacturer.

PART 3 - EXECUTION
3.01 EXAMINATION
A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
B. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION
A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
B. Concrete Substrates for Resilient Stair Treads and Accessories: Prepare according to ASTM F 710.
   1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
   2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
   3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer.
   4. Moisture Testing: Perform tests recommended by manufacturer and as follows. Proceed with installation only after substrates pass testing.
      a. Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
      b. Perform relative humidity test using in situ probes, ASTM F 2170. Proceed with installation only after substrates have maximum 75 percent relative humidity level measurement.
C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.
D. Do not install resilient products until they are same temperature as the space where they are to be installed.
1. Move resilient products and installation materials into spaces where they will be installed at least 48 hours in advance of installation.

E. Sweep and vacuum clean substrates to be covered by resilient products immediately before installation.

3.03 RESILIENT BASE INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient base.

B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.

C. Install resilient base in lengths as long as practicable without gaps at seams and with tops of adjacent pieces aligned.

D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

E. Do not stretch resilient base during installation.

F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.

G. Preformed Corners: Install preformed corners before installing straight pieces.

H. Job-Formed Corners:
   1. Outside Corners: Use straight pieces of maximum lengths possible. Form without producing discoloration (whitening) at bends.
   2. Inside Corners: Use straight pieces of maximum lengths possible.

3.04 RESILIENT ACCESSORY INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient accessories.

B. Resilient Stair Accessories:
   1. Use stair-tread-nose filler to fill nosing substrates that do not conform to tread contours.
   2. Tightly adhere to substrates throughout length of each piece.
   3. For treads installed as separate, equal-length units, install to produce a flush joint between units.
   4. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.
   5. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures.
   6. Adhere floor tiles to flooring substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

C. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of carpet and resilient floor covering that would otherwise be exposed.

3.05 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protection of resilient products.
B. Perform the following operations immediately after completing resilient product installation:
   1. Remove adhesive and other blemishes from exposed surfaces.
   2. Sweep and vacuum surfaces thoroughly.
   3. Damp-mop surfaces to remove marks and soil.

C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

D. Floor Polish: Remove soil, visible adhesive, and surface blemishes from resilient stair treads before applying liquid floor polish.
   1. Apply three coat(s).

E. Cover resilient products until Substantial Completion.

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. This Section includes the following:
   1. Tufted carpet.
B. Related Sections include the following:
   1. Division 01 Section "Sustainable Design Requirements" for additional LEED requirements.
   2. Division 09 Section "Resilient Base and Accessories" for resilient wall base and accessories installed with carpet.

1.03 SUBMITTALS
A. Product Data: For the following, including installation recommendations for each type of substrate:
   1. Carpet: For each type indicated. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
B. Shop Drawings: Show the following:
   1. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet.
   2. Existing flooring materials to be removed.
   3. Existing flooring materials to remain.
   4. Carpet type, color, and dye lot.
   5. Locations where dye lot changes occur.
   6. Seam locations, types, and methods.
   7. Pattern type, repeat size, location, direction, and starting point.
   8. Pile direction.
   9. Type, color, and location of insets and borders.
   10. Type, color, and location of edge, transition, and other accessory strips.
   11. Transition details to other flooring materials.
C. Samples: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.
   2. Exposed Edge, Transition, and other Accessory Stripping: 12-inch- long Samples.
D. LEED Submittals:
   1. Credit MR 4.1 and 4.2: Recycled Content:
      a. Submit documentation from manufacturer indicating separate percentages, by weight, of pre-consumer and post-consumer recycled
content per unit of product. Also include material costs, excluding cost of installation.

2. Credits MR 5.1 and 5.2: Regionally Extracted, Harvested, or Recovered, and Manufactured Materials:
   a. Indicate location of manufacturing facility, including name, address, and distance between manufacturing facility and the project site. Provide manufacturer’s documentation indicating location where the base materials were extracted, mined, quarried, harvested, etc., and the distance between this location and the project site. Also include material costs, excluding cost of installation.

3. Credit EQ 4.3: Manufacturers' product data for carpet and installation adhesive, including printed statement of VOC content and documentation carpets are Carpet and Rug Institute (CRI) "Green Label Plus" certified.

E. Maintenance Data: For carpet to include in maintenance manuals. Include the following:
   1. Methods for maintaining carpet, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
   2. Precautions for cleaning materials and methods that could be detrimental to carpet.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer with minimum 5 years experience who is certified by the Floor Covering Installation Board or who can demonstrate compliance with its certification program requirements.

B. Manufacturer: Firm (carpet mill) with not less than 5 years of production experience with carpet manufacturing, and whose published product literature clearly indicates general compliance of products with requirements of this section.

C. Fire-Test-Response Characteristics: Provide products with the critical radiant flux classification indicated in Part 2, as determined by testing identical products per ASTM E 648 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.

D. Mockups: Before installing carpet, build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

E. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." Review methods and procedures related to carpet installation including, but not limited to, the following:
   1. Review delivery, storage, and handling procedures.
   2. Review ambient conditions and ventilation procedures.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Comply with CRI 104, Section 5, "Storage and Handling."

1.06 PROJECT CONDITIONS

A. Comply with CRI 104, Section 7.2, "Site Conditions; Temperature and Humidity" and Section 7.12, "Ventilation."
B. Environmental Limitations: Do not install carpet until wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

C. Do not install carpet over concrete slabs until slabs have cured, are sufficiently dry to bond with adhesive, and have pH range recommended by carpet manufacturer.

D. Where demountable partitions or other items are indicated for installation on top of carpet, install carpet before installing these items.

1.07 WARRANTY

A. Special Warranty for Carpet: Manufacturer's standard form in which manufacturer agrees to repair or replace components of carpet installation that fail in materials or workmanship within specified warranty period.
   1. Warranty does not include deterioration or failure of carpet due to unusual traffic, failure of substrate, vandalism, or abuse.
   2. Failures include, but are not limited to, more than 10 percent loss of face fiber, edge raveling, snags, runs, loss of tuft bind strength, excess static discharge, and delamination.
   3. Warranty Period: 10 years from date of Substantial Completion.

1.08 EXTRA MATERIALS

A. Furnish extra materials described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. The Owner will review all carpet scraps and retain chosen pieces for future repairs. Selected remnants, usable scraps and overage shall be packaged and identified. The balance shall be removed from the job site.
   2. in addition to remnants and scraps, provide full-width rolls equal to 2 percent of amount installed for each type installed, but not less than 10 sq. yd.

PART 2 - PRODUCTS

2.01 GENERAL

A. Recycled Content: Materials/products shall contain the maximum amount of recycled content allowed that retains material integrity.

B. Regionally Extracted, Harvested, or Recovered, and Manufactured Materials:
   1. Preference shall be given to manufacturer's whose facilities are within a 500 mile radius of the project site.
   2. Preference shall also be given to materials that are harvested, extracted, mined, quarried, etc. within a 500 mile radius of the project site.

C. VOC Limits: Carpet tile and installation adhesives shall not exceed VOC limits specified in Division 01 Section "Sustainable Design Requirements."
   1. Carpet system must meet or exceed the requirements of the Carpet and Rug Institute’s "Green Label Plus" indoor air quality test program.

2.02 BASIS OF DESIGN PRODUCTS

A. The design is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product. Plans, elevations, details, characteristics, and other requirements indicated are based upon standards of the Basis of Design Product. Other manufacturers may be acceptable, provided their details and characteristics comply with size and profile requirements, and material and performance standards.
B. Comparables To Basis Of Design Products:

1. Conditions:
   a. Proposed alternative products shall be submitted for evaluation by the Architect at least two weeks prior to awarding contract to the manufacturer of an alternative product.
   b. Obtain samples of Basis of Design product.
   c. Select alternative product(s) that comply with the characteristics specified below for evaluation by Architect.
   d. Submit evidence demonstrating compliance.
   e. Submit samples of alternative product(s) displayed side-by side with sample of Basis of Design product.
   f. Architect will be the sole judge of whether a proposed alternative is acceptable. Architect is not obligated to prove non-equivalence.

2.03 TUFTED CARPET CPT-1

A. Basis-of-Design Product: "Balance" by Bolyu Contract, #BN795 "Brownie Points."

   1. Characteristics:
      a. Fiber Content: XTI Nylon.
      c. Average Density: 8514.
      d. Pile Thickness: 0.148 inches for finished carpet per ASTM D 6859.
      e. Stitches: 13 per inch.
      f. Gage: 1/10 inch.
      g. Yarn Weight Tufted: 36 oz./sq. yd.
      h. Primary Backing: Manufacturer's standard material.
      i. Secondary Backing: Woven polypropylene.
      j. Applied Soil-Resistance Treatment: Manufacturer's standard material.

   2. Performance Characteristics: As follows:
      a. Electrostatic Propensity: Less than 3.5 kV per AATCC 134.
      b. VOC Limits: Provide carpet that complies with the Carpet and Rug Institute's "Green Label Plus" 24-hour/14-day emissions test criteria.

2.04 TUFTED CARPET CPT-2

A. Basis-of-Design Product: "Night Shade" by Bolyu Contract, #NS544 "Dusk."

   1. Characteristics:
      c. Average Density: 6103.
      d. Pile Thickness: 0.21 inches for finished carpet per ASTM D 6859.
      e. Stitches: 15 per inch.
      f. Gage: 1/10 inch.
      g. Yarn Weight Tufted: 34.3 oz./sq. yd.
      h. Primary Backing: Manufacturer's standard material.
      i. Secondary Backing: Woven polypropylene.
      j. Applied Soil-Resistance Treatment: Manufacturer's standard material.

   2. Performance Characteristics: As follows:
      a. Electrostatic Propensity: Less than 3.5 kV per AATCC 134.
      b. VOC Limits: Provide carpet that complies with the Carpet and Rug Institute's "Green Label Plus" 24-hour/14-day emissions test criteria.
2.05 INSTALLATION ACCESSORIES

A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet manufacturer.

B. Adhesives: Water-resistant, mildew-resistant, nonstaining type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet and is recommended or provided by carpet manufacturer. Obtain Owner's approval of adhesive.
   1. VOC Limits: All indoor adhesives shall meet or exceed VOC limit requirements of South Coast Air Quality Management District Rule #1168.

C. Seam Adhesive: Hot-melt adhesive tape or similar product recommended by carpet manufacturer for sealing and taping seams and butting cut edges at backing to form secure seams and to prevent pile loss at seams.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet performance. Examine carpet for type, color, pattern, and potential defects.

B. Concrete Subfloors: Verify that concrete slabs comply with ASTM F 710 and the following:
   1. Slab substrates are dry and free of curing compounds, sealers, hardeners, and other materials that may interfere with adhesive bond. Determine adhesion and dryness characteristics by performing bond and moisture tests recommended by carpet manufacturer.
   2. Subfloor finishes comply with requirements specified in Division 03 Section "Cast-in-Place Concrete" for slabs receiving carpet.
   3. Subfloors are free of cracks, ridges, depressions, scale, and foreign deposits.
   4. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.
   5. Moisture Testing: Perform tests recommended by manufacturer and as follows.
      a. Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
   6. Perform relative humidity test using in situ probes, ASTM F 2170. Proceed with installation only after substrates have maximum 75 percent relative humidity level measurement.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. General: Comply with CRI 104, Section 7.3, "Site Conditions; Floor Preparation," and with carpet manufacturer's written installation instructions for preparing substrates.

B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch wide or wider, and protrusions more than 1/32 inch, unless more stringent requirements are required by manufacturer's written instructions.
C. Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by carpet manufacturer.

D. Broom and vacuum clean substrates to be covered immediately before installing carpet.

3.03 INSTALLATION

A. Comply with CRI 104 and carpet manufacturer’s written installation instructions for the following:

1. Direct-Glue-Down Installation: Comply with CRI 104, Section 9, "Direct Glue-Down Installation."

2. Stair Installation: Comply with CRI 104, Section 13, "Carpet on Stairs" for glue-down installation.

B. Comply with carpet manufacturer’s written recommendations and Shop Drawings for seam locations and direction of carpet; maintain uniformity of carpet direction and lay of pile. At doorways, center seams under the door in closed position.

1. Level adjoining border edges.

C. Do not bridge building expansion joints with carpet.

D. Cut and fit carpet to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet manufacturer.

E. Extend carpet into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.

F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on subfloor. Use nonpermanent, nonstaining marking device.

G. Install pattern parallel to walls and borders to comply with CRI 104, Section 15, "Patterned Carpet Installations" and with carpet manufacturer’s written recommendations.

3.04 CLEANING AND PROTECTING

A. Perform the following operations immediately after installing carpet:

1. Remove excess adhesive, seam sealer, and other surface blemishes using cleaner recommended by carpet manufacturer.

2. Remove yarns that protrude from carpet surface.


B. Protect installed carpet to comply with CRI 104, Section 16, "Protection of Indoor Installations."

1. Verify appearance of carpet is acceptable to Architect prior to installation of protective materials.

C. Protect carpet against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet manufacturer and carpet adhesive manufacturer.

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. This Section includes back-mounted acoustical wall panels.
B. Related Sections include the following:
   1. Division 01 Section "Sustainable Design Requirements" for additional LEED requirements.
   2. Division 09 Section "Acoustical Panel Ceilings" for acoustical ceiling panels supported by exposed suspension system and tested for noise reduction.

1.03 DEFINITIONS
A. NRC: Noise reduction coefficient.

1.04 SUBMITTALS
A. Product Data: For each type of panel edge, core material, and mounting indicated.
B. Shop Drawings: For acoustical wall panels. Include mounting devices and details; details at panel head, base, joints, and corners; and details at ceiling, floor base, and wall intersections. Include elevations showing panel sizes and direction of fabric weave and pattern matching. Indicate panel edge and core materials.
C. Coordination Drawings: Show intersections with wall base, shelves, countertops, drawers, doors, chart rails, chalk rails, electrical outlets and switches, thermostats, lighting fixtures, air outlets and inlets, speakers, sprinklers, access panels, and other adjacent work. Show operation of casework doors and drawers and other doors.
D. Samples: For the following products. Prepare Samples from same material to be used for the Work.
   1. Fabric: Full-width by 36-inch-long Sample from dye lot to be used for the Work, and as follows:
      a. With specified treatments applied.
      b. Show complete pattern repeat.
      c. Mark top and face of fabric.
   2. Panel Edge: 12-inch-long Sample showing edge profile, corner, and finish.
   3. Core Material: 12-inch-square Sample showing corner.
E. LEED Submittals:
   1. Credit EQ 4.1: Manufacturer's product data for installation adhesive, including printed statement of VOC content.
F. Maintenance Data: For acoustical wall panels to include in maintenance manuals. Include fabric manufacturers' written cleaning and stain-removal recommendations.
1.05 QUALITY ASSURANCE
A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.
B. Source Limitations: Obtain acoustical wall panels through one source from a single manufacturer.
C. Fire-Test-Response Characteristics: Provide acoustical wall panels with the following surface-burning characteristics as determined by testing identical products per ASTM E 84 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
   1. Flame-Spread Index: 25 or less.
   2. Smoke-Developed Index: 450 or less.
D. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.06 DELIVERY, STORAGE, AND HANDLING
A. Comply with fabric and acoustical wall panel manufacturers' written instructions for minimum and maximum temperature and humidity requirements for shipment, storage, and handling.
B. Deliver materials and panels in unopened bundles and store in a temperature-controlled dry place with adequate air circulation.
C. Protect panel edges from crushing and impact.

1.07 PROJECT CONDITIONS
A. Environmental Limitations: Do not install acoustical wall panels until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
B. Lighting: Do not install acoustical wall panels until a lighting level of not less than 50 fc is provided on surfaces to receive acoustical wall panels.
C. Air-Quality Limitations: Protect acoustical wall panels from exposure to airborne odors, such as tobacco smoke, and install panels under conditions free from odor contamination of ambient air.
D. Field Measurements: Verify locations of acoustical wall panels by field measurements before fabrication and indicate measurements on Shop Drawings.

1.08 WARRANTY
A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of acoustical wall panels that fail in performance, materials, or workmanship within specified warranty period.
   1. Failure in performance includes, but is not limited to, acoustical performance.
   2. Failures in materials include, but are not limited to, fabric sagging, distorting, or releasing from panel edge; or warping of core.
   3. Warranty Period: Two years from date of Substantial Completion.

1.09 EXTRA MATERIALS
A. Furnish extra materials described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Fabric: For each fabric, color, and pattern installed, provide length equal to 10 percent of amount installed, but no fewer than 10 yards.
2. Acoustical Wall Panel Mounting Devices: Full-size units equal to 5 percent of amount installed, but no fewer than 5 attachment devices.

PART 2 - PRODUCTS

2.01 CORE MATERIALS
A. Mineral-Fiber Board: Maximum flame-spread and smoke-developed indexes of 15 and 5, respectively.

2.02 BACK-MOUNTED ACOUSTICAL WALL PANELS WITH PERFORATED MINERAL-FIBER BOARD CORE
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   2. Decoustics.

B. Panel Construction: Manufacturer's standard panel construction consisting of facing material laminated to front face of a perforated, water-felted, mineral-fiber board core of not less than 13-lb/cu. ft. nominal density; with perforated surface.

C. Facing Material: Fabric from same dye lot; color and pattern as selected by Architect from manufacturer's full range.
   1. Manufacturer: Knoll Textiles.
   2. Product Line/Pattern: "Progression Striae."
   4. Color: As selected by Architect from manufacturer's full range.
   5. Fiber Content: Solution-dyed polyester

D. Nominal Core Thickness and Overall System NRC: 3/4 inch and not less than NRC 0.45, for Type A mounting.

E. Panel Width: As indicated on Drawings.

F. Panel Height: Fabricated from units in height as indicated on Drawings; mounting height as indicated on Drawings.

G. Panel Edge: Core self-edge.

H. Panel Short Edge Detail: Square.

2.03 FABRICATION
A. Sound-Absorption Performance: Provide acoustical wall panels with minimum NRCs indicated, as determined by testing per ASTM C 423 for mounting type specified.

B. Acoustical Wall Panels: Panel construction consisting of facing material adhered to face, edges and back border of dimensionally stable core; with rigid edges to reinforce panel perimeter against warpage and damage.

C. Fabric Facing: Stretched straight, on the grain, tight, square, and free from puckers, ripples, wrinkles, sags, blisters, seams, adhesive, or other foreign matter. Applied with visible surfaces fully covered.
   1. Where square corners are indicated, tailor corners.
2. Where radius or other nonsquare corners are indicated, attach facing material so there are no seams or gathering of material.
3. Where fabrics with directional or repeating patterns or directional weave are indicated, mark fabric top and attach fabric in same direction so pattern or weave matches in adjacent panels.

D. Core-Face Layer: Evenly stretched over core face and edges and securely attached to core; free from puckers, ripples, wrinkles, sags.

E. Dimensional Tolerances of Finished Units: Plus or minus 1/16 inch for the following:
   1. Thickness.
   2. Edge straightness.
   3. Overall length and width.
   4. Squareness from corner to corner.
   5. Chords, radii, and diameters.

F. Back-Mounting Devices: Concealed on backside of panel, recommended to support weight of panel, with base-support bracket system where recommended by manufacturer for additional support of panels, and as follows:
   1. Metal "Z" Clips: Two-part panel clips, with one part of each clip mechanically attached to back of panel and the other part to wall substrate, designed to allow for panel removal.

PART 3 - EXECUTION

3.01 EXAMINATION
   A. Examine fabric, substrates, blocking, and conditions, with Installer present, for compliance with requirements, installation tolerances, and other conditions affecting performance of acoustical wall panels.
      1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION
   A. Install acoustical wall panels in locations indicated with vertical surfaces and edges plumb, top edges level and in alignment with other panels, faces flush, and scribed to fit adjoining work accurately at borders and at penetrations.
   B. Comply with acoustical wall panel manufacturer's written instructions for installation of panels using type of concealed mounting accessories indicated or, if not indicated, as recommended by manufacturer. Anchor panels securely to supporting substrate.
   C. Match and level fabric pattern and grain among adjacent panels.
   D. Installation Tolerances: As follows:
      1. Variation from Level and Plumb: Plus or minus 1/16 inch.
      2. Variation of Panel Joints from Hairline: Not more than 1/32 inch wide.

3.03 CLEANING
   A. Clip loose threads; remove pills and extraneous materials.
   B. Clean panels with fabric facing, on completion of installation, to remove dust and other foreign materials according to manufacturer's written instructions.
3.04 PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, to ensure that acoustical wall panels are without damage or deterioration at time of Substantial Completion.

B. Replace acoustical wall panels that cannot be cleaned and repaired, in a manner approved by Architect, before time of Substantial Completion.

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. This Section is general in nature. Paint systems are specified for various substrates that may or may not be encountered in the Work.
   B. This Section includes surface preparation and the application of paint systems on the following exterior substrates:
      1. Concrete.
      2. Concrete masonry units (CMU).
      3. Steel.
      5. Aluminum (not anodized or otherwise coated).
      6. Wood.
   C. Related Sections include the following:
      1. Division 05 Sections for shop priming of metal substrates with primers specified in this Section.
      2. Division 09 Section "Interior Painting" for surface preparation and the application of paint systems on interior substrates.

1.03 SUBMITTALS
   A. Product Data: For each type of product indicated.
   B. Samples: For each type of paint system and each color and gloss of topcoat indicated.
      1. Submit Samples on rigid backing, 8 inches square.
      2. Step coats on Samples to show each coat required for system.
      3. Label each coat of each Sample.
      4. Label each Sample for location and application area.
   C. Product List: For each product indicated, include the following:
      1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
      2. Printout of current "MPI Approved Products List" for each product category specified in Part 2, with the proposed product highlighted.
   D. LEED Submittals:
      1. Credit MR 5.1 and 5.2: Regionally Extracted, Harvested, or Recovered, and Manufactured Materials:
         a. Indicate location of manufacturing facility, including name, address, and distance between manufacturing facility and the project site. Provide manufacturer’s documentation indication location where the base materials were extracted, mined, quarried, harvested, etc., and the distance between this location and the project site. Also include material costs, excluding cost of installation.
1.04 QUALITY ASSURANCE

A. MPI Standards:
   1. Products: Complying with MPI standards indicated and listed in "MPI Approved Products List."

B. Mockups: Apply benchmark samples of each paint system indicated and each color and finish selected to verify preliminary selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Architect will select one surface to represent surfaces and conditions for application of each paint system specified in Part 3.
   2. Final approval of color selections will be based on benchmark samples.
      a. If preliminary color selections are not approved, apply additional benchmark samples of additional colors selected by Architect at no added cost to Owner.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
   1. Maintain containers in clean condition, free of foreign materials and residue.
   2. Remove rags and waste from storage areas daily.

1.06 PROJECT CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.

B. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

1.07 EXTRA MATERIALS

A. Furnish extra materials described below that are from same production run (batch mix) as materials applied and that are packaged for storage and identified with labels describing contents.
   1. Quantity: Furnish an additional 5 percent, but not less than 1 gallon of each material and color applied.

PART 2 - PRODUCTS

2.01 GENERAL

A. Regionally Extracted, Harvested, or Recovered and Manufactured Materials:
   1. Preference shall be given to manufacturer’s whose facilities are within a 500 mile radius of the project site.
   2. Preference shall also be given to materials that are harvested, extracted, mined, quarried, etc. within a 500 mile radius of the project site.

2.02 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following:
   1. Benjamin Moore & Co.
   2. Coronado Paint.
4. ICI Paints.
7. PPG Architectural Finishes, Inc.
8. Sherwin-Williams Company (The).

2.03 PAINT, GENERAL
A. Material Compatibility:
   1. Provide materials for use within each paint system that are compatible with one
      another and substrates indicated, under conditions of service and application as
      demonstrated by manufacturer, based on testing and field experience.
   2. For each coat in a paint system, provide products recommended in writing by
      manufacturers of topcoat for use in paint system and on substrate indicated.

B. Colors: [As selected by Architect from manufacturer's full range] [As indicated in a color
   schedule].
   1. Assume a maximum of 6 colors, including 2 deep-tone colors.

2.04 BLOCK FILLERS

2.05 PRIMERS/SEALERS
A. Alkali-Resistant Primer: MPI #3.
B. Wood-Knot Sealer: Sealer recommended in writing by topcoat manufacturer for use in
   paint system indicated.

2.06 METAL PRIMERS
A. Alkyd Anticorrosive Metal Primer: MPI #79.
C. Quick-Drying Primer for Aluminum: MPI #95.

2.07 WOOD PRIMERS

2.08 EXTERIOR LATEX PAINTS
A. Exterior Latex (Semigloss): MPI #15 (Gloss Level 3-4).

2.09 EXTERIOR ALKYD PAINTS
A. Exterior Alkyd Enamel (Gloss): MPI #9 (Gloss Level 6).

2.10 FLOOR COATINGS
A. Interior/Exterior Clear Concrete Floor Sealer (Water Based): MPI #99.

PART 3 - EXECUTION

3.01 EXAMINATION
A. Examine substrates and conditions, with Applicator present, for compliance with
   requirements for maximum moisture content and other conditions affecting performance
   of work.
B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
   1. Concrete: 12 percent.
   3. Wood: 15 percent.
   4. Plaster: 12 percent.
   5. Gypsum Board: 12 percent.

C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

D. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.
   1. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

3.02 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.

B. Remove plates, machined surfaces, and similar items already in place that are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
   1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
   2. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

C. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.
   1. Remove incompatible primers and reprime substrate with compatible primers as required to produce paint systems indicated.

D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

E. Concrete Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

F. Steel Substrates: Remove rust and loose mill scale. Clean using methods recommended in writing by paint manufacturer.

G. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

H. Aluminum Substrates: Remove surface oxidation.

I. Wood Substrates:
   1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
   2. Sand surfaces that will be exposed to view, and dust off.
   3. Prime edges, ends, faces, undersides, and backsides of wood.
   4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

J. Plaster Substrates: Do not begin paint application until plaster is fully cured and dry.
3.03 APPLICATION

A. Apply paints according to manufacturer's written instructions.
   1. Use applicators and techniques suited for paint and substrate indicated.
   2. Paint surfaces behind movable items same as similar exposed surfaces.
   3. Paint surfaces behind items to be permanently fixed with prime coat only.
   4. Paint backsides of access panels and removable or hinged covers to match exposed surfaces.
   5. Do not paint factory-finished equipment, fixtures, or components, unless indicated otherwise.
   6. Finish exterior and interior doors on tops, bottoms, and side edges the same as exterior faces.

B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

3.04 FIELD QUALITY CONTROL

A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure at any time and as often as Owner deems necessary during the period when paints are being applied:
   1. Owner will engage the services of a qualified testing agency to sample paint materials being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
   2. Testing agency will perform tests for compliance of paint materials with product requirements.
   3. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying-paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

3.05 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.06 EXTERIOR PAINTING SCHEDULE

A. Concrete Substrates, Nontraffic Surfaces:

B. Concrete Substrates, Traffic Surfaces:
   1. Water-Based Clear Sealer System: MPI EXT 3.2H.

C. CMU Substrates:

D. Steel Substrates:

E. Galvanized-Metal Substrates:

F. Aluminum Substrates:

G. Dressed Lumber Substrates: Including architectural woodwork and doors.

H. Dimension Lumber Substrates, Nontraffic Surfaces:

END OF SECTION
SECTION 09 91 23
INTERIOR PAINTING

PART 1 - GENERAL

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

1.02 SUMMARY
A. This Section is general in nature. Paint systems are specified for various substrates that may or may not be encountered in the Work.
B. This Section includes surface preparation and the application of paint systems on the following interior substrates:
   1. Concrete.
   2. Concrete masonry units (CMU).
   3. Steel.
   5. Aluminum (not anodized or otherwise coated).
   6. Wood.
   7. Gypsum board.
C. Related Sections include the following:
   1. Division 01 Section "Sustainable Design Requirements" for additional LEED requirements.
   2. Division 05 Sections for shop priming of metal substrates with primers specified in this Section.
   3. Division 09 Section "Exterior Painting" for surface preparation and the application of paint systems on exterior substrates.

1.03 SUBMITTALS
A. Product Data: For each type of product indicated.
B. Samples: For each type of paint system and in each color and gloss of topcoat indicated.
   1. Submit 3 Samples on hardboard backing, 12 inches square.
   2. Step coats on Samples to show each coat required for system.
   3. Label each coat of each Sample.
   4. Label each Sample for location and application area.
   5. Resubmit samples, if requested, until required sheen, color and texture is achieved.
C. Product List: For each product indicated, include the following:
   1. Complete summary list of specific manufacturer's products, color identification numbers, manufacturer technical data sheets and MSDS. List shall compare each color number with each specified or selected color number. A copy of this list shall be given to the appropriate UCB Project Manager, and Structural Analyst in Work Management Group.
   2. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
   3. Printout of current "MPI Approved Products List" for each product category specified in Part 2, with the proposed product highlighted.
D. LEED Submittals:
   1. Credit MR 5.1 and 5.2: Regionally Extracted, Harvested, or Recovered, and Manufactured Materials:
      a. Indicate location of manufacturing facility, including name, address, and distance between manufacturing facility and the project site. Provide manufacturer’s documentation indicating location where the base materials were extracted, mined, quarried, harvested, etc., and the distance between this location and the project site. Also include material costs, excluding cost of installation.
   2. Credit EQ 4.2: Low Emitting Materials:
      a. Submit product data and material safety data sheets (MSDS) for paints and coatings used on the interior of the building indicating VOC content of each product used.

1.04 QUALITY ASSURANCE
A. MPI Standards:
   1. Products: Complying with MPI standards indicated and listed in "MPI Approved Products List."
B. Mockups: Apply benchmark samples of each paint system indicated and each color and finish selected to verify preliminary selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Architect will select one surface to represent surfaces and conditions for application of each paint system specified in Part 3.
      a. Wall and Ceiling Surfaces: Provide samples of at least 100 sq. ft.
      b. Other Items: Architect will designate items or areas required.
   2. Apply benchmark samples after permanent lighting and other environmental services have been activated.
   3. Final approval of color selections will be based on benchmark samples.
      a. If preliminary color selections are not approved, apply additional benchmark samples of additional colors selected by Architect at no added cost to Owner.

1.05 DELIVERY, STORAGE, AND HANDLING
A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
   1. Maintain containers in clean condition, free of foreign materials and residue.
   2. Remove rags and waste from storage areas daily.

1.06 PROJECT CONDITIONS
A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 65 and 95 deg F.
B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

1.07 EXTRA MATERIALS
A. Furnish extra materials described below that are from same production run (batch mix) as materials applied and that are packaged for storage and identified with labels describing contents.
PART 1 - QUANTITY

1. Quantity: Furnish an additional 5 percent, but not less than 1 gallon of each material and color applied.

PART 2 - PRODUCTS

2.01 GENERAL

A. Regionally Extracted, Harvested, or Recovered and Manufactured Materials:
   1. Preference shall be given to manufacturer's whose facilities are within a 500 mile radius of the project site.
   2. Preference shall also be given to materials that are harvested, extracted, mined, quarried, etc. within a 500 mile radius of the project site.

B. All paint to be lowest VOC for type indicated. Provide water based paints where applicable to installation requirements. All architectural paint topcoats shall meet "Green Seal" GS-11 VOC requirements:
   1. Reference VOC Limits specified in Division 01 Section "Sustainable Design Requirements."

2.02 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Benjamin Moore & Co.
   2. Diamond Vogel Paints.
   3. ICI Paints.
   6. PPG Architectural Finishes, Inc.
   7. Sherwin-Williams Company (The).

2.03 PAINT, GENERAL

A. Material Compatibility:
   1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
   2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

B. Chemical Components of Field-Applied Interior Paints and Coatings: Provide products that comply with the following limits for VOC content, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24) and the following chemical restrictions; these requirements do not apply to primers or finishes that are applied in a fabrication or finishing shop:
   1. Flat Paints and Coatings: VOC content of not more than 50 g/L.
   2. Nonflat Paints and Coatings: VOC content of not more than 150 g/L.
   3. Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight of total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).

C. Colors: [As selected by Architect from manufacturer's full range] [As indicated in a color schedule].
   1. Assume a maximum of 18 colors, including up to 6 deep-tone colors.

2.04 BLOCK FILLERS

2.05 PRIMERS/SEALERS
A. Interior Latex Primer/Sealer: MPI #50.
B. Wood-Knot Sealer: Sealer recommended in writing by topcoat manufacturer for use in paint systems indicated.

2.06 METAL PRIMERS
A. Alkyd Anticorrosive Metal Primer: MPI #79.
B. Waterborne Galvanized-Metal Primer: MPI #134.
C. Quick-Drying Primer for Aluminum: MPI #95.

2.07 WOOD PRIMERS
A. Interior Latex-Based Wood Primer: MPI #39.

2.08 LATEX PAINTS
A. Interior Latex (Eggshell): MPI #52 (Gloss Level 3).
B. Interior Latex (Satin): MPI #43 (Gloss Level 4).
C. Interior Latex (Semigloss): MPI #54 (Gloss Level 5).

2.09 ALKYD PAINTS
A. Interior Alkyd (Gloss): MPI #48 (Gloss Level 6).

2.10 DRY FOG/FALL COATINGS
A. Latex Dry Fog/Fall: MPI #118.

2.11 FLOOR COATINGS
A. Interior Concrete Floor Stain: MPI #58.
B. Interior/Exterior Clear Concrete Floor Sealer (Water Based): MPI #99.

PART 3 - EXECUTION

3.01 EXAMINATION
A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.
B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
   1. Concrete: 12 percent.
   3. Wood: 15 percent.
   4. Gypsum Board: 12 percent.
   5. Plaster: 12 percent.
C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
D. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.
1. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

3.02 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.

B. Remove plates, machined surfaces, and similar items already in place that are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
   1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
   2. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

C. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.
   1. Remove incompatible primers and reprime substrate with compatible primers as required to produce paint systems indicated.

D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

E. Concrete Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

F. Steel Substrates: Remove rust and loose mill scale. Clean using methods recommended in writing by paint manufacturer.

G. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

H. Aluminum Substrates: Remove surface oxidation.

I. Wood Substrates:
   1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
   2. Sand surfaces that will be exposed to view, and dust off.
   3. Prime edges, ends, faces, undersides, and backsides of wood.
   4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

J. Gypsum Board Substrates: Do not begin paint application until finishing compound is dry and sanded smooth.

K. Plaster Substrates: Do not begin paint application until plaster is fully cured and dry.

3.03 APPLICATION

A. Apply paints according to manufacturer's written instructions.
   1. Use applicators and techniques suited for paint and substrate indicated.
   2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
   3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
   4. Paint backsides of access panels and removable or hinged covers to match exposed surfaces.
5. Factory-Finished Objects: When directed by Architect, paint factory-finished objects such as grilles, louvers, switch-plates, etc. that do not match the color of surfaces in which they are located.

6. Apply additional coats of primer to joints in gypsum board assemblies as necessary to preclude joint "read-through."

B. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

C. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

D. Painting Mechanical and Electrical Work: Paint items exposed in equipment rooms and occupied spaces including, but not limited to, the following:
   1. Mechanical Work:
      a. Tanks that do not have factory-applied final finishes.
      b. Visible portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets.
         1) Paint with a flat, nonspecular black paint.
      c. Mechanical equipment that is indicated to have a factory-primed finish for field painting.
   2. Electrical Work:
      a. Electrical equipment that is indicated to have a factory-primed finish for field painting.
      b. Surface-mounted electrical conduits, boxes and wiremold when they occur in finished areas.

3.04 FIELD QUALITY CONTROL

A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure at any time and as often as Owner deems necessary during the period when paints are being applied:
   1. Owner will engage the services of a qualified testing agency to sample paint materials being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
   2. Testing agency will perform tests for compliance with product requirements.
   3. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying-paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

3.05 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.
3.06 INTERIOR PAINTING SCHEDULE

A. Concrete Substrates, Nontraffic Surfaces:
      c. Topcoat: MPI 43 High-performance architectural latex (satin).

B. Concrete Substrates, Traffic Surfaces:
   1. Concrete Stain System: MPI INT 3.2E.
      a. First Coat: MPI 58 Interior concrete floor stain.
      b. Topcoat: MPI 58 Interior concrete floor stain.
   2. Water-Based Clear Sealer System: MPI INT 3.2G.

C. CMU Substrates:
      c. Topcoat: MPI 43 High-performance architectural latex (satin).

D. Steel Substrates:
   1. Water-Based Dry-Fall System: MPI INT 5.1C. Use for overhead applications.
      b. Topcoat: MPI 118 Waterborne dry fall.
      1) Paint [steel deck] [steel beams and joists] [and] [ductwork] different colors.
      c. Topcoat: MPI 48 Interior alkyd (gloss).
   3. High-Performance Architectural Latex System: MPI INT 5.1R-G5. Use for steel substrates unless otherwise indicated.
      c. Topcoat: MPI 54 High-performance architectural latex (semigloss).

E. Galvanized-Metal Substrates:
   1. Water-Based Dry-Fall System: MPI INT 5.3H. Use for overhead applications.
      a. Prime Coat: MPI 133 Waterborne dry fall.
      b. Topcoat: MPI 133 Waterborne dry fall.
      c. Topcoat: MPI 54 High-performance architectural latex (semigloss).

F. Aluminum (Not Anodized or Otherwise Coated) Substrates:
c. Topcoat: MPI 54 High-performance architectural latex (semigloss).

G. Dressed Lumber Substrates:
c. Topcoat: MPI 54 High-performance architectural latex (semigloss).

H. Wood Panel Substrates: Including painted plywood, medium-density fiberboard and hardboard.
c. Topcoat: MPI 43 High-performance architectural latex (satin).

I. Gypsum Board Substrates:
c. Topcoat: MPI 52 High-performance architectural latex (eggshell).

END OF SECTION
SECTION 10 11 00

VISUAL DISPLAY SURFACES

PART 1 - GENERAL

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

1.02 SUMMARY
A. This Section includes the following:
   1. Markerboards.
   2. Tackboards.
B. Related Sections include the following:
   1. Division 01 Section "Sustainable Design Requirements" for additional LEED requirements.

1.03 DEFINITIONS
A. Tackboard: Framed or unframed tackable surface.
B. Visual Display Boards: Markerboards, and tackboards.

1.04 SUBMITTALS
A. Product Data: For each type of product indicated.
B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Illustrate each distinct marker/tackboard assembly.
      a. Include sections of typical trim members.
C. Samples: For each type of visual display surface indicated and as follows:
   1. Visual Display Surface: Not less than 8-1/2 by 11 inches, mounted on substrate indicated for final Work. Include one panel for each type, color, and texture required.
   2. Trim: 6-inch-long sections of each trim profile.
D. LEED Submittals:
   1. Credit EQ 4.4: Composite wood manufacturer's product data for each composite wood product used indicating that the bonding agent contains no urea formaldehyde.
E. Maintenance Data: For visual display surfaces to include in maintenance manuals.

1.05 QUALITY ASSURANCE
A. Installer Qualifications: An authorized representative of motor-operated, sliding visual display unit manufacturer for installation and maintenance of units required for this Project.
B. Source Limitations: Obtain each type of visual display surface through one source from a single manufacturer.
C. **Product Options:** Drawings indicate size, profiles, and dimensional requirements of visual display surfaces and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
   1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.

D. **Preinstallation Conference:** Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

### 1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver factory-built visual display boards, including factory-applied trim where indicated, completely assembled in one piece without joints, where possible. If dimensions exceed maximum manufactured panel size, provide two or more pieces of equal length as acceptable to Architect. When overall dimensions require delivery in separate units, prefit components at the factory, disassemble for delivery, and make final joints at the site.

B. Store visual display units vertically with packing materials between each unit.

### 1.07 PROJECT CONDITIONS

A. **Field Measurements:** Verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings.
   1. **Established Dimensions:** Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating visual display surfaces without field measurements. Coordinate wall construction to ensure that actual dimensions correspond to established dimensions.
   2. Allow for trimming and fitting where taking field measurements before fabrication might delay the Work.

### 1.08 WARRANTY

A. **Special Warranty for Porcelain-Enamel Face Sheets:** Manufacturer's standard form in which manufacturer agrees to repair or replace porcelain-enamel face sheets that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Surfaces lose original writing and erasing qualities.
      b. Surfaces become slick or shiny.
      c. Surfaces exhibit crazing, cracking, or flaking.
   2. **Warranty Period:** Life of the building.

### PART 2 - PRODUCTS

#### 2.01 MATERIALS, GENERAL

A. **Porcelain-Enamel Face Sheet:** Manufacturer's standard steel sheet with porcelain-enamel coating fused to steel; uncoated thickness indicated.
   1. Matte Finish: Low reflective; chalk wipes clean with dry cloth or standard eraser.
   2. Gloss Finish: Gloss as indicated; dry-erase markers wipe clean with dry cloth or standard eraser.

B. **Hardboard:** AHA A135.4, tempered.

C. **Fiberboard:** ANSI A208.2, Grade MD, made with binder containing no urea formaldehyde.
D. Plastic-Impregnated Cork Sheet: MS MIL-C-15116-C, Type I, seamless, homogeneous, self-sealing sheet consisting of granulated cork, linseed oil, resin binders, and dry pigments that are mixed and calendared onto burlap backing; with washable vinyl finish and integral color throughout.

E. Extruded Aluminum: ASTM B 221, Alloy 6063.

F. Aluminum Sheet: ASTM B 209.

2.02 MARKERBOARD ASSEMBLIES

A. Porcelain-Enamel Markerboard Assembly: Balanced, high-pressure, factory-laminated markerboard assembly of 3-ply construction consisting of backing sheet, core material, and 0.021-inch-thick, porcelain-enamel face sheet with low-gloss finish.

1. Manufacturers:
   a. ADP/Lemco, Inc.
   b. APCO.
   c. Claridge Products & Equipment, Inc.
   d. Ghent Manufacturing Inc.
   e. Greensteel Division of IDT, Inc.
   g. Platinum Visual Systems; a division of ABC School Equipment, Inc.
   h. PolyVision Corporation.

2. Fiberboard Core: 3/8 inch thick; with 0.015-inch-thick, aluminum sheet backing.

3. Laminating Adhesive: Manufacturer's standard moisture-resistant thermoplastic type.

2.03 TACK ASSEMBLIES

A. Manufacturers:
   2. ADP/Lemco, Inc.
   3. Claridge Products & Equipment, Inc.
   4. Ghent Manufacturing Inc.
   5. Marsh Industries, Inc.
   8. walltalkers; a division of RJF International Corporation.

B. Plastic-Impregnated-Cork Tack Assembly: 1/4-inch-thick, plastic-impregnated cork sheet factory laminated to 1/4-inch-thick hardboard backing.

2.04 VISUAL DISPLAY WALL PANELS

A. Manufacturers:
   2. ADP/Lemco, Inc.
   3. Claridge Products & Equipment, Inc.
   5. PolyVision Corporation.

B. Marker Wall Panels: Fabricated from markerboard assembly indicated.

2.05 MARKERBOARD AND TACKBOARD ACCESSORIES

A. Aluminum Frames and Trim: Fabricated from not less than 0.062-inch-thick, extruded aluminum; of size and shape indicated.

   1. Field-Applied Trim: Manufacturer's standard snap-on trim with no visible screws or exposed joints.

B. Chalktray: Manufacturer's standard, continuous.
   1. Solid Type: Extruded aluminum with ribbed section and smoothly curved exposed ends.

C. Map Rail: Provide the following accessories:
   1. Display Rail: Continuous and integral with map rail; fabricated from cork approximately 1 to 2 inches wide.
   2. End Stops: Located at each end of map rail.
   3. Map Hooks and Clips: Two map hooks with flexible metal clips for every 48 inches of map rail or fraction thereof.

2.06 FABRICATION

A. Porcelain-Enamel Visual Display Assemblies: Laminate porcelain-enamel face sheet and backing sheet to core material under heat and pressure with manufacturer's standard flexible, waterproof adhesive.

B. Visual Display Boards: Factory assemble visual display boards, unless otherwise indicated.
   1. Where factory-applied trim is indicated, trim shall be assembled and attached to visual display boards at manufacturer's factory before shipment.

C. Factory-Assembled Visual Display Units: Coordinate factory-assembled units with trim and accessories indicated. Join parts with a neat, precision fit.
   1. Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, as indicated on approved Shop Drawings.
   2. Where size of visual display boards or other conditions require support in addition to normal trim, provide structural supports or modify trim as indicated or as selected by Architect from manufacturer's standard structural support accessories to suit conditions indicated.

D. Visual Display Wall Panels: Fabricate panels with 0.0209-inch- thick, porcelain-enamel face sheets.

E. Aluminum Frames and Trim: Fabricate units straight and of single lengths, keeping joints to a minimum. Miter corners to neat, hairline closure.
   1. Where factory-applied trim is indicated, trim shall be assembled and attached to visual display units at manufacturer's factory before shipment.

2.07 ALUMINUM FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

D. Baked-Enamel Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below). Apply baked enamel complying with paint manufacturer's written instructions for cleaning, conversion coating, and painting.
   1. Organic Coating: Thermosetting, modified-acrylic enamel primer/topcoat system complying with AAMA 2603 except with a minimum dry film thickness of 1.5 mils, medium gloss.
E. Powder-Coat Finish: Apply manufacturer's standard baked finish, complying with manufacturer's written instructions for surface preparation including pretreatment, application, baking, and minimum dry film thickness.

PART 3 - EXECUTION

3.01 EXAMINATION
A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, surface conditions of wall, and other conditions affecting performance.
B. Examine walls and partitions for proper backing for visual display surfaces.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION
A. Remove dirt, scaling paint, projections, and depressions that will affect smooth, finished surfaces of visual display boards.
B. Prepare surfaces to achieve a smooth, dry, clean surface free of flaking, unsound coatings, cracks, defects, and substances that will impair bond between visual display boards and surfaces.
   1. Seal wall surfaces indicated to receive visual display fabric.
C. Prepare recesses for sliding visual display units as required by type and size of unit.

3.03 INSTALLATION, GENERAL
A. General: Install visual display surfaces in locations and at mounting heights indicated on Drawings. Keep perimeter lines straight, level, and plumb. Provide grounds, clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for complete installation.
B. Field-Assembled Visual Display Units: Coordinate field-assembled units with grounds, trim, and accessories indicated. Join parts with a neat, precision fit.
   1. Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, as indicated on approved Shop Drawings.
   2. Provide manufacturer's standard mullion trim at joints between markerboards and tackboards of combination units.
   3. Where size of visual display boards or other conditions require support in addition to normal trim, provide structural supports or modify trim as indicated or as selected by Architect from manufacturer's standard structural support accessories to suit conditions indicated.

3.04 INSTALLATION OF FACTORY-FABRICATED VISUAL DISPLAY UNITS
A. Visual Display Boards: Attach concealed clips, hangers, and grounds to wall surfaces and to visual display boards with fasteners at not more than 16 inches o.c. Secure both top and bottom of boards to walls.
   1. Field-Applied Aluminum Trim: Attach trim over edges of visual display boards and conceal grounds and clips. Attach trim to boards with fasteners at not more than 24 inches o.c.
      a. Attach chalktrays to boards with fasteners at not more than 12 inches o.c.
3.05 INSTALLATION OF VISUAL DISPLAY WALL PANELS
   A. Marker Wall Panels: Attach panels to wall surface with egg-size adhesive gobs at 16 inches o.c. horizontally and vertically.
      1. Join adjacent wall panels with concealed steel splines for smooth alignment.

3.06 CLEANING AND PROTECTION
   A. Clean visual display surfaces according to manufacturer's written instructions. Attach one cleaning label to visual display surface in each room.
   B. Touch up factory-applied finishes to restore damaged or soiled areas.
   C. Cover and protect visual display surfaces after installation and cleaning.

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. This Section includes the following:
      1. Panel signs.

   B. Related Sections include the following:
      1. Division 01 Section "Temporary Facilities and Controls" for temporary Project
         identification signs and for temporary information and directional signs.
      2. Division 22 Section "Identification for Plumbing Piping and Equipment" for labels, tags, and
         nameplates for plumbing systems and equipment.
      3. Division 23 Section "Identification for HVAC Piping and Equipment" for labels, tags, and
         nameplates for HVAC systems and equipment.
      4. Division 26 Sections for electrical service and connections for illuminated signs.
      5. Division 26 Section "Electrical Identification" for labels, tags, and nameplates for
         electrical equipment.
      6. Division 26 Section "Interior Lighting" for illuminated Exit signs.

1.03 DEFINITIONS
   A. ADA-ABA Accessibility Guidelines: U.S. Architectural & Transportation Barriers
      Compliance Board's "Americans with Disabilities Act (ADA) Accessibility Guidelines for
      Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines."

1.04 PERFORMANCE REQUIREMENTS
   A. Provide signage in accordance with American National Standards Institute/International
      Code Council (ANSI/ICC) A117.1 and International Building Code Sections 1020 and
      1110 and as otherwise indicated.

1.05 SUBMITTALS
   A. Product Data: For each type of product indicated.
   B. Shop Drawings: Show fabrication and installation details for signs.
      1. Show sign mounting heights, locations of supplementary supports to be provided
         by others, and accessories.
      2. Provide message list, typestyles, graphic elements, including tactile characters
         and Braille, and layout for each sign.
   C. Samples: For each of the following products and for the full range of color, texture, and
      sign material indicated, of sizes indicated:
      1. Panel Signs: One typical room identification sign, including updatable lateral slot.
   D. Sign Schedule: Use same designations indicated on Drawings.
   E. Maintenance Data: For signs to include in maintenance manuals.
1.06 QUALITY ASSURANCE
   A. Fabricate signs to comply with the University of Colorado at Boulder Campus Facilities Identification System guidelines.
   B. Installer Qualifications: An employer of workers trained and approved by manufacturer.
   C. Fabricator Qualifications: For each sign form and graphic image process indicated furnish products of a single manufacturer with a minimum of 3 years successful experience in the types of signs required.
   D. Source Limitations for Signs: Obtain each sign type indicated from one source from a single manufacturer.

1.07 PROJECT CONDITIONS
   A. Weather Limitations: Proceed with installation only when weather conditions permit installation of signs in exterior locations to be performed according to manufacturers' written instructions and warranty requirements.
   B. Field Measurements: Verify recess openings by field measurements before fabrication and indicate measurements on Shop Drawings.

1.08 COORDINATION
   A. Coordinate placement of anchorage devices with templates for installing signs.

1.09 WARRANTY
   A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
      1. Failures include, but are not limited to, the following:
         a. Deterioration of finishes beyond normal weathering.
         b. Deterioration of embedded graphic image colors and sign lamination.
      2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MATERIALS
   A. Aluminum Sheet and Plate: ASTM B 209, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with at least the strength and durability properties of Alloy 5005-H32.
   B. Aluminum Extrusions: ASTM B 221, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with at least the strength and durability properties of Alloy 6063-T5.
   C. Provide materials manufactured by New Hermes or approved substitute.
      1. General Signage: Gravoply.
      2. Raised Lettering and Braille Signage: GravoTac 2-ply system.

2.02 PANEL SIGNS
   A. Manufacturers: Subject to compliance with requirements, provide products by New Hermes.
1. Substitutions: Architect will consider comparable products. Submit in accordance with Division 01 Section "Product Requirements."

B. General:
1. Fabricate all signs to comply with requirements of referenced standards, as indicated below, or as specifically approved.
2. Produce smooth, even, level sign panel surfaces, constructed to remain flat under installed conditions within a tolerance of ±1/16" measured diagonally from corner to corner.

C. Interior Room Signs:
1. Fabricate white plastic room signs with edges mechanically and smoothly finished with square cut edges and 3/8” radiused corners. Sign face shall be edged with a recessed 1/8” border.
   a. Size: 6 inches by 6 inches for room number signs and directional signs.
   b. Letters shall be black in color and in the Helvetica Medium letter style raised from the background not less than 0.03125 as required by ADAAG.
   c. Provide 1.125" letter height for room numbers, centered 2” from the top of the letter to the top of the sign. Center a ½” wide black braille lettering panel 3/8” from the bottom of the sign.
   d. Provide raised copy and recessed braille lettering in copy thickness not less than 0.03125” thick as required by ADAAG.
2. Fabricate black anodized aluminum sleeve inserts for occupant use.
   a. Size 1 inch by 6 inches, open-ended horizontal sleeve.
   b. Provide a blank white 90 pound card stock insert covered with a clear acrylic matte strip 0.625” (1/16”) thick.
   c. Where required for informational signage, provide 6 inch by 6 inch black anodized insert sleeve open at the top.
   d. Provide a blank white 90 pound card stock insert covered with a clear acrylic matte strip 0.625” (1/16”) thick for 6 inch by 6 inch insert sleeve.
3. Fabricate white plastic directional signs with edges mechanically and smoothly finished with square cut edges and 3/8” radiused corners. Sign face shall be edged with a recessed 1/8” black border.
   a. Size: 6 inch by 6 inch surface-mounted signs that may be arranged one over the other, or side by side, as necessary to carry the message.
   b. Provide upper and lower case black vinyl diecut letters in the Helvetica Medium letter style.
   c. Provide black vinyl die-cut left, right, up, or down arrows as required.
4. Provide symbol for handicapped access on signage designating those areas accessible for the handicapped in conformance with Society for Environmental Graphic Designers (SEGD) recommendations for accessible signage, most recent edition.

D. Panel Sign Schedule:
1. Sign Type <Insert designation>
   a. Sign Size: [As indicated] <Insert dimensions>
   b. Message Panel Material: [As indicated] <Insert material>
   c. Message Panel Finish/Color: <Insert finish/color>
   d. Background Finish/Color: <Insert finish/color>
   e. Character Size: [As indicated] <Insert size>
   f. Character Finish/Color: <Insert finish/color>
   g. Panel Sign Frame Finish/Color: <Insert finish/color>
   h. Text/Message: [As indicated] <Insert text/message>
   i. Location: [As indicated] <Insert designation>
   j. Room: <Insert designation>
2.03 FABRICATION
A. General: Provide manufacturer's standard signs of configurations indicated.
   1. Welded Connections: Comply with AWS standards for recommended practices in shop welding. Provide welds behind finished surfaces without distortion or discoloration of exposed side. Clean exposed welded surfaces of welding flux and dress exposed and contact surfaces.
   2. Mill joints to tight, hairline fit. Form joints exposed to weather to exclude water penetration.
   3. Preassemble signs in the shop to greatest extent possible. Disassemble signs only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation, in location not exposed to view after final assembly.
   4. Conceal fasteners if possible; otherwise, locate fasteners where they will be inconspicuous.

2.04 LIFE SAFETY SIGNAGE:
A. Provide surface-mounted signs as specified above and as required by applicable Building Code and Fire Department regulations for life safety which may include stair and exitway doors, areas of refuge, elevator lobbies, elevators, fire command center and standpipe valve cabinets.
   1. Provide signs, 12" x 12", on stairwell side of each stairwell door at each floor for buildings four stories or more in accordance with the provisions of the 1997 Uniform Building Code.

2.05 FINISHES, GENERAL
A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.06 ALUMINUM FINISHES
A. Clear Anodic Finish: Manufacturer's standard Class 1 clear anodic coating, 0.018 mm or thicker, over a satin (directionally textured) mechanical finish, complying with AAMA 611.

2.07 PLASTIC SHEET FINISHES
A. Colored Coatings: For copy and background colors, provide colored coatings, including inks, dyes, and paints, that are recommended by manufacturers for optimum adherence to surface and that are UV and water resistant for five years for application intended.
   1. Color: As selected by Architect from manufacturer's full range.
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 work.

B. Verify that items, including anchor inserts, are sized and located to accommodate signs.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Locate signs and accessories where indicated, using mounting methods of types described and complying with manufacturer's written instructions.
   1. Install signs level, plumb, and at heights indicated, with sign surfaces free of distortion and other defects in appearance.
   2. Interior Wall Signs: Locate surface-mounted signs on the wall adjacent to the latch side of the door (or the nearest adjacent wall) at 60" above finished floor from the centerline of the sign (any size) and out of the swing of the door. Mount signs with right edge 4" from inside face of the door jamb.
   3. Locate surface-mounted insert sleeves centered below the room sign in multiples as necessary, each spaced 1 inch apart.

B. Wall-Mounted Signs: Comply with sign manufacturer's written instructions except where more stringent requirements apply.
   1. Two-Face Tape: Mount signs to smooth, nonporous surfaces. Do not use this method for vinyl-covered or rough surfaces.
   2. Silicone-Adhesive Mounting: Attach signs to irregular, porous, or vinyl-covered surfaces.
   3. Shim Plate Mounting: Provide 1/8-inch- thick, concealed aluminum shim plates with predrilled and countersunk holes, at locations indicated, and where other mounting methods are not practicable. Attach plate with fasteners and anchors suitable for secure attachment to substrate. Attach panel signs to plate using method specified above.

3.03 CLEANING AND PROTECTION

A. After installation, clean soiled sign surfaces according to manufacturer's written instructions. Protect signs from damage until acceptance by Owner.

END OF SECTION
SECTION 10 21 13
TOILET COMPARTMENTS

PART 1 - GENERAL

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

1.02 SUMMARY
A. This Section includes baked-enamel units as follows:
   1. Toilet Enclosures: Overhead braced.
B. Related Sections include the following:
   1. Division 01 Section "Sustainable Design Requirements" for additional LEED requirements.
   2. Division 06 Section "Miscellaneous Rough Carpentry" for blocking.
   3. Division 10 "Toilet, Bath, and Laundry Accessories" for toilet tissue dispensers, grab bars, purse shelves, and similar accessories.

1.03 SUBMITTALS
A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Show locations of cutouts for compartment-mounted toilet accessories.
   2. Show locations of reinforcements for compartment-mounted grab bars.
C. Samples: Of each type of color and finish required for units, prepared on 6-inch-square Samples of same thickness and material indicated for Work.
D. LEED Submittals:
   1. Credits MR 4.1 and 4.2: Recycled Content:
      a. Submit documentation from manufacturer indicating separate percentages, by weight, of pre-consumer and post-consumer recycled content per unit of product. Also include material costs, excluding cost of installation.
   2. Credits MR 5.1 and 5.2: Regionally Extracted, Harvested, or Recovered and Manufactured Materials:
      a. Indicate location of manufacturing facility, including name, address, and distance between manufacturing facility and the project site. Provide manufacturer's documentation indication location where the base materials were extracted, mined, quarried, harvested, etc., and the distance between this location and the project site. Also include material costs, excluding cost of installation.

1.04 QUALITY ASSURANCE
A. Installer Qualifications: 3 years experience in installation of metal toilet partitions.
1.05 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls, columns, ceilings, and other construction contiguous with toilet compartments by field measurements before fabrication and indicate measurements on Shop Drawings.

   1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating toilet compartments without field measurements. Coordinate wall, floor, ceilings, and other contiguous construction to ensure that actual dimensions correspond to established dimensions.

PART 2 - PRODUCTS

2.01 GENERAL

A. Recycled Content: Materials/products shall contain the maximum amount of recycled content allowed that retains material integrity.

B. Regionally Extracted, Harvested, or Recovered and Manufactured Materials:

   1. Preference shall be given to manufacturer's whose facilities are within a 500 mile radius of the project site.

   2. Preference shall also be given to materials that are harvested, extracted, mined, quarried, etc. within a 500 mile radius of the project site.

2.02 METAL UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   1. Accurate Partitions Corporation.
   2. General Partitions Mfg. Corp.
   3. Global Steel Products Corp.
   4. Knickerbocker Partitions Corp.
   5. Metpar Corp.
   6. Sanymetal; a Crane Plumbing Company.
   7. Weis-Robart Partitions, Inc.

B. Baked-Enamel Units: Facing sheets and closures fabricated from ASTM A 591/A 591M, 80Z (electrolytically zinc-coated) or ASTM A 653/A 653M (hot-dip galvanized or galvannealed), commercial steel sheet for exposed applications, that is mill phosphatized, and selected for smoothness.

   1. Facing Sheet Thicknesses: Minimum base-metal (uncoated) thicknesses as follows:

      a. Pilasters, Braced at Both Ends: Manufacturer's standard thickness, but not less than 0.0329 inch.
      b. Panels: Manufacturer's standard thickness, but not less than 0.0269 inch.
      c. Doors: Manufacturer's standard thickness, but not less than 0.0269 inch.
      d. Integral-Flange, Wall-Hung Urinal Screens: Manufacturer's standard thickness, but not less than 0.0269 inch.

   2. Finish: Manufacturer's standard pigmented, organic coating, including thermosetting, electrostatically applied, and powder coatings. Provide coating system that complies with coating manufacturer's written instructions for pretreatment, application, baking, and minimum dry film thickness.

      a. Color: One color in each room as selected by Architect from manufacturer's full range of colors.

C. Door, Panel, and Pilaster Construction: Seamless, metal facing sheets are pressure laminated to core material. Units have continuous, interlocking molding strip or lapped
and formed edge closures. Exposed surfaces are free of pitting, seam marks, roller marks, stains, discolorations, telegraphing of core material, or other imperfections. Corners are sealed by welding or clips. Exposed welds are ground smooth.

1. Core Material: Manufacturer's standard sound-deadening honeycomb of resin-impregnated kraft paper in thickness required to provide finished thickness of 1 inch for doors and panels and 1-1/4 inches for pilasters.
2. Grab-Bar Reinforcement: Provide concealed internal reinforcement for grab bars mounted on units.
3. Tapping Reinforcement: Provide concealed reinforcement for tapping (threading) at locations where machine screws are used for attaching items to units.

D. Pilaster Shoes and Sleeves (Caps): Stainless steel, ASTM A 666, Type 302 or 304, not less than 0.0312 inch specified thickness and 3 inches high, finished to match hardware.

E. Brackets (Fittings):
   1. Stirrup Type: Ear or U-brackets, stainless steel.

2.03 ACCESSORIES

A. Hardware and Accessories: Manufacturer's standard design, heavy-duty operating hardware and accessories.

B. Overhead Bracing: Manufacturer's standard continuous, extruded-aluminum head rail with antigrip profile and in manufacturer's standard finish.

C. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel or chrome-plated steel or brass, finished to match hardware, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use hot-dip galvanized or other rust-resistant, protective-coated steel.

2.04 FABRICATION

A. Overhead-Braced Units: Provide manufacturer's standard corrosion-resistant supports, leveling mechanism, fasteners, and anchors at pilasters to suit floor conditions. Make provisions for setting and securing continuous head rail at top of each pilaster. Provide shoes at pilasters to conceal supports and leveling mechanism.

B. Doors: Unless otherwise indicated, provide 24-inch- wide in-swinging doors for standard toilet compartments and 36-inch- wide out-swinging doors with a minimum 32-inch- wide clear opening for compartments indicated to be accessible to people with disabilities.
   1. Hinges: Manufacturer's standard self-closing type that can be adjusted to hold doors open at any angle up to 90 degrees.
   2. Latch and Keeper: Manufacturer's standard recessed latch unit designed for emergency access and with combination rubber-faced door strike and keeper. Provide units that comply with accessibility requirements of authorities having jurisdiction at compartments indicated to be accessible to people with disabilities.
   3. Coat Hook: Manufacturer's standard combination hook and rubber-tipped bumper, sized to prevent door from hitting compartment-mounted accessories.
   4. Door Bumper: Manufacturer's standard rubber-tipped bumper at out-swinging doors.
   5. Door Pull: Manufacturer's standard unit at out-swinging doors that complies with accessibility requirements of authorities having jurisdiction. Provide units on both sides of doors at compartments indicated to be accessible to people with disabilities.
PART 3 - EXECUTION

3.01 INSTALLATION

A. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position with manufacturer's recommended anchoring devices.

1. Maximum Clearances:
   a. Pilasters and Panels: 1/2 inch.
   b. Panels and Walls: 1 inch.

2. Stirrup Brackets: Secure panels to walls and to pilasters with not less than two brackets attached near top and bottom of panel.
   a. Locate wall brackets so holes for wall anchors occur in masonry or tile joints.
   b. Align brackets at pilasters with brackets at walls.

B. Overhead-Braced Units: Secure pilasters to floor and level, plumb, and tighten. Secure continuous head rail to each pilaster with not less than two fasteners. Hang doors to align tops of doors with tops of panels and adjust so tops of doors are parallel with overhead brace when doors are in closed position.

C. Wall-Hung Urinal Screens: Attach with anchoring devices to suit supporting structure. Set units level and plumb and to resist lateral impact.

3.02 ADJUSTING

A. Hardware Adjustment: Adjust and lubricate hardware according to manufacturer's written instructions for proper operation. Set hinges on in-swinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on out-swinging doors to return doors to fully closed position.

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. Manually operated, acoustical panel partitions.
B. Related Sections:
   1. Division 01 Section "Sustainable Design Requirements" for additional LEED requirements.
   2. Division 05 Section "Metal Fabrications" for supports that attach supporting tracks to overhead structural system.
   3. Division 08 Section "Door Hardware" for hardware to the extent not specified in this Section.
   4. Division 09 Section "Gypsum Board" for sound barrier construction above the ceiling at track.

1.03 DEFINITIONS
B. Glass and Glazing Definitions: See Division 08 Section "Glazing."
C. NIC: Noise Isolation Class.
D. NRC: Noise Reduction Coefficient.
E. STC: Sound Transmission Class.

1.04 PERFORMANCE REQUIREMENTS
A. Acoustical Performance: Provide operable panel partitions tested by a qualified testing agency for the following acoustical properties according to test methods indicated:
   1. Sound-Transmission Requirements: Operable panel partition assembly tested for laboratory sound-transmission loss performance according to ASTM E 90, determined by ASTM E 413, and rated for not less than the STC indicated.
   2. Noise-Reduction Requirements: Operable panel partition assembly, identical to partition tested for STC, tested for sound-absorption performance according to ASTM C 423, and rated for not less than the NRC indicated.
   3. Acoustical Performance Requirements: Installed operable panel partition assembly, identical to partition tested for STC, tested for NIC according to ASTM E 336, determined by ASTM E 413, and rated for 10 dB less than STC value indicated.

1.05 SUBMITTALS
A. Product Data: For each type of product indicated.
B. LEED Submittals:
1. Credit MR 4.1 and MR 4.2: Product Data indicating percentages by weight of postconsumer and preconsumer recycled content for products having recycled content.
   a. Include statement indicating costs for each product having recycled content.
2. Credits MR 5.1 and MR 5.2: Regionally Extracted, Harvested, or Recovered and Manufactured Materials:
   a. Indicate location of manufacturing facility, including name, address, and distance between manufacturing facility and the project site. Provide manufacturer’s documentation indicating location where the base materials were extracted, mined, quarried, harvested, etc., and the distance between this location and the project site. Also include material costs, excluding cost of installation.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
1. Indicate storage and operating clearances. Indicate location and installation requirements for hardware and track, blocking, and direction of travel.

D. Samples:
For each type of exposed material, finish, covering, or facing indicated, prepared on Samples of size indicated below:
1. Panel Facing Material: Manufacturer’s standard-size unit, not less than 3 inches square.

E. Coordination Drawings:
Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
1. Suspended ceiling components.
2. Structural members to which suspension systems will be attached.
3. Size and location of initial access modules for acoustical tile.
4. Items penetrating finished ceiling, including the following:
   a. Lighting fixtures.
   b. HVAC ductwork, outlets, and inlets.
   c. Speakers.
   d. Sprinklers.
   e. Smoke detectors.
   f. Access panels.
5. Plenum acoustical barriers.

F. Setting Drawings:
For embedded items and cutouts required in other work, including support-beam, mounting-hole template.

G. Operation and Maintenance Data:
For operable panel partitions to include in maintenance manuals. In addition to items specified in Division 01 Section “Operation and Maintenance Data,” include the following:
1. Panel finish facings and finishes for exposed trim and accessories. Include precautions for cleaning materials and methods that could be detrimental to finishes and performance.
2. Seals, hardware, track, carriers, and other operating components.

1.06 QUALITY ASSURANCE

A. Installer Qualifications:
An employer of workers trained and approved by manufacturer.

B. Fire-Test-Response Characteristics:
Provide panels with finishes meeting one of the following as determined by testing identical products by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
1. Surface-Burning Characteristics: As determined by testing per ASTM E 84.
   a. Flame-Spread Index: 25 or less.
   b. Smoke-Developed Index: 450 or less.

2. Fire Growth Contribution: Meeting acceptance criteria of local code and authorities having jurisdiction when tested according to NFPA 265 and NFPA 286.

C. Preinstallation Conference: Conduct conference at Project site.

1.07 DELIVERY, STORAGE, AND HANDLING
A. Protectively package and sequence panels in order for installation. Clearly mark packages and panels with numbering system used on Shop Drawings. Do not use permanent markings on panels.

1.08 PROJECT CONDITIONS
A. Field Measurements: Verify actual dimensions of operable panel partition openings by field measurements before fabrication.

1.09 WARRANTY
A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of operable panel partitions that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Faulty operation of operable panel partitions.
      b. Deterioration of metals, metal finishes, and other materials beyond normal wear.
   2. Warranty Period: Two years from date of Substantial Completion.

1.10 EXTRA MATERIALS
A. Furnish extra materials from the same production run that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Panel Finish-Facing Material: Furnish full width in quantity to cover both sides of two panels when installed.

PART 2 - PRODUCTS

2.01 GENERAL
A. Recycled Content: Materials/products shall contain the maximum amount of recycled content allowed that retains material integrity.

B. Regionally Extracted, Harvested, or Recovered and Manufactured Materials:
   1. Preference shall be given to suppliers whose facilities are within a 500 mile radius of the project site.
   2. Preference shall also be given to materials that are harvested, extracted, mined, quarried, etc. within a 500 mile radius of the project site.

2.02 MATERIALS
A. Steel Frame: Steel sheet, manufacturer's standard nominal minimum thickness for uncoated steel.
B. Steel Face/Liner Sheets: Tension-leveled steel sheet, manufacturer's standard nominal minimum thickness for uncoated steel.

C. Aluminum: Alloy and temper recommended by aluminum producer and finisher for type of use, corrosion resistance, and finish indicated; ASTM B 221 for extrusions; manufacturer's standard strengths and thicknesses for type of use.

2.03 OPERABLE ACOUSTICAL PANELS

A. Operable Acoustical Panels: Operable acoustical panel partition system, including panels, seals, finish facing, suspension system, operators, and accessories.

1. Basis-of-Design Product: Subject to compliance with requirements, provide "Acousti-Seal" 932S by Modernfold, Inc. or comparable product by one of the following. Plans, elevations, details, characteristics, and other requirements indicated are based upon standards of the Basis of Design Product. Other manufacturers listed may be acceptable, provided their details and characteristics comply with size and profile requirements, and material and performance standards.
   b. Curtition, Inc.
   c. FolDoor; Holcomb & Hoke Mfg. Co., Inc.
   d. Hufcor.
   e. KWIK-WALL Company.
   f. Moderco Inc.
   g. Modernfold, Inc.; a DORMA Group Company.
   h. Panelfold Inc.

B. Panel Operation: Manually operated, paired panels.

C. Panel Construction: Provide top reinforcement as required to support panel from suspension components and provide reinforcement for hardware attachment. Fabricate panels with tight hairline joints and concealed fasteners. Fabricate panels so finished in-place partition is rigid; level; plumb; aligned, with tight joints and uniform appearance; and free of bow, warp, twist, deformation, and surface and finish irregularities.

D. Dimensions: Fabricate operable acoustical panel partitions to form an assembled system of dimensions indicated and verified by field measurements.
   1. Panel Width: Equal widths.

E. STC: Not less than 52.

F. Panel Weight: 12 lb/sq. ft. maximum.

G. Panel Thickness: Not less than 3 inches.

H. Panel Closure: Manufacturer's standard.
   1. Initial Closure: Flexible, resilient PVC, bulb-shaped acoustical seal .
   2. Final Closure: Constant-force, lever-operated mechanical closure expanding from panel edge to create a constant-pressure acoustical seal.

I. Hardware: Manufacturer's standard as required to operate operable panel partition and accessories; with decorative, protective finish.
   1. Hinges: Concealed (invisible).

2.04 SEALS

A. General: Provide types of seals indicated that produce operable panel partitions complying with acoustical performance requirements and the following:
   1. Manufacturer's standard seals.
   2. Seals made from materials and in profiles that minimize sound leakage.
3. Seals fitting tight at contact surfaces and sealing continuously between adjacent panels and between operable panel partition perimeter and adjacent surfaces, when operable panel partition is extended and closed.

B. Vertical Seals: Deep-nesting, interlocking astragals mounted on each edge of panel, with continuous PVC acoustical seal.

C. Horizontal Top Seals:
   1. Continuous-contact, extruded-PVC seal exerting uniform constant pressure on track or PVC-faced, mechanical, retractable, constant-force-contact seal exerting uniform constant pressure on track when extended.

D. Horizontal Bottom Seals: PVC-faced, mechanical, retractable, constant-force-contact seal exerting uniform constant pressure on floor when extended, ensuring horizontal and vertical sealing and resisting panel movement.
   1. Mechanically Operated for Acoustical Panels: Extension and retraction of bottom seal by operating handle or built-in operating mechanism, with operating range not less than 2 inches between retracted seal and floor finish.

2.05 FINISH FACING

A. General: Provide finish facings for panels that comply with indicated fire-test-response characteristics and that are factory applied to operable panel partitions with appropriate backing, using mildew-resistant nonstaining adhesive as recommended by facing manufacturer's written instructions.
   1. Apply one-piece, seamless facings free of air bubbles, wrinkles, blisters, and other defects, with edges tightly butted, and with no gaps or overlaps. Horizontal butted edges and seams are not permitted. Tightly secure and conceal raw and selvage edges of facing for finished appearance.
   2. Color/Pattern: As selected by Architect from manufacturer's full range.

B. Vinyl-Coated Fabric Wall Covering: Manufacturer's standard, mildew-resistant, washable, vinyl-coated fabric wall covering; complying with CFFA-W-101-D for type indicated; Class A.
   1. Total Weight: 20 oz.
   2. Antimicrobial Treatment: Additives capable of inhibiting growth of bacteria, fungi, and yeasts.

C. Paint: Manufacturer's standard factory-painted finish.

D. Trimless Edges: Fabricate exposed panel edges so finish facing wraps uninterrupted around panel, covering edge and resulting in an installed partition with facing visible on vertical panel edges, without trim, for minimal sightlines at panel-to-panel joints.

2.06 SUSPENSION SYSTEMS

A. Suspension Tracks: Steel or aluminum with adjustable steel hanger rods for overhead support, designed for type of operation, size, and weight of operable panel partition indicated. Size track to support partition operation and storage without damage to suspension system, operable panel partitions, or adjacent construction. Limit track deflection to no more than 0.10 inch between bracket supports. Provide a continuous system of track sections and accessories to accommodate configuration and layout indicated for partition operation and storage.
   1. Panel Guide: Aluminum; finished with factory-applied, decorative, protective finish.
   2. Head Closure Trim: As required for acoustical performance; with factory-applied, decorative, protective finish.
B. Carriers: Trolley system as required for configuration type, size, and weight of partition and for easy operation; with ball-bearing wheels.

C. Aluminum Finish: Manufacturer's standard, factory-applied, decorative finish unless otherwise indicated.

D. Steel Finish: Manufacturer's standard, factory-applied, corrosion-resistant, protective coating unless otherwise indicated.

2.07 ACCESSORIES

A. Storage Pocket Door: Full height at end of partition runs to conceal stacked partition; of same materials, finish, construction, thickness, and acoustical qualities as panels; complete with operating hardware and acoustical seals at soffit, floor, and jambs. Hinges in finish to match other exposed hardware.
   1. Manufacturer's standard triple-leaf assembly to secure storage pocket door in closed position and close-off storage pocket when partition is in use.
   2. Rim Lock: Deadlock to receive cylinder, to secure storage pocket door in closed position. Refer to Division 08 door hardware Sections for lock cylinder and keying requirements.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine flooring, structural support, and opening, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of operable panel partitions.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. General: Comply with ASTM E 557 except as otherwise required by operable panel partition manufacturer's written installation instructions.

B. Install operable panel partitions and accessories after other finishing operations, including painting, have been completed.

C. Install panels from marked packages in numbered sequence indicated on Shop Drawings.

D. Broken, cracked, chipped, deformed, or unmatched panels are not acceptable.

E. Broken, cracked, deformed, or unmatched gasketing or gasketing with gaps at butted ends is not acceptable.

3.03 ADJUSTING

A. Adjust operable panel partitions to operate smoothly, without warping or binding. Lubricate hardware and other moving parts.

B. Adjust storage pocket doors to operate smoothly and easily, without binding or warping. Check and readjust operating hardware. Confirm that latches and locks engage accurately and securely without forcing or binding.

3.04 FIELD QUALITY CONTROL

A. Light-Leakage Test: Illuminate one side of partition installation and observe vertical joints and top and bottom seals for voids; adjust partitions for acceptable fit.

B. NIC Testing: Engage a qualified testing agency to perform tests and inspections.
C.  Testing Methodology: Perform testing of installed operable panel partition for noise isolation according to ASTM E 336, determined by ASTM E 413, and rated for not less than NIC indicated. Adjust and fit partitions to comply with NIC test method requirements.

D.  Testing Extent: Testing agency shall randomly select one operable panel partition installation(s) for testing.

E.  Repair or replace operable panel partitions that do not comply with requirements.

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

G.  Prepare test and inspection reports.

3.05 CLEANING

A.  Clean soiled surfaces of operable panel partitions to remove dust, loose fibers, fingerprints, adhesives, and other foreign materials according to manufacturer's written instructions.

3.06 DEMONSTRATION

A.  Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain operable panel partitions.

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. This Section includes the following:
   1. Corner guards.
B. Related Sections include the following:
   1. Division 01 Section "Sustainable Design Requirements" for additional LEED requirements.
   2. Division 08 Section "Door Hardware" for metal armor, kick, mop, and push plates.

1.03 PERFORMANCE REQUIREMENTS
A. Where corner guards are indicated for fire-rated walls and partitions, provide fire-rated corner guards with ratings matching those of the walls and partitions on which they are located.

1.04 SUBMITTALS
A. Product Data: Include construction details, material descriptions, impact strength, dimensions of individual components and profiles, and finishes for each impact-resistant wall-protection unit.
B. Shop Drawings: For each impact-resistant wall-protection unit showing locations and extent. Include sections, details, and attachments to other work.
C. Samples: For each type of exposed finish required, prepared on Samples of size indicated below. Include Samples of accent strips to verify color selected.
   1. Wall and Corner Guards: 12 inches long. Include examples of joinery, corners, end caps, top caps, and field splices.
D. LEED Submittals:
   1. Credit EQ 4.1: Manufacturers' product data for adhesives, including printed statement of VOC content.
E. Maintenance Data: For each impact-resistant wall-protection unit to include in maintenance manuals.
   1. Include recommended methods and frequency of maintenance for maintaining optimum condition of plastic covers under anticipated traffic and use conditions. Include precautions against using cleaning materials and methods that may be detrimental to plastic finishes and performance.

1.05 QUALITY ASSURANCE
A. Source Limitations: Obtain impact-resistant wall-protection units through one source from a single manufacturer.
B. **Product Options:** Drawings indicate size, profiles, and dimensional requirements of impact-resistant wall-protection units and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
   1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect’s approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.

C. **Fire-Test-Response Characteristics:** Provide impact-resistant, plastic wall-protection units with surface-burning characteristics as determined by testing identical products per ASTM E 84, NFPA 255, or UL 723 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.

D. **Preinstallation Conference:** Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.06 **DELIVERY, STORAGE, AND HANDLING**

A. Store impact-resistant wall-protection units in original undamaged packages and containers inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.
   1. Maintain room temperature within storage area at not less than 70 deg F during the period plastic materials are stored.
   2. Keep plastic sheet material out of direct sunlight.
   3. Store plastic wall-protection components for a minimum of 72 hours, or until plastic material attains a minimum room temperature of 70 deg F.
      a. Store corner-guard covers in a vertical position.
      b. Store wall-guard covers in a horizontal position.

1.07 **PROJECT CONDITIONS**

A. **Environmental Limitations:** Do not deliver or install impact-resistant wall-protection units until building is enclosed and weatherproof, wet work is complete and dry, and HVAC system is operating and maintaining temperature at 70 deg F for not less than 72 hours before beginning installation and for the remainder of the construction period.

B. **Field Measurements:** Verify actual locations of walls, columns, and other construction contiguous with impact-resistant wall-protection units by field measurements before fabrication and indicate measurements on Shop Drawings.

1.08 **WARRANTY**

A. **Special Warranty:** Manufacturer’s standard form in which manufacturer agrees to repair or replace components of impact-resistant wall-protection units that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures.
      b. Deterioration of plastic and other materials beyond normal use.
   2. Warranty Period: Five years from date of Substantial Completion.

1.09 **EXTRA MATERIALS**

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. **Corner-Guard Covers:** Full-size plastic covers of maximum length equal to 2 percent of each type, color, and texture of units installed, but no fewer than 2, full height units.
B. Include mounting and accessory components. Replacement materials shall be from the same production run as installed units.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Extruded Rigid Plastic: ASTM D 1784, Class 1, textured, chemical- and stain-resistant, high-impact-resistant PVC or acrylic-modified vinyl plastic with integral color throughout; thickness as indicated.
   1. Impact Resistance: Minimum 25.4 ft-lbf/in. of notch when tested according to ASTM D 256, Test Method A.
   2. Chemical and Stain Resistance: Tested according to ASTM D 543.
   3. Self-extinguishing when tested according to ASTM D 635.
   4. Flame-Spread Index: 25 or less.
   5. Smoke-Developed Index: 450 or less.

B. Polycarbonate Plastic Sheet: ASTM D 6098, S-PC01, Class 1 or 2, abrasion resistant; with a minimum impact-resistance rating of 15 ft-lbf/in. of notch when tested according to ASTM D 256, Test Method A.

C. Aluminum Extrusions: Alloy and temper recommended by manufacturer for type of use and finish indicated but with not less than strength and durability properties specified in ASTM B 221 for Alloy 6063-T5.

D. Fasteners: Aluminum, nonmagnetic stainless-steel, or other noncorrosive metal screws, bolts, and other fasteners compatible with items being fastened. Use security-type fasteners where exposed to view.

2.02 CORNER GUARDS

A. Flush-Mounted, Resilient, Plastic Corner Guards: Assembly consisting of snap-on plastic cover that is flush with adjacent wall surface, installed over continuous retainer; including mounting hardware; fabricated with 90- or 135-degree turn to match wall condition; full wall height.
   1. Basis-of-Design Product: CG-7 series by Pawling Corporation or a comparable product by one of the following:
   2. Manufacturers:
      a. American Floor Products Co., Inc.
      b. ARDEN Architectural Specialties, Inc.
      c. Balco, Inc.
      d. Construction Specialties, Inc.
      e. IPC Door and Wall Protection Systems; Division of InPro Corporation.
      f. Korogard Wall Protection Systems; Division of RJF International Corporation.
   3. Cover: Extruded rigid plastic, minimum 0.078-inch wall thickness; as follows:
      a. Profile: Nominal 2-inch-long leg and 1/4-inch corner radius.
      b. Height: Full height of space installed unless indicated otherwise.
      c. Color and Texture: As selected by Architect from manufacturer's full range.
   4. Retainer: Minimum 0.060-inch-thick, 1-piece, extruded aluminum.

B. Fire-Rated, Resilient, Plastic Corner Guards: Assembly consisting of snap-on plastic cover that is flush with adjacent wall surface, installed over continuous retainer and intumescent fire barrier; including mounting hardware; fabricated with 90- or 135-degree turn to match wall condition; full wall height.
1. Basis-of-Design Product: CGF-7 series by Pawling Corporation or a comparable product by one of the following:
2. Manufacturers:
   a. American Floor Products Co., Inc.
   b. ARDEN Architectural Specialties, Inc.
   c. Balco, Inc.
   d. Construction Specialties, Inc.
   e. IPC Door and Wall Protection Systems; Division of InPro Corporation.
   f. Korogard Wall Protection Systems; Division of RJF International Corporation.
3. Use for: Corner guards required in fire-rated walls.
4. Fire Rating: Same rating as wall in which corner guard is installed; UL listed and labeled according to UL 2079.
5. Cover: Extruded rigid plastic, minimum 0.078-inch wall thickness; as follows:
   a. Leg: Nominal 2 inches.
   b. Corner Radius: 1/4 inch.
   c. Height: Full height of space installed unless indicated otherwise.
   d. Color and Texture: As selected by Architect from manufacturer's full range.
6. Retainer: Minimum 0.070-inch- thick, 1-piece, extruded aluminum.

2.03 FABRICATION
A. Fabricate impact-resistant wall-protection units to comply with requirements indicated for design, dimensions, and member sizes, including thicknesses of components.
B. Assemble components in factory to greatest extent possible to minimize field assembly. Disassemble only as necessary for shipping and handling.
C. Fabricate components with tight seams and joints with exposed edges rolled. Provide surfaces free of wrinkles, chips, dents, uneven coloration, and other imperfections. Fabricate members and fittings to produce flush, smooth, and rigid hairline joints.

2.04 METAL FINISHES
A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
   1. Remove tool and die marks and stretch lines or blend into finish.
   2. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.
B. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
C. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.01 EXAMINATION
A. Examine substrates and wall areas, with Installer present, for compliance with requirements for installation tolerances, fire rating, and other conditions affecting performance of work.
1. Examine walls to which impact-resistant wall protection will be attached for blocking, grounds, and other solid backing that have been installed in the locations required for secure attachment of support fasteners.

2. For impact-resistant wall-protection units attached with adhesive or foam tape, verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.

3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Complete finishing operations, including painting, before installing impact-resistant wall-protection system components.

B. Before installation, clean substrate to remove dust, debris, and loose particles.

3.03 INSTALLATION

A. General: Install impact-resistant wall-protection units level, plumb, and true to line without distortions. Do not use materials with chips, cracks, voids, stains, or other defects that might be visible in the finished Work.

1. Provide splices, mounting hardware, anchors, and other accessories required for a complete installation.
   a. Provide anchoring devices to withstand imposed loads.

3.04 CLEANING

A. Immediately after completion of installation, clean plastic covers and accessories using a standard, ammonia-based, household cleaning agent.

B. Remove excess adhesive using methods and materials recommended in writing by manufacturer.

END OF SECTION
SECTION 10 28 00
TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 - GENERAL

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

1.02 SUMMARY
A. This Section includes the following:
   1. Public-use washroom accessories.
   2. Public-use shower room accessories.
   3. Underlavatory guards.
   5. Coat hooks.
B. Owner-Furnished Material: Jumbo toilet paper dispensers, roll paper towel dispensers,
   foam hand-soap dispensers.
   1. Allow Owner minimum 3 weeks advance notice for procurement of dispensers.
   2. Verify sufficiency of space and clearances provided for Owner-furnished
      dispensers: Owner's contract for toilet room supplies renews on a yearly basis.
C. Related Sections include the followings:
   1. Division 01 Section "Sustainable Design Requirements" for additional LEED
      requirements.
   2. Division 08 Section "Mirrors" for frameless mirrors.
   3. Division 10 Section "Detention Toilet Accessories" for accessories designed for
      installation in detention facilities.

1.03 SUBMITTALS
A. Product Data: For each type of product indicated. Include the following:
   1. Construction details and dimensions.
   2. Anchoring and mounting requirements, including requirements for cutouts in
      other work and substrate preparation.
   3. Material and finish descriptions.
   4. Features that will be included for Project.
B. Product Schedule: Indicating types, quantities, sizes, and installation locations by room
   of each accessory required.
   1. Identify locations using room designations indicated on Drawings.
   2. Identify products using designations indicated on Drawings.
C. LEED Submittals:
   1. Credits MR 5.1 and 5.2: Regionally Extracted, Harvested, or Recovered and
      Manufactured Materials:
      a. Indicate location of manufacturing facility, including name, address, and
         distance between manufacturing facility and the project site. Provide
         manufacturer's documentation indication location where the base
         materials were extracted, mined, quarried, harvested, etc., and the
         distance between this location and the project site. Also include material
         costs, excluding cost of installation.
D. Maintenance Data: For toilet and bath accessories to include in maintenance manuals.
1.04 QUALITY ASSURANCE
A. Source Limitations: For products listed together in the same articles in Part 2, provide products of same manufacturer unless otherwise approved by Architect.
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.

1.05 COORDINATION
A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.
B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

1.06 WARRANTY
A. Special Mirror Warranty: Manufacturer's standard form in which manufacturer agrees to replace mirrors that develop visible silver spoilage defects and that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: 15 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 GENERAL
A. Regionally Extracted, Harvested, or Recovered and Manufactured Materials:
   1. Preference shall be given to manufacturer's whose facilities are within a 500 mile radius of the project site.
   2. Preference shall also be given to materials that are harvested, extracted, mined, quarried, etc. within a 500 mile radius of the project site.

2.02 MATERIALS
A. Stainless Steel: ASTM A 666, Type 304, 0.0312-inch minimum nominal thickness, unless otherwise indicated.
B. Brass: ASTM B 19 flat products; ASTM B 16, rods, shapes, forgings, and flat products with finished edges; or ASTM B 30, castings.
C. Steel Sheet: ASTM A 1008/A 1008M, Designation CS (cold rolled, commercial steel), 0.0359-inch minimum nominal thickness.
D. Galvanized Steel Sheet: ASTM A 653/A 653M, with G60 hot-dip zinc coating.
F. Fasteners: Screws, bolts, and other devices of same material as accessory unit and tamper-and-theft resistant where exposed, and of galvanized steel where concealed.
G. Chrome Plating: ASTM B 456, Service Condition Number SC 2 (moderate service).
H. Mirrors: ASTM C 1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.
2.03 BASIS OF DESIGN PRODUCTS
A. The design for accessories is based on products by American Specialties, Inc., unless noted otherwise. Subject to compliance with requirements, provide the named product or a comparable product by one of the following:
1. A & J Washroom Accessories, Inc.
2. Bobrick Washroom Equipment, Inc.
5. McKinney/Parker Products Co.
7. San Jamar.

2.04 PUBLIC-USE WASHROOM ACCESSORIES
A. Material and Finish: Stainless steel, No. 4 finish (satin), unless indicated otherwise.
B. Toilet Tissue (Roll) Dispensers TA-1:
   1. Typical Toilet Tissue (Roll) Dispenser TA-1a: Not used.
   2. Accessible Toilet Tissue (Roll) Dispenser TA-1b:
      b. Mounting: Surface mounted.
      c. Operation: Noncontrol delivery with standard spindle.
      d. Capacity: Designed for 4-1/2- or 5-inch-diameter tissue rolls.
      e. Material and Finish: Satin-finish aluminum bracket with plastic spindle.
C. Paper Towel Dispensers TA-2:
   1. Paper Towel (Roll) Dispenser TA-2c: Owner-Furnished, Contractor-installed.
D. Waste Receptacles: TA-3:
   3. Waste Receptacle TA-3c:
      b. Mounting: Recessed with projecting receptacle.
      c. Minimum Capacity: 18 gal.
      d. Lockset: Tumbler type.
E. Liquid-Soap Dispensers TA-4: Owner-Furnished, Contractor-installed.
F. Mirror Unit TA-5:
   2. Frame: Stainless-steel channel.
      a. Corners: Manufacturer's standard.
      a. Wall bracket of galvanized steel, equipped with concealed locking devices requiring a special tool to remove.
   4. Size: As indicated on Drawings.
G. Grab Bars TA-6:
   3. Material: Stainless steel, 0.05 inch thick.
a. Finish: Smooth, No. 4, satin finish on ends and slip-resistant texture in grip area.

5. Configuration and Length: As indicated on Drawings.

H. Vendor TA-7: Not Used.

I. Sanitary-Napkin Disposal Unit TA-8:
2. Door or Cover: Self-closing disposal-opening cover.


K. Warm-Air Dryer TA-10: Not Used.

L. Diaper-Changing Station TA-11:
1. Basis-of-Design Product: Model 9013 Baby Changing Station, or a comparable product by one of the following:
   a. American Infant Care Products Inc.
   b. Bobrick, Koala Care Division.
   c. Brocar Products, Inc.
   d. Safe-Strap Company, Inc.
2. Description: Horizontal unit that opens by folding down from stored position and with child-protection strap.
   a. Engineered to support a minimum of 250-lb static load when opened.
3. Mounting: Surface mounted, with unit projecting not more than 4 inches from wall when closed.
5. Material and Finish: Stainless steel, No. 4 finish (satin), with replaceable insulated polystyrene tray liner and rounded plastic corners.

M. Small Article Shelf TA-12:
2. Nominal Size: 16 inches long by 5 inches deep.

N. Book and Pack Rack TA-13:
2. Size: As indicated on Drawings.

O. TA-14 and 15: Not Used.

2.05 PUBLIC-USE SHOWER ROOM ACCESSORIES

A. Material and Finish: Stainless steel, No. 4 finish (satin), unless indicated otherwise.

B. Shower Curtain Rod TA-16:
2. Description: 1-1/4-inch OD; fabricated from nominal 0.05-inch-thick stainless steel.

C. Shower Curtain TA-17:
2. Size: Minimum 12 inches wider than opening by 72 inches high.
3. Material: Vinyl, minimum 0.006-inch- thick, opaque, matte.
4. Color: As selected from manufacturer's full range.
5. Grommets: Corrosion resistant at minimum 6 inches o.c. through top hem.
6. Shower Curtain Hooks: Chrome-plated or stainless-steel, spring wire curtain hooks with snap fasteners, sized to accommodate specified curtain rod. Provide one hook per curtain grommet.

D. Folding Shower Seat TA-18:
2. Configuration: L-shaped seat, designed for wheelchair access. Provide seat handed properly for shower configuration indicated on Drawings.
3. Seat: Phenolic or polymeric composite of slat-type or one-piece construction in color as selected by Architect.
5. Dimensions: 33 inches wide, projecting from wall 23 inches.

E. Soap Dish TA-19:
1. Basis-of-Design Product: Model 0398-D Recessed Heavy-Duty Stainless Steel Soap Dish and Bar.
2. Description: With washcloth bar.

F. Towel Bar TA-20:
2. Description: 3/4-inch- round tube with circular end brackets.
4. Length: 30 inches.

G. Robe Hook TA-21:
2. Description: Single-prong unit.


2.06 UNDERLAVATORY GUARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Plumberex Specialty Products, Inc.
2. TCI Products.
3. Truebro, Inc.

B. Underlavatory Guard:
1. Description: Insulating pipe covering for supply and drain piping assemblies, that prevent direct contact with and burns from piping, and allow service access without removing coverings.

2.07 CUSTODIAL ACCESSORIES

A. Mop and Broom Holder TA-26:
1. Basis-of-Design Product: Model 1315 Utility Shelf with Mop Holders and Rag Hooks:
2. Description: Unit with shelf, hooks, holders, and rod suspended beneath shelf.
3. Length: 30 inches.
5. Mop/Broom Holders: Three, spring-loaded, rubber hat, cam type.
   a. Shelf: Not less than nominal 0.05-inch- thick stainless steel.
   b. Rod: Approximately 1/4-inch- diameter stainless steel.
B. Stainless Steel Splash Guards TA-27:
   1. Type 304 stainless steel sheet, No. 4 finish (satin), 20 gauge.
   2. Adhesive mount to walls adjacent to mop-sink basin to height 6” above mop-sink faucet.

2.08 COAT HOOKS
A. Basis-of-Design Product: Model 7345 Double Robe Hook.
   1. Description: Double-prong unit.
   2. Provide coats hooks on inside of all office entrance doors.

2.09 FABRICATION
A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.
B. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

PART 3 - EXECUTION

3.01 INSTALLATION
A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
B. Grab Bars: Install to withstand a downward load of at least 250 lbf, when tested according to method in ASTM F 446.

3.02 ADJUSTING AND CLEANING
A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.
B. Remove temporary labels and protective coatings.
C. Clean and polish exposed surfaces according to manufacturer's written recommendations.

END OF SECTION
SECTION 10 44 10
FIRE PROTECTION SPECIALTIES

PART 1 - GENERAL

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

1.02 SUMMARY
A. This Section includes the following:
1. Fire protection cabinets for the following:
   a. Portable fire extinguishers.
2. Portable fire extinguishers.

1.03 PERFORMANCE REQUIREMENTS
A. Where recessed or semi-recessed fire protection cabinets are located in fire-rated construction, provide cabinets with fire ratings equivalent to that of the element in which they are located.

1.04 SUBMITTALS
A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fire protection cabinets.
   1. Fire Protection Cabinets: Include roughing-in dimensions, details showing mounting methods, relationships of box and trim to surrounding construction, door hardware, cabinet type, trim style, and panel style.
   2. Show location of knockouts for hose valves.
B. Maintenance Data: For fire protection cabinets to include in maintenance manuals.

1.05 QUALITY ASSURANCE
A. Fire-Rated, Fire Protection Cabinets: Listed and labeled to comply with requirements in ASTM E 814 for fire-resistance rating of walls where they are installed.
B. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, “Portable Fire Extinguishers.”
C. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

1.06 COORDINATION
A. Coordinate size of fire protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.
B. Coordinate size of fire protection cabinets to ensure that type and capacity of fire hoses, hose valves, and hose racks indicated are accommodated.
C. Coordinate sizes and locations of fire protection cabinets with wall depths.
1.07 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Failure of hydrostatic test according to NFPA 10.
   b. Faulty operation of valves or release levers.

2. Warranty Period: 6 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.

B. Transparent Acrylic Sheet: ASTM D 4802, Category A-1 (cell-cast sheet), 3 mm thick, with Finish 1 (smooth or polished).

2.02 FIRE PROTECTION CABINETS

A. Cabinet Type: Suitable for fire extinguisher.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. Larsen's Manufacturing Company.
3. Modern Metal Products, Division of Technico Inc.
4. Potter Roemer LLC.

C. Cabinet Construction: Provide fire-rated cabinets where required by Performance Requirements article.

1. Fire-Rated Cabinets: Construct fire-rated cabinets with double walls fabricated from 0.0428-inch-thick, cold-rolled steel sheet lined with minimum 5/8-inch-thick, fire-barrier material. Provide factory-drilled mounting holes.

D. Cabinet Material: Steel sheet.

1. Shelf: Same metal and finish as cabinet.

E. Recessed Cabinet: Cabinet box recessed in walls of sufficient depth to suit style of trim indicated.

1. Trimless with Concealed Flange: Surface of surrounding wall finishes flush with exterior finished surface of cabinet frame and door, without overlapping trim attached to cabinet. Provide recessed flange, of same material as box, attached to box to act as drywall bead.
   a. Use for: Fire Protection Cabinets located in framed gypsum board partitions.

2. Exposed Flat Trim: One-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend).
   a. Use for: Fire Protection Cabinets located in concrete or masonry walls.

F. Semirecessed Cabinet: Cabinet box partially recessed in walls of sufficient depth to suit style of trim indicated; with one-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend).

1. Rolled-Edge Trim: 2-1/2-inch backbend depth.
2. Provide where walls are of insufficient depth for recessed cabinets but are of sufficient depth to accommodate semirecessed cabinet installation.

G. Surface-Mounted Cabinet: Cabinet box fully exposed and mounted directly on wall with no trim. Provide where walls are of insufficient depth for semirecessed cabinet installation.

H. Door Material: Steel sheet.

I. Door Style: Fully glazed, frameless, backless, acrylic panel.

J. Door Glazing: Acrylic sheet.
   1. Acrylic Sheet Color: Clear transparent acrylic sheet.

K. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.
   1. Provide projecting door pull and friction latch.
   2. Provide continuous hinge, of same material and finish as trim, permitting door to open 180 degrees.

L. Accessories:
   1. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
   2. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as directed by Architect.
      a. Identify fire extinguisher in fire protection cabinet with the words “FIRE EXTINGUISHER.”
         1) Location: Applied to cabinet door.
         3) Lettering Color: Red.
         4) Orientation: Vertical.

M. Finishes:
   1. Manufacturer's standard baked-enamel.

2.03 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

A. Fire Extinguishers: Type, size, and capacity for each fire protection cabinet and mounting bracket indicated.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Amerex Corporation.
      b. Ansul Incorporated; Tyco International Ltd.
      c. Badger Fire Protection; a Kidde company.
      d. Buckeye Fire Equipment Company.
      e. Fire End & Croker Corporation.
      g. Kidde Residential and Commercial Division; Subsidiary of Kidde plc.
      h. Larsen's Manufacturing Company.
      i. Moon-American.
      j. Pem All Fire Extinguisher Corp.; a division of PEM Systems, Inc.
      k. Potter Roemer LLC.
      l. Pyro-Chem; Tyco Safety Products.

2. Valves: Manufacturer's standard.
3. Handles and Levers: Manufacturer's standard.
4. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B.
B. Multipurpose Dry-Chemical Type in Steel Container: UL-rated 4-A:60-B:C, 10-lb nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.

2.04 FABRICATION
A. Fire Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.
   1. Weld joints and grind smooth.
   2. Provide factory-drilled mounting holes.
   3. Prepare doors and frames to receive locks.
   4. Install door locks at factory.
B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles selected.
   1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 1/2 inch thick.
   2. Miter and weld perimeter door frames.
C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

2.05 GENERAL FINISH REQUIREMENTS
A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
B. Protect mechanical finishes on exposed surfaces of fire protection cabinets from damage by applying a strippable, temporary protective covering before shipping.
C. Finish fire protection cabinets after assembly.
D. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.06 STEEL FINISHES
A. Baked-Enamel or Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils.
   1. Color and Gloss: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION
3.01 EXAMINATION
A. Examine walls and partitions for suitable framing depth and blocking where recessed and semirecessed cabinets will be installed.
B. Examine fire extinguishers for proper charging and tagging.
   1. Remove and replace damaged, defective, or undercharged fire extinguishers.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION
A. Prepare recesses for recessed and semirecessed fire protection cabinets as required by type and size of cabinet and trim style.
3.03 INSTALLATION

A. General: Install fire protection cabinets in locations and at mounting heights indicated or, if not indicated, at heights indicated below:
   1. Fire Protection Cabinets: 54 inches above finished floor to top of cabinet.

B. Fire Protection Cabinets: Fasten cabinets to structure, square and plumb.
   1. Unless otherwise indicated, provide recessed fire protection cabinets. If wall thickness is not adequate for recessed cabinets, provide semirecessed fire protection cabinets.
   2. Fasten mounting brackets to inside surface of fire protection cabinets, square and plumb.

C. Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.
   1. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

3.04 ADJUSTING AND CLEANING

A. Remove temporary protective coverings and strippable films, if any, as fire protection cabinets are installed unless otherwise indicated in manufacturer’s written installation instructions.

B. Adjust fire protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.

C. On completion of fire protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.

D. Touch up marred finishes, or replace fire protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire protection cabinet and mounting bracket manufacturers.

E. Replace fire protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION
 SECTION 12 48 13
ENTRANCE FLOOR MATS AND FRAMES

PART 1 - GENERAL

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

1.02 SUMMARY
A. This Section includes the following:
   1. Entrance mats in recessed frames.
B. Related Sections include the following:
   1. Division 03 Section "Cast-in-Place Concrete" for slab depression, grouting, and filling for recessed mats and frames.

1.03 SUBMITTALS
A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
B. Shop Drawings: Show the following:
   1. Perimeter floor moldings.
C. Samples: For each type of product indicated.
   1. Floor Mat: 12-inch-square, assembled sections of floor mat.
   2. Tread Rail: 12-inch-long Sample of each type and color.
   3. Frame Members: 12-inch-long Sample of each type and color.
D. Maintenance Data: For floor mats and frames to include in maintenance manuals.

1.04 QUALITY ASSURANCE
A. Source Limitations: Obtain floor mats and frames through one source from a single manufacturer.
B. Accessibility Requirements: Provide installed floor mats that comply with Section 4.5 in the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)" and Sections 302 and 303 in ICC A117.1.

1.05 PROJECT CONDITIONS
A. Field Measurements: Indicate measurements on Shop Drawings.

1.06 COORDINATION
A. Coordinate size and location of recesses in concrete with installation of finish floors to receive floor mats and frames.
PART 2 - PRODUCTS

2.01 ENTRANCE MATS
A. Resilient Link Mats: 11/16 inch thick, reversible rubber-tire link mats with aluminum wire link rods and divider bars, vulcanized edge-nosing trim, steel-reinforced end trim, and links consisting of rectangular units or continuous strips in a heel-proof, solid-weave pattern with no openings between links.
   a. Substitutions: Architect will consider comparable products. Submit in accordance with Division 01 Section "Product Requirements."
   2. Color: As selected by Architect from manufacturer's full range.
   3. Mat Size: As indicated.
B. Recessed Frames:
   1. Extruded Aluminum: ASTM B 221, Alloy 6061-T6 or Alloy 6063-T5, T6, or T52.

2.02 CONCRETE FILL AND GROUT MATERIALS
A. Provide concrete grout and fill equivalent in strength to cast-in-place concrete slabs for recessed mats and frames. Use aggregate no larger than one-third fill thickness.

2.03 FABRICATION
A. Floor Mats: Shop fabricate units to greatest extent possible in sizes indicated. Unless otherwise indicated, provide single unit for each mat installation; do not exceed manufacturer's recommended maximum sizes for units that are removed for maintenance and cleaning. Where joints in mats are necessary, space symmetrically and away from normal traffic lanes. Miter corner joints in framing elements with hairline joints or provide prefabricated corner units without joints.
B. Recessed Frames: As indicated, for permanent recessed installation, complete with corner pins or reinforcement and anchorage devices.
   1. Fabricate edge-frame members in single lengths or, where frame dimensions exceed maximum available lengths, provide minimum number of pieces possible, with hairline joints equally spaced and pieces spliced together by straight connecting pins.
C. Coat surfaces of aluminum frames that will contact cementitious material with manufacturer's standard protective coating.

PART 3 - EXECUTION

3.01 EXAMINATION
A. Examine substrates and floor conditions for compliance with requirements for location, sizes, minimum recess depth, and other conditions affecting installation of floor mats and frames.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION
A. Install recessed mat frames to comply with manufacturer's written instructions. Set mat tops at height recommended by manufacturer for most effective cleaning action;
coordinate top of mat surfaces with bottom of doors that swing across mats to provide clearance between door and mat.

1. Install necessary shims, spacers, and anchorages for proper location and secure attachment of frames.
2. Install grout and fill around frames and, if required to set mat tops at proper elevations, in recesses under mats. Finish grout and fill smooth and level.

3.03 PROTECTION

A. After completing frame installation and concrete work, provide temporary filler of plywood or fiberboard in recesses and cover frames with plywood protective flooring. Maintain protection until construction traffic has ended and Project is near Substantial Completion.
SECTION 14 21 23
MACHINE ROOMLESS ELEVATORS

PART 1 - GENERAL

1.01 WORK INCLUDED

A. One (1) traction elevator as follows:
   1. 1 Gearless Passenger Elevator, Car 1

B. All engineering, equipment, labor, and permits required to satisfactorily complete elevator
   installation required by Contract Documents.

C. Applicable conditions of General, Special, and Supplemental Conditions, and Division 1.

D. Preventive maintenance as described herein.

E. Additional equipment or finishes furnished under other sections, installed under this section:

1.02 RELATED WORK PROVIDED UNDER OTHER SECTIONS

A. Hoistway and Pit:
   1. Clear, plumb, substantially flush hoistway with variations not to exceed 1” at any
      point.
   2. Bevel cants not less than 75° from the horizontal on any rear or side wall ledges and
      beams that project or recess 4” or more into the hoistway. Not required on hoistway
      divider beams.
   3. Supports at each floor for car and counterweight guide rail fastening including
      supports for car guide rail fastening above top landing. Intermediate car guide rail
      support when floor heights exceed 14'-0". Building supports not to deflect in excess
      of 1/8" under normal conditions.
   4. Installation of guide rail bracket supports in concrete. Inserts or embeds, if used, will
      be furnished under this Section.
   5. Hoist machine supports including two (2) additional horizontal supports above the top
      terminal landing on the machine side of the hoistway. Locate as required for selected
      providers' equipment.
   6. Wall blockouts and fire rated closure for control and signal fixture boxes which
      penetrate walls.
   7. Cutting and patching walls and floors.
   8. Concrete wall pockets and/or structural steel beams for support of hoist machine,
      rope sheaves, and dead-end hitch beams. Support deflection shall not exceed
      1/1666 of span under static load.
   9. Erect front hoistway wall after elevator entrances are installed.
  10. Grout floor up to hoistway sills and around hoistway entrances.
  11. Pit access ladder for the elevator.
  12. Structural support at pit floor for buffer impact loads, guide rail loads.
  13. Waterproof pit. Indirect waste drain or sump with flush grate and pump.
  14. Protect open hoistways and entrances during construction per OSHA Regulations.
  15. Protect car enclosure, hoistway entrance assemblies, and special metal finishes from
      damage.
  17. Seal fireproofing to prevent flaking.
B. Control Room and Machinery Spaces:
1. Enclosure with access.
2. Self-closing and locking access door.
3. Ventilation and heating. Maintain minimum temperature of 55° F, maximum 90° F. Maintain maximum 80% relative humidity, non-condensing.
4. Paint walls and ceiling.
5. Class "ABC" fire extinguisher in each elevator controller space.
6. Seal fireproofing to prevent flaking.
7. Self-closing and locking governor access door and access means.
8. Fire sprinklers where required.

C. Electrical Service, Conductors, and Devices:
1. Lighting and GFCI convenience outlets in pit, controller space, and overhead machinery spaces. Provide one additional non-GFCI convenience outlet in pit for sump pump.
2. Three-phase mainline copper power feeder with true earthen grounding to terminals of each elevator controller in the controller space with protected lockable "open" disconnecting means.
3. Single-phase copper power feeder to each elevator controller for car lighting and exhaust blower with individual protected lockable "open" disconnecting means located in the controller space.
4. Emergency telephone line to elevator control panel in elevator controller space.
5. Fire alarm initiating devices in each elevator lobby for each group of elevators or single elevator and each controller space to initiate firefighters' return feature. Device at top of hoistway if sprinklered. Provide alarm initiating signal wiring from hoistway or controller space connection point to elevator controller terminals. Device in machine room and at top of hoistway to provide signal for general alarm and discrete signal for Phase II firefighters' operation.
6. Temporary power and illumination to install, test, and adjust elevator equipment.
7. Means to automatically disconnect power to affected elevator drive unit and controller prior to activation of the controller space fire sprinkler system, and/or hoistway fire sprinkler system. Manual shut-off means shall be located outside bounds of the controller space.
8. When sprinklers are provided in the hoistway all electrical equipment, located less than 4'-0" above the pit floor shall be identified for use in wet locations. Exception: seismic protection devices.

1.03 DEFINITIONS
A. Terms used are defined in the latest edition of the Safety Code for Elevators and Escalators, ASME A17.1.
B. Reference to a device or a part of the equipment applies to the number of devices or parts required to complete the installation.
C. Provisions of this specification are applicable to all elevators unless identified otherwise.

1.04 QUALITY ASSURANCE
A. Approved Providers: Alternate Providers must receive approval of Architect, Purchaser and/or Consultant at least 14 calendar days prior to bid date.
1. Gearless Elevator(s): KONE, Otis, Schindler, ThyssenKrupp, Motion Control Engineering.

B. Compliance with Regulatory Agencies: Comply with most stringent applicable provisions of following codes, laws, and/or authorities, including revisions and changes in effect:
1. Safety Code for Elevators and Escalators, ASME A17.1
2. Guide for Inspection of Elevators, Escalators, and Moving Walks, ASME A17.2
3. Elevator and Escalator Electrical Equipment, ASME A17.5
4. National Electrical Code, NFPA 70
5. Americans with Disabilities Act, ADA
6. Local Fire Authority
7. Requirements of IBC and all other Codes, Ordinances and Laws applicable within the governing jurisdiction

C. Warranty:
1. Material and workmanship of installation shall comply in every respect with Contract Documents. Correct defective material or workmanship which develops within one year from date of final acceptance of all work to satisfaction of Architect, Purchaser and Consultant at no additional cost, unless due to ordinary wear and tear, or improper use or care by Purchaser. Perform maintenance in accordance with terms and conditions indicated in the Preventive Maintenance Agreement.
2. Defective is defined to include, but not limited to: operation or control system failures, car performance below required minimum, excessive wear, unusual deterioration, or aging of materials or finishes, unsafe conditions, the need for excessive maintenance, abnormal noise, or vibration, and similar unsatisfactory conditions.
3. Make modifications, requirements, adjustments, and improvements to meet performance requirements in Parts 2 and 3.

1.05 DOCUMENT VERIFICATION

A. In order to discover and resolve conflicts or lack of definition which might create problems, Provider must review Contract Documents for compatibility with its product prior to submittal of quotation. Purchaser will not pay for change to structural, mechanical, electrical, or other systems required to accommodate Provider’s equipment.

1.06 SUBMITTALS

A. Within 60 calendar days after award of contract and before beginning equipment fabrication submit shop drawings and required materials for review as outlined in Division I. Allow 30 calendar days for response to initial submittal.
1. Scaled or Fully Dimensioned Layout: Plan of pit, hoistway, and control room indicating equipment arrangement, elevation section of hoistway, details of car enclosures, hoistway entrances, and car/hall signal fixtures.
2. Design Information: Indicate equipment lists, reactions, and design information on layouts.
4. Fixtures: Cuts, samples, or shop drawings.
5. Finish Material: Submit 3” x 12” samples of actual finished material for Architect review of color, pattern, and texture. Compliance with other requirements is the exclusive responsibility of the Provider. Include, if requested, signal fixtures, lights, graphics, Braille plates, and details of mounting provisions.
B. Acknowledge and/or respond to review comments within 14 calendar days of return. Promptly incorporate required changes due to inaccurate data or incomplete definition so that delivery and installation schedules are not affected. Provider’s revision response time is not justification for equipment delivery or installation delay.

1.07 PERMIT, TEST AND INSPECTION

A. Obtain and pay for permit, license, and inspection fee necessary to complete installation.

B. Perform test required by Governing Authority in accordance with procedure described in ASME A17.2 Guide for Inspection of Elevators, Escalators, and Moving Walks in the presence of Authorized Representative.

C. Supply personnel and equipment for test and final review by Consultant as required in Part 3.

1.08 MAINTENANCE

A. Interim:
1. When one or more elevators are near completion and ready for service, the General Contractor may accept elevators for interim use and place in service prior to substantial completion of project.
2. During this period General Contractor may pay a mutually agreed upon monthly amount per elevator for preventive maintenance. Indicate amount per unit per month with quotation.
3. Temporary acceptance form must be acceptable to General Contractor and signed prior to use.
4. General Contractor must provide or pay for temporary hoistway and car enclosures; protect installed equipment and finishes; pay for and return elevators to elevator sub-contractor for all cleaning, repairs, and replacement of materials necessary to restore elevator to "as-new" condition prior to final acceptance.

B. Warranty Maintenance:
1. Provide preventive maintenance and 24-hour emergency callback service for one year commencing on date of final acceptance by Purchaser. Systematically examine, adjust, clean, and lubricate all equipment. Repair or replace defective parts using parts produced by the Provider of installed equipment. Maintain elevator control room, hoistway, and pit in clean condition.
2. Use competent personnel, acceptable to the Purchaser, supervised and employed by Provider.
3. The warranty maintenance period specified in Item 1 above shall be extended one (1) month for each three (3) month period in which equipment related failures average more than .25 per unit per month.
4. Purchaser retains the option to delete cost of warranty maintenance from new equipment contract and remit twelve (12) equal installments directly to Provider during period in which maintenance is being performed.
PART 2 - PRODUCTS

2.01 SUMMARY

A. 1 Passenger Elevator

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number:</td>
<td>Car 1</td>
</tr>
<tr>
<td>Capacity:</td>
<td>4000 #</td>
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<tr>
<td>Class Loading:</td>
<td>Passenger Class A</td>
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<tr>
<td>Contract Speed:</td>
<td>350 F.P.M.</td>
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<tr>
<td>Roping:</td>
<td>1:1</td>
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<tr>
<td>Machine:</td>
<td>Gearless</td>
</tr>
<tr>
<td>Machine Location:</td>
<td>Providers’ Standard Location</td>
</tr>
<tr>
<td>Operational Control:</td>
<td>Selective Collective Microprocessor-Based System</td>
</tr>
<tr>
<td>Motor Control:</td>
<td>AC Variable Voltage Variable Frequency Microprocessor-Based with Digital Closed-Loop Feedback</td>
</tr>
<tr>
<td>Power Characteristics:</td>
<td>480 Volts, 3 Phase, 60 Hertz</td>
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<td>Stops:</td>
<td>5 Front</td>
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<tr>
<td>Openings:</td>
<td>5 Front</td>
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<tr>
<td>Floors Served:</td>
<td>B, 1-4 Front</td>
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<tr>
<td>Travel:</td>
<td>60'-0&quot; ±</td>
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<tr>
<td>Platform Size:</td>
<td>6'-0&quot; Wide X 8'-4&quot; Deep</td>
</tr>
<tr>
<td>Minimum Clear Inside Car:</td>
<td>7'-5&quot; Wide X 5'-8&quot; Deep</td>
</tr>
<tr>
<td>Entrance Size:</td>
<td>4'-0&quot; Wide X 7'-0&quot; High</td>
</tr>
<tr>
<td>Entrance Type:</td>
<td>Two Speed, Side Opening</td>
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<tr>
<td>Door Operation:</td>
<td>High Speed, Heavy-Duty, Door Operator, Minimum Opening Speed 2-1/2 F.P.S.</td>
</tr>
<tr>
<td>Door Protection:</td>
<td>Infrared, Full Screen Device, with Differential Timing Nudging and Interrupted Beam Time</td>
</tr>
<tr>
<td>Safety:</td>
<td>Flexible Guide Clamp – Type B, Car</td>
</tr>
<tr>
<td>Guide Rails:</td>
<td>Planed Steel Tees</td>
</tr>
<tr>
<td>Buffers:</td>
<td>Oil</td>
</tr>
</tbody>
</table>
Car Enclosure: As Specified

Car Interior Finishes Provided Under This Section

8'-0" Clear Height Under Canopy

Pad Buttons and Vinyl-Covered Pads

Battery Powered Emergency Car Lighting. Provide Separate Constant Pressure Test Button in Car Service Compartment. Illuminate Portion of Normal Car Lighting

Signal Fixtures: LED Illumination, Provider's Standard Design

Hall And Car Pushbutton Stations: Single Hall Pushbutton Riser, Single Car Operating Panel

Vandal Resistant Car and Hall Pushbuttons

Car Position Indicators: Single Digital with Car Direction Arrows

Hall Lanterns: At All Floors with Volume Adjustable Electronic Chime or Tone. Sound Twice for Down Direction. Vandal Resistant Assembly

Communication System: Self-Dialing, Vandal Resistant, Push To Call, Two-Way Communication System with Recall, Tracking and Voiceless Communication

Fixture Submittal: Submit Brochure Depicting Provider's Proposed Designs with Bid

Additional Features, Car 1:

Car and Counterweight Roller Guides

Car Top Inspection Station

Firefighters’ Service, Phase I and II, including Alternate Floor Return

Accessibility Signage

Swing Car Return Panel(s) Arranged for Integral Car Operating Panel(s)

Hoistway Access Switches Top and Bottom Floors

Hoistway Door Unlocking Device, All Floors

Platform Isolation
2.02 MATERIALS

A. Steel:  

B. Stainless Steel: Type 302 or 304 complying with ASTM A167, with standard tempers and hardness required for fabrication, strength and durability. Apply mechanical finish on fabricated work in the locations shown or specified, Federal Standard and NAAMM nomenclature, with texture and reflectivity required to match Architect’s sample. Protect with adhesive paper covering.  
1. No. 4: Directional polish (satin finish). Graining directions as shown or, if not shown, in longest dimension.

C. Aluminum: Extrusions per ASTM B221; sheet and plate per ASTM B209.

D. Plastic Laminate: ASTM E84 Class A and NEMA LD3.1, Fire-Rated Grade (GP-50), Type 7, 0.050" ±.005" thick, color and texture as follows:  
1. Exposed Surfaces: Color and texture selected by Architect.  
2. Concealed Surfaces: Provider’s standard color and finish.

E. Fire-Retardant Treated Particle Board Panels: Minimum 3/4" thick backup for natural finished wood and plastic laminate veneered panels, edged and faced as shown, provided with suitable anti-warp backing; meet ASTM E84 Class “I” rating with a flame-spread rating of 25 or less, registered with Local Authorities for elevator finish materials.
F. Paint: Clean exposed metal parts and assemblies of oil, grease, scale, and other foreign matter and factory paint one shop coat of standard rust-resistant primer. After erection, provide one finish coat of industrial enamel paint. Galvanized metal need not be painted.

G. Prime Finish: Clean all metal surfaces receiving a baked enamel paint finish of oil, grease, and scale. Apply one coat of rust-resistant primer followed by a filler coat over uneven surfaces. Sand smooth and apply final coat of primer.

H. Baked Enamel Finish: Prime finish per above. Unless specified “prime finish” only, apply and bake three (3) additional coats of enamel in the selected solid color.


2.03 CAR PERFORMANCE

A. Car Speed: ± 3% of contract speed under any loading condition.

B. Car Capacity: Safely lower, stop and hold 125% of rated load.

C. Car Stopping Zone: ±1/4" under any loading condition.

D. Door Opening Time: Seconds from start of opening to fully open:
   1. Car 1: 2.5 seconds.

E. Door Closing Time: Seconds from start of closing to fully closed:
   1. Car 1: 4.4 seconds.

F. Car Floor-to-Floor Performance Time: Seconds from start of doors closing until doors are 3/4 open (1/2 open for side opening doors) and car level and stopped at next successive floor under any loading condition or travel direction (14’-8” typical floor height):
   1. Car 1: 12.5 seconds.

G. Car Ride Quality:
   1. Horizontal and vertical acceleration within car during all riding and door operating conditions. Not more than 15 mg peak to peak (adjacent peaks) in the 1 - 10 Hz range.
   2. Acceleration and Deceleration: Smooth constant and not more than 3 feet/second² with an initial ramp between 0.5 and 0.75 second.
   3. Sustained Jerk: Not more than 6 feet/second³.
   4. Measurement Standards: Measure and evaluate ride quality consistent with ISO 18738, using low pass cutoff frequency of 10 Hz and A95 peak-to-peak average calculations.

2.04 OPERATION

A. Selective Collective Microprocessor Based:
   1. Operate car without attendant from pushbuttons in car and located at each floor. When car is available, automatically start car, and dispatch it to floor corresponding to registered car or hall call. Once car starts, respond to registered calls in direction of travel and in the order the floors are reached.
   2. Do not reverse car direction until all car calls have been answered, or until all hall calls ahead of car and corresponding to the direction of car travel have been answered.
3. Slow car and stop automatically at floors corresponding to registered calls, in the order in which they are approached in either direction of travel. As slowdown is initiated for a hall call, automatically cancel hall call. Cancel car calls in the same manner. Hold car at arrival floor an adjustable time interval to allow passenger transfer.

4. Answer calls corresponding to direction in which car is traveling unless call in the opposite direction is highest (or lowest) call registered.

5. Illuminate appropriate pushbutton to indicate call registration. Extinguish light when call is answered.

B. Other Items:
1. Load Weighing: Provide means for weighing car passenger load. Control system to provide dispatching at main floor in advance of normal intervals when car fills to capacity. Provide hall call by-pass when the car is filled to preset percentage of rated capacity and traveling in down direction. Field adjustment range: 10% to 100%.

2. Anti-Nuisance Feature: If car loading relative to weight in car is not commensurate with number of registered car calls, cancel car calls. Systems employing either load weighing or door protective device for activation of this feature are acceptable.

3. Independent Service: Provide controls for operation of each car from its pushbuttons only. Close doors by constant pressure on desired destination floor button or door close button. Open doors automatically upon arrival at selected floor.

C. Firefighters’ Service: Provide equipment and operation in accordance with code requirements.

D. Automatic Car Stopping Zone: Stop car within 1/4” above or below the landing sill. Maintain stopping zone regardless of load in car, direction of travel, distance between landings, hoist rope slippage, or stretch.

E. Remote Monitoring and Diagnostics: Equip each controller, with standard ports, interface boards, and drivers to accept maintenance, data logging, fault finding diagnostic, and monitoring computers, keyboards, modems, and programming tools. The system shall be capable of driving remote color CRT monitor that continually scan and display the status of each car and call.

F. Motion Control: Microprocessor based AC, variable-voltage, variable frequency with digitally encoded closed-loop velocity feedback suitable for operation specified and capable of providing smooth, comfortable car acceleration, retardation, and dynamic braking. Limit the difference in car speed between full load and no load to not more than ±3% of the contract speed.

G. Door Operation: Automatically open doors when car arrives at main floor. At expiration of normal dwell time, close doors.

H. Standby Lighting and Alarm: Car mounted battery unit with solid-state charger to operate alarm bell and car emergency lighting. Battery to be rechargeable with minimum 5-year life expectancy. Include required transformer. Provide constant pressure test button in service compartment of car operating panel. Provide lighting integral with portion of normal car lighting system.

I. Card/Proximity Reader Security System: Provide provisions inside Car 1 for reader unit. Mount reader unit as directed by Architect and cross connect from car pushbuttons to control module in control room. Reader control unit, mounting brackets, wiring materials, logic circuits, etc., by Security Subcontractor. Provide a filler plate to match card slot size and car return panel finish, including direction of graining, where card slot or proximity reader cutout is not initially utilized. Elevator control systems shall facilitate system tracking.
of persons accessing secure floors via printout by passenger I.D. number, floor accessed, and time of entry.

2.05 CONTROL ROOM EQUIPMENT

A. Arrange equipment in spaces shown on drawings.

B. Solid State Power Conversion and Regulation Unit: Provide solid-state, alternating current, variable voltage, variable frequency (ACV3F), I.G.B.T. converter/inverter drives.
1. Design unit to limit current, suppress noise, and prevent transient voltage feedback into building power supply. Provide internal heat sink cooling fans for the power drive portion of the converter panels. Conform to IEEE standards 519-1992 for line harmonics and switching noise.
2. Isolate unit to minimize noise and vibration transmission. Provide isolation transformers, filter networks, and choke inductors.
3. Suppress solid-state converter noises, radio frequency interference, and eliminate regenerative transients induced into the mainline feeders or the building standby power generator.
4. Supplemental direct-current power for the operation of hoist machine brake, door operator, dispatch processor, signal fixtures, etc., from separate static power supply.
5. ACV3F Drives for gearless elevators shall be regenerative and utilize IGBT converter/inverter and dynamic braking during overhauling condition.

C. Encoder: Direct drive, solid-state, digital type. Update car position at each floor and automatically restore after power loss.

D. Controller: UL/CSA labeled.
1. Compartment: Securely mount all assemblies, power supplies, chassis switches, relays, etc., on a substantial, self-supporting steel frame. Completely enclose equipment with covers. Provide means to prevent overheating.
2. Relay Design: Magnet operated with contacts of design and material to insure maximum conductivity, long life, and reliable operation without overheating or excessive wear. Provide wiping action and means to prevent sticking due to fusion. Contacts carrying high inductive currents shall be provided with arc deflectors or suppressors.
3. Microprocessor-Related Hardware
   a. Provide built-in noise suppression devices which provide a high level of noise immunity on all solid-state hardware and devices.
   b. Provide power supplies with noise suppression devices.
   c. Isolate inputs from external devices (such as pushbuttons) with opto-isolation modules.
   d. Design control circuits with one leg of power supply grounded.
   e. Safety circuits shall not be affected by accidental grounding of any part of the system.
   f. System shall automatically restart when power is restored.
   g. System memory shall be retained in the event of power failure or disturbance.
   h. Equipment shall be provided with Electro Magnetic Interference (EMI) shielding within FCC guidelines.
4. Wiring: CSA labeled copper for factory wiring. Neatly route all wiring interconnections and securely attach wiring connections to studs or terminals.
5. Permanently mark components (relays, fuses, PC boards, etc.) with symbols shown on wiring diagrams.
6. Provide controller or machine mounted auxiliary, lockable “open” disconnect if mainline disconnect is not in sight of controller and/or machine.
E. Sleeves and Guards: Provide 2” steel angle guards around cable or duct slots through floor slabs and/or walls. Provide rope and smoke guards for sheaves, cables, and cable slots in control room.

F. Noise/Vibration Isolation: All elevator equipment including their supports and fastenings to building, shall be mechanically and electrically isolated from the building structure and main line power feeders to minimize objectionable noise and vibration transmission to car, building structure, or adjacent occupied areas of building.

2.06 HOISTWAY EQUIPMENT

A. Gearless Traction Hoist Machine:
   1. AC induction or P.M.S.M. ACV3F gearless traction type motor with brake, drive sheave, and deflector sheave mounted in proper alignment on a common, isolated machine support frame at the top of the hoistway or mounted on the back of the guide rail at the top landing.
   2. Provide hoist machine mounted direct drive, digital, closed-loop velocity encoder.
   3. Provide structural imbeds and deflector supporting steel beams and fastenings to mount machine sheaves (if required) to building structure. Provide minimum 16 gauge easily removable sound insulated sheet metal closures in hoistway wall opening around machine.
   4. Provide ladders and platforms with handrails and toeboards for overhead machine and/or sheave access within the bounds of the control room as required.

B. Machine and Equipment Support Beams:
   1. Provide structural steel frame required for direct support of and attachment to building structure of hoist machine, deflector sheaves, overhead sheaves, governor, and hoist rope dead-end hitch assemblies.
   2. Provide bearing plates, anchors, shelf angles, blocking, embedment, etc., for support and fastening of machine support frame or equipment to the building structure.
   3. Isolate machine and/or machine support frame to prevent noise and vibration transmission to building structure.

C. Governor: Centrifugal-type, car driven with pull-through jaws and bi-directional shutdown switches. Provide required bracketing and supports for attachment to guide rail or machine support frame.

D. Emergency Brake: Provide means to prevent ascending car over-speed and unintended car movement per code.

E. Guide Rails: Planed steel T-sections for car and counterweight of suitable size and weight for the application, including brackets for attachment to building structure. Provide rail backing and intermediate counterweight tie brackets to meet code requirements. No additional structural points of rail attachment, other than those shown on the Contract Documents, will be provided.

F. Buffers, Car and Counterweight: Oil type with blocking and support channels.

G. Sheaves: Machined grooves and sealed bearings. Provide mounting means to machine support frame and car and counterweight structural members.

H. Counterweight: Steel frame with metal filler weights.

I. Counterweight Guide Shoes: Spring dampened roller guide shoes
J. Counterweight Guard: Metal guard in pit.

K. Governor Rope and Encoder Tape Tensioning Sheaves: Mount sheaves and support frame on pit floor or guide rail. Provide frame with guides or pivot point to enable free vertical movement and proper tension of rope and tape.

L. Hoist and Governor Ropes:
   1. 8 x 19 or 8 x 25 Seale construction, traction steel type. Fasten with staggered length, adjustable, spring isolated wedge type shackles.
   2. Flat, polyurethane coated reinforced steel belts.
   3. Governor rope to suit Provider’s specification.

M. Terminal Stopping: Provide normal and final devices.

N. Electrical Wiring and Wiring Connections:
   1. Conductors and Connections: Copper throughout with individual wires coded and connections on identified studs or terminal blocks. Use no splices or similar connections in wiring except at terminal blocks, control compartments, or junction boxes. Provide 10% spare conductors throughout. Run spare wires from car connection points to individual elevator controllers in the control room. Provide four pair of spare shielded communication wires in addition to those required to connect specified items. Tag spares in control room.
   2. Conduit: Painted or galvanized steel conduit, EMT, or duct. Conduit size, 1/2" minimum. Flexible heavy-duty service cord may be used between fixed car wiring and car door switches for door protective devices.
   3. Traveling Cables: Flame and moisture-resistant outer cover. Prevent traveling cable from rubbing or chafing against hoistway or equipment within hoistway. Provide five (5) pair of shielded wires and two (2) RG-6/U type coaxial cables for card reader.
   4. Auxiliary Wiring: Connect fire alarm initiating devices, emergency two-way communication system and card reader in car controller in control room.

O. Entrance Equipment:
   1. Door Hangers: Two-point hanger roller with neoprene roller surface and suspension with eccentric upthrust roller adjustment.
   2. Door Tracks: Bar or formed, cold-drawn removable steel tracks with smooth roller contact surface.
   3. Door Interlocks: Operable without retiring cam. Paint interlock box flat black.
   4. Door Closers: Spring, spirator, or jamb/strut mounted counterweight type. Design and adjust to insure smooth, quiet mechanical close of doors.
   5. Hoistway Door Unlocking Device: Provide unlocking device with escutcheon in door panel at all floors, with finish to match adjacent surface.

P. Floor Numbers: Stencil paint 4" high floor designations in contrasting color on inside face of hoistway doors or hoistway fascia in location visible from within car.

2.07 HOISTWAY ENTRANCES

A. Complete entrances bearing fire labels from a nationally recognized testing laboratory approved within the governing jurisdiction.

B. Frames: 14 gauge hollow metal at all floors. Bolted and lapped head to jamb assembly at all floors. Provide Arabic floor designation/Braille plates, centered at 60" above finished floor, on both side jambs of all entrances. Provide plates at main egress landing with “Star”
designation. For designated emergency car, provide “Star of Life” designation plates at height of 78” – 84” above finished floor on both side jambs at all floors. Braille indications shall be below Arabic floor designation. Provide cast floor designation/Braille plates as manufactured by SCS, Vision Mark, or Entrada.

C. Door Panels: Minimum 18 gauge steel, sandwich construction without binder angles. Provide leading edges of center-opening doors with rubber astragals. Provide a minimum of two (2) gibs per panel, one at leading and one at trailing edge with gibs in the sill groove entire length of door travel. Construct door panels with interlocking, stiffening ribs.

D. Sight Guards: Minimum 16 gauge, same material and finish as hoistway entrance door panels. Construct without sharp edges.

E. Sills: Extruded aluminum.

F. Sill Supports: Structural or formed steel designed to support door sill based upon car loading classification. Mount to eliminate need for grout under the sill.

G. Fascia, Toe Guards and Hanger Covers: Minimum 16 gauge furniture steel with Provider’s standard finish.

H. Struts and Headers: Provide for vertical support of entrances and related material. Provide door open bumpers on entrances equipped with vertical struts.

I. Finish of Frames and Doors:

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2.08 CAR EQUIPMENT

A. Frame: Welded or bolted, rolled or formed steel channel construction to meet load classification specified.

B. Safety Device: Type “B,” flexible guide clamp.

C. Platform: Isolated type, constructed of steel, or steel and wood which is fireproofed on underside. Design and construct to accommodate load classification requirements. Provide Class “A” construction for passenger elevators.

D. Platform Apron: Minimum 16 gauge steel, reinforced and braced to car platform with Provider’s standard finish.

E. Guide Shoes: Roller type with three or more spring dampened, sound-deadening rollers per shoe. Maximum roller rotation speed, 350 r.p.m.

F. Finish Floor Covering: Provided under other sections.

G. Sills: One piece extrusion with extruded extension between car entrance columns to face of car front return. Extruded extension to match finish of sill.

1. Car 1: Aluminum

H. Doors: Provide as specified for hoistway entrance doors.
I. Door Hangers: Two-point hanger roller with neoprene roller surface and suspension with eccentric upthrust roller adjustment.

J. Door Track: Bar or formed, cold-drawn removable steel track with smooth roller contact surface.

K. Door Header: Construct of minimum 12 gauge steel, shape to provide stiffening flanges.

L. Door Electrical Contact: Prohibit car operation unless car door is closed.

M. Door Clutch: Heavy-duty clutch, linkage arms, drive blocks and pickup rollers or cams to provide positive, smooth, quiet door operation. Design clutch so car doors can be closed, while hoistway doors remain open.

N. Restricted Opening Device: Restrict opening of car door(s) outside unlocking zone.

O. Door Operator: High speed, heavy-duty closed loop door operator capable of opening doors at no less than 2-1/2 f.p.s. Accomplish reversal in no more than 2-1/2" of door movement. Provide solid-state door control with closed loop circuitry to constantly monitor and automatically adjust door operation based upon velocity, position, and motor current. Maintain consistent, smooth, and quiet door operation at all floors, regardless of door weight or varying air pressure.

P. Door Control Device:
   1. Infrared Reopening Device: Black, fully enclosed device with full screen infrared matrix or multiple beams extending vertically along leading edge of each door panel to minimum height of 7'-0" above finished floor. Device shall prevent doors from closing and reverse doors at normal opening speed if beams are obstructed while doors are closing, except during nudging operation. In event of device failure, provide for automatic shutdown of car at floor level with doors open
      a. Acceptable Infrared Reopening Device:
         1) Cegard/MAX-154 by CEDES
         2) Gatekeeper by Adams
         3) Lambda II by Otis
         4) Magic Edge by Tri-Tronics
         5) Microlite by ThyssenKrupp
         6) Microscan E by T.L. Jones
         7) Pana40 Plus by Janus
         8) MBS 400 by Mitsubishi
   2. Nudging Operation: After beams of door control device are obstructed for a predetermined time interval (minimum 20.0 - 25.0 seconds), warning signal shall sound and doors shall attempt to close with a maximum of 2.5 foot pounds kinetic energy. Activation of the door open button shall override nudging operation and reopen doors.
   3. Interrupted Beam Time: When beams are interrupted during initial door opening, hold door open a minimum of 3.0 seconds. When beams are interrupted after the initial 3.0 second hold open time, reduce time doors remain open to an adjustable time of approximately 1.0 - 1.5 seconds after beams are reestablished.
   4. Differential Door Time: Provide separately adjustable timers to vary time that doors remain open after stopping in response to calls.
      a. Car Call: Hold open time adjustable between 3.0 and 5.0 seconds.
      b. Hall Call: Hold open time adjustable between 5.0 and 8.0 seconds. Use hall call time when car responds to coincidental calls.
Q. Car Operating Panel:
1. One car operating panel without faceplate, consisting of a metal box containing
   vandal resistant operating fixtures, mounted behind the car swing front return panel.
2. Suitably identify floor buttons, alarm button, door open button, door close button and
   emergency push-to-call button with SCS, Visionmark, or Entrada cast tactile symbols
   surface mounted. Configure plates per local building code accessibility standards
   including Braille. Locate operating controls no higher than 48" above the car floor; no
   lower than 35" for emergency push-to-call button and alarm button.
3. Provide minimum 3/4" diameter raised or flush floor pushbuttons which illuminate to
   indicate call registration.
4. Provide alarm button to ring bell located on car. Illuminate button when actuated.
5. Provide keyed stop switch at bottom of car operating panel in locked car service
   compartment.
6. Provide “door open” button to stop and reopen doors or hold doors in open position.
7. Provide “door close” button to activate door close cycle. Cycle shall not begin until
   normal door dwell time for a car or hall call has expired, except firefighters’ operation.
8. Provide firefighters’ Phase II key switch with engraved instructions filled red. Include
   light jewel, audible signal, and call cancel button.
9. Provide lockable service compartment with recessed flush door. Door material and
   finish shall match car return panel or car operating panel faceplate.
10. Include the following controls in lockable service cabinet with function and operating
    positions identified by permanent signage or engraved legend:
    a. Inspection switch.
    b. Light switch.
    c. Three-position exhaust blower switch.
    d. Independent service switch.
    e. Constant pressure test button for battery pack emergency lighting.
    f. 120-volt, AC, GFCI protected electrical convenience outlet.
    g. Card reader override switch.
    h. Stop switch.
11. Provide black paint filled (except as noted), engraved, or approved etched signage
    as follows with approved size and font:
    a. Phase II firefighters’ operating instructions on main operating panel above
       corresponding keyswitch filled red.
    b. Car number on main car operating panel.
    c. “No Smoking” on main car operating panel.
    d. Car capacity in pounds on service compartment door.

R. Car Top Control Station: Mount to provide safe access and utilization while standing in an
   upright position on car top.

S. Work Light and Duplex Plug Receptacle: GFCI protected outlet at top and bottom of car.
   Include on/off switch and lamp guard.

T. Communication System:
1. “Push to Call,” two-way communication instrument in car with automatic dialing,
   tracking, and recall features with shielded wiring to car controller in control room.
   Provide dialer with automatic rollover capability with minimum two numbers.
   a. “Push to Call” button or adjacent light jewel shall illuminate and flash when call
      is acknowledged. Button shall match car operating panel pushbutton design.
      Provide uppercase “PUSH TO CALL,” “HELP ON THE WAY” engraved
      signage adjacent to button.
   b. Provide “Push to Call” button tactile symbol, engraved signage, and Braille
      adjacent to button mounted integral with car front return panel.
2. Provide two-way communication between car and control room if required.
2.09 CAR ENCLOSURE

A. Car Enclosure Passenger Elevator: Provide complete as specified herein. Provide the following features.
   1. Shell: Reinforced minimum 16 gauge furniture steel formed panels with baked enamel interior finish as selected. Apply sound-deadening mastic to exterior.
   2. Canopy: Reinforced 12 gauge furniture steel formed panels with lockable, hinged emergency exit. Interior finish white reflective baked enamel.
   3. Front Return Panels and Integral Entrance Columns: Reinforced minimum 16 gauge stainless steel satin finish. Swing entire unit on substantial pivot points (minimum 3) for service access to car operating panel(s). Locate pivot points to provide full swing of front return panel without interference with side wall finish or handrail. Secure in closed position with concealed three-point latch. Provide service compartment with recessed flush cover and cutouts for operating switches, etc.
   4. Transom: Reinforced minimum 16 gauge stainless steel satin finish full width of enclosure.
   5. Car Door Panels: Reinforced minimum 18 gauge stainless steel satin finish. Same construction as hoistway door panels.
   7. Interior Wall Finish: Removable panels, faced and edged, with color core plastic laminate. Color and finish as selected.
   8. Ventilation: Two-speed type SOE Model No. 06-01055 exhaust blower mounted to car canopy on isolated rubber grommets.
   10. Suspended Ceiling: Three section, translucent plastic panels mounted in an extruded aluminum angle and T-frame.
   11. Handrails: Minimum 1-1/4" diameter aluminum tubular grab bar across rear and side walls.
   12. Pads and Buttons, Car 1: Three-piece removable pads. Two pads covering side walls and adjacent front returns and one covering rear wall. Provide cutouts to access main car operating panel.

2.10 HALL CONTROL STATIONS

A. Pushbuttons: Provide one riser with flush mounted faceplates. Include pushbuttons for each direction of travel which illuminate to indicate call registration. Include approved engraved message and pictorial representation prohibiting use of elevator during fire or other emergency situation as part of faceplate. Pushbutton design shall match car operating panel pushbuttons. Provide vandal resistant pushbutton and light assemblies.

2.11 SIGNALS

A. Hall Lantern, Car 1: Provide at each entrance to indicate travel direction of arriving car. Illuminate up or down LED lights and sound tone once for up and twice for down direction prior to car arrival at floor. Sound level shall be adjustable from 20 - 80 dBA measured at 5'-0" in front of hall control station and 3'-0" off floor. Illuminate light until the car doors start to close. Provide advanced hall lantern notification to comply with ADA hall call notification time. Car direction lenses shall be arrow shaped with faceplates. Lenses shall be minimum 2-1/2" in their smallest dimension.

B. Car Position Indicator: Alpha-numeric digital indicator containing floor designations and direction arrows a minimum of 1/2" high to indicate floor served and direction of car travel. Locate fixture in car front return panel. When a car leaves or passes a floor, illuminate
indication representing position of car in hoistway. Illuminate proper direction arrow to indicate direction of travel.

C. Faceplate Material and Finish: Stainless steel satin finish, all fixtures.

D. Floor Passing Tone: Provide an audible tone of no less than 20 decibels and frequency of no higher than 1500 Hz, to sound as the car passes or stops at a floor served.

PART 3 - EXECUTION

3.01 SITE CONDITION INSPECTION

A. Prior to beginning installation of equipment examine hoistway and control room areas. Verify no irregularities exist which affect execution of work specified.

B. Do not proceed with installation until work in place conforms to project requirements.

3.02 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver material in Provider’s original unopened protective packaging.

B. Store material in original protective packaging. Prevent soiling, physical damage, or moisture damage.

C. Protect equipment and exposed finishes from damage and stains during transportation, erection, and construction.

3.03 INSTALLATION

A. Install all equipment in accordance with Provider’s instructions, referenced codes, specification, and approved submittals.

B. Install control room equipment with clearances in accordance with referenced codes and specification.

C. Install all equipment so it may be easily removed for maintenance and repair.

D. Install all equipment for ease of maintenance.

E. Install all equipment to afford maximum accessibility, safety, and continuity of operation.

F. Remove oil, grease, scale, and other foreign matter from the following equipment and apply one coat of field-applied machinery enamel.
   1. All exposed equipment and metal work installed as part of this work which does not have architectural finish.
   2. Control room equipment, hoistway equipment including guide rails, guide rail brackets, and pit equipment.
   3. Neatly touch up damaged factory-painted surfaces with original paint color. Protect machine-finish surfaces against corrosion.
3.04 FIELD QUALITY CONTROL
A. Work at jobsite will be checked during course of installation. Full cooperation with reviewing personnel is mandatory. Accomplish corrective work required prior to performing further installation.
B. Have Code Authority acceptance inspection performed and complete corrective work.

3.05 ADJUSTMENTS
A. Install rails plumb and align vertically with tolerance of 1/16" in 100'-0". Secure joints without gaps and file any irregularities to a smooth surface.
B. Static balance car to equalize pressure of guide shoes on guide rails.
C. Lubricate all equipment in accordance with Provider’s instructions.
D. Adjust motors, power conversion units, brakes, controllers, leveling switches, limit switches, stopping switches, door operators, interlocks, and safety devices to achieve required performance levels.

3.06 CLEANUP
A. Keep work areas orderly and free from debris during progress of project. Remove packaging materials on a daily basis.
B. Remove all loose materials and filings resulting from work.
C. Clean control room equipment and floor.
D. Clean hoistways, car, car enclosure, entrances, operating, and signal fixtures.

3.07 ACCEPTANCE REVIEW AND TESTS
A. Review procedure shall apply for individual elevators, portions of groups of elevators, and completed groups of elevators accepted on an interim basis or elevators and groups of elevators completed, accepted, and placed into operation.
B. Provider shall perform review and evaluation of all aspects of its work prior to requesting Consultant’s final review. Work shall be considered ready for Consultant’s final contract compliance review when all Provider’s tests are complete and all elements of work or a designated portion thereof are in place and elevator or groups of elevators are deemed ready for service as intended.
C. Furnish labor, materials, and equipment necessary for Consultant’s review. Notify Consultant a minimum of five (5) working days in advance when ready for final review of elevator or group.
D. Consultants’ written list of observed deficiencies of materials, equipment, and operating systems will be submitted to Provider for corrective action. Consultant’s review shall include as a minimum:
   1. Workmanship and equipment compliance with Contract Documents.
   3. Performance of following is satisfactory:
a. Starting, accelerating, running  
b. Decelerating, stopping accuracy  
c. Door operation and closing force  
d. Equipment noise levels  
e. Signal fixture utility  
f. Overall ride quality  
g. Performance of door control devices  
h. Operations of emergency two-way communication device  
i. Operations of firefighters’ service  

4. Test Results:  
a. In all test conditions obtain specified contract speed, performance times, stopping accuracy without re-leveling, and ride quality to satisfaction of Purchaser and Consultant. Tests shall be conducted under both no load and full load condition.  
b. Temperature rise in motor windings limited to 50° Celsius above ambient. A full-capacity one (1) hour running test, stopping at each floor for ten (10) seconds in up and down directions, may be required.  

E. Performance Guarantee: Should Consultant’s review identify defects, poor workmanship, variance or noncompliance with requirements of specified codes and/or ordinances, or variance or noncompliance with the requirements of Contract Documents, Provider shall complete corrective work in an expedient manner to satisfaction of Purchaser and Consultant at no cost as follows:  
1. Replace equipment that does not meet code or Contract Document requirements.  
2. Perform work and furnish labor, materials, and equipment necessary to meet specified operation and performance.  

F. A follow-up final contract compliance review shall be performed by Consultant after notification by Provider that all deficiencies have been corrected. Provide Consultant with copies of the initial deficiency report marked to indicate items which Provider considers complete. If additional reviews are required due to Provider’s gross non-compliance with initial and follow-up deficiency reports, consultant shall bill Provider at normal billing rates plus expenses, and Provider acknowledges it will pay for additional compliance reviews.  

3.08 PURCHASER’S INFORMATION  

A. Provide three sets of neatly bound written information necessary for proper maintenance and adjustment of equipment within 30 days following final acceptance. Final retention will be withheld until data is received by Purchaser and reviewed by Consultant. Include the following as minimums:  
1. Straight-line wiring diagrams of “as-installed” elevator circuits with index of location and function of components. Provide one set reproducible master. Mount one set wiring diagrams on panels, racked, or similarly protected, in elevator control room. Provide remaining set rolled and in a protective drawing tube. Maintain all drawing sets with addition of all subsequent changes. These diagrams are Purchaser’s property.  
2. Lubrication instructions including recommended grade of lubricants.  
3. Parts catalogs for all replaceable parts including ordering forms and instructions.  
4. Four sets of keys for all switches and control features properly tagged and marked.  
5. Diagnostic test devices together with all supporting information necessary for interpretation of test data and troubleshooting of elevator system, and performance of routine safety tests.  
6. The elevator installation shall be a design that can be maintained by any licensed elevator maintenance company employing journeymen mechanics, without the need
to purchase or lease additional diagnostic devices, special tools, or instructions from the original equipment Provider.

a. Provide on site capability to diagnose faults to the level of individual circuit boards and individual discrete components for the solid state elevator controller.

b. Provide a separate, detachable device, as required to the Purchaser as part of this installation if the equipment for fault diagnosis is not completely self-contained within the controller. Such device shall be in possession of and become property of the Purchaser.

c. Installed equipment not meeting this requirement shall be removed and replaced with conforming equipment at no cost to the Purchaser.

7. Provide upgrades and/or revisions of software during the progress of the work, warranty period, and the term of the ongoing maintenance agreement between the Purchaser and Provider.

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PART 1 - GENERAL

1.01 The proposed mechanical systems for the University of Colorado at Boulder (UCB), Institute of Behavioral Science (IBS) building attempt to balance the building usage requirements with other factors such as UCB standards, occupant safety, first cost, operating costs, life cycle and system maintainability. The building gross area is approximately 50,000 ft². Within this narrative, the following system characteristics are addressed:

A. Design criteria
B. Heating system
C. Cooling system
D. Supply air system
E. Exhaust air systems
F. Temperature control system
G. Plumbing system
H. Fire protection system
I. Mechanical Space Requirements

PART 2 - DESIGN CRITERIA

2.01 Outdoor Design Conditions: The summer design conditions of 91°F dry bulb (db) and 60°F wet bulb (wb) will be used to size mechanical systems. This is consistent with the 1% ASHRAE design conditions for Denver. The make-up air design conditions for summer will be 95°F db / 59°F wb. A winter design temperature of -20°F db will be used for a 90°F temperature difference between inside and outside conditions. The make-up air winter design shall be -30°F per UCB standards.

2.02 Indoor Design Conditions: Consistent with UCB standards, a summer indoor design temperature of 73°F db, and a winter indoor temperature of 70°F will be used for calculating loads for occupied spaces.

2.03 Humidity control is not a requirement of the program plan; however humidity sensors will be utilized in the building to control the use of direct evaporative cooling during periods of high outdoor humidity.

2.04 Applicable Codes and Standards:

A. International Building Code (IBC) 2006
B. International Mechanical Code (IMC), 2006
D. International Plumbing Code (IPC), 2006
E. International Fuel Gas Code (IFGC), 2006
F. International Fire Code (IFC) 2006
G. NFPA 13, Installation of Sprinkler Systems, 2007
K. ASHRAE Handbooks, Current Editions
2.05 System Sizing and Design: The building heating, ventilation, and air conditioning (HVAC) systems will be sized for the present projected loads. The sizing does not account for any future building additions.

2.06 Projected Loads: Based on the preliminary building plans, computer-based cooling and heating load calculations have been completed. The projected loads are as described below in the heating and cooling system sections of the report.

PART 3 - HEATING SYSTEM

3.01 The IBS building will be served by two gas-fired direct vent/sealed combustion boilers each sized for approximately 60% of the total projected heating load. A higher capacity boiler was reviewed (to provide additional spare capacity) however, the next size boiler is capable of providing approximately 90% of the total load. A breakdown of the projected load (zone load and ventilation load) is as follows and includes a 25% safety factor for the space heating loads.

<table>
<thead>
<tr>
<th>Description</th>
<th>MBH</th>
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<tr>
<td>Space Heating Load</td>
<td>308</td>
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<tr>
<td>Ventilation Heating Load</td>
<td>810</td>
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<tr>
<td>Total</td>
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</table>

3.02 Heating water is circulated in the building with two main distribution pumps located in the basement mechanical room. Each pump will be sized for 100% of the peak heating flow rate. Both pumps will be controlled from variable frequency drives (VFDs).

3.03 Each boiler will have a boiler circulation pump to circulate water through the boiler. The pumps will be constant volume and will operate when the corresponding boiler is enabled.

3.04 An in-line pump will be provided to circulate heating water at the air handling unit heating coil. The pump will be located in a piping vestibule as part of the air handling unit.

3.05 Surface-mounted hydronic convectors will be provided along the building perimeter to provide building heating. The convectors will be zoned to match the VAV box zoning arrangement so the temperature control of the equipment is coordinated.

3.06 Hydronic cabinet unit heaters will be provided at building entrances and stairwells to provide heating for these spaces.

3.07 Hydronic unit heaters will be provided in the mechanical room and storage areas to provide heating for these spaces.

3.08 Hydronic fan coil units will be provided in the 4th floor ceiling plenum to provide heating to offset the heat loss through the roof. This is in lieu of providing heating coils at the VAV boxes.

3.09 A reverse-return piping arrangement will be used as much as is practical for the heating water piping in the building to facilitate hydronic balancing.

3.10 Materials for the heating water system will be as follows:

- 2 ½” and larger pipe: Schedule 40, black steel (welded)
- 2” and smaller pipe: Type L copper (soldered) or Schedule 40, black steel (threaded)

3.11 The heating water system will be a glycol solution (40%) consistent with UCB standards due to the freeze risk of the heating water coil in the roof-mounted air handling unit. The glycol feeder and associated piping and accessories will be located in the basement mechanical room.
PART 4 - COOLING SYSTEM

4.01 The building cooling system will include indirect and direct evaporative cooling as part of the air handling system. The roof-mounted air handling unit will include an integral cooling tower for the indirect evaporative cooling coil.

4.02 The projected cooling loads, including a 10% safety factor, for the building are indicated in the table below.

<table>
<thead>
<tr>
<th>Space Cooling Load:</th>
<th>829 MBH / 69 tons</th>
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<tr>
<td>Ventilation Cooling Load:</td>
<td>1,188 MBH / 99 tons</td>
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<tr>
<td>Total Cooling Load / Chilled Water Demand:</td>
<td>2,017 MBH / 168 tons</td>
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4.03 Direct expansion (DX) split system cooling systems will be provided for spaces that require dedicated cooling systems (including cooling during the winter months). These spaces include the telecommunication rooms, server rooms, and elevator equipment room. Please note that detailed information regarding the loads in the telecommunication rooms and server rooms has not been provided to the design team, so the estimated cooling capacities indicated are projected. If it is later determined that the loads are minimal, it is possible that these spaces can be adequately cooled with general exhaust.

PART 5 - SUPPLY AIR SYSTEMS

5.01 The proposed building addition supply air systems will include one central variable air volume (VAV) air handling unit with a capacity of 60,000 cfm. The air handling unit will be located on the roof. Overhead ductwork will deliver medium pressure air from the air handling unit to VAV boxes. The VAV boxes then deliver low pressure air to the individual space diffusers and grilles.

5.02 AHU-1 will be equipped as follows:

A. Return fan in housing with double wall construction and perforated inner liner.
B. Relief air section.
C. Outside air/mixing section with motorized return and outside air dampers.
D. Minimum outside air damper.
E. 30% (MERV 8) efficient pleated filters and 85% (MERV 13) final filters.
F. Hydronic heating coil, minimum 2-row.
G. Indirect evaporative cooling coil section.
H. Direct evaporative cooling coil.
I. Supply fan with double wall construction and perforated inner liner.
J. Discharge plenum of double wall housing construction with perforated inner liner.
K. Double wall housing construction throughout AHU.
L. Duct smoke detectors located in each main supply and return ducts connected to AHU.
M. Access doors with windows.
5.03 Air Distribution: Overhead medium-pressure supply duct mains will distribute air to variable air volume (VAV) terminal units. Each terminal unit will operate to deliver a variable air volume during occupied hours, and shall be full shut-off type. Both medium and low pressure ductwork will be constructed of galvanized steel with 1-1/2" thick internal fiberglass liner for insulation and acoustical benefits.

5.04 Building Pressurization: During occupied hours, the building will be balanced to a slight (+0.05" W.C.) positive pressure to minimize infiltration at exterior doors and windows. During unoccupied hours, outside dampers are closed and exhaust fans are off, resulting in a neutral building pressure.

5.05 Combination fire/smoke dampers will be located in ducts at each shaft penetration, occupancy separation, and area separation as required by the International Building Code.

5.06 Carbon dioxide (CO₂) sensors are provided in the main return and outside air ducts, and in rooms with widely varying occupancies (e.g. lounge, conference rooms, etc.) to monitor indoor air quality. These sensors will accommodate the use of demand controlled ventilation to reduce outside airflow quantities at off-peak periods.

5.07 In general, one VAV terminal box will be provided for each conference room and generally for groups of four offices with similar exposure.

PART 6 - EXHAUST SYSTEMS

6.01 A roof-mounted exhaust fan is provided for general building exhaust during occupied hours only. Spaces that will be exhausted include:

A. Restrooms
B. Janitor Closets
C. Kitchen areas
D. Copy rooms

PART 7 - TEMPERATURE CONTROLS

7.01 The temperature control system will be an Andover direct digital control (DDC) system with a communication connection to the main control station at the Facilities Services Center.

7.02 Specific control sequences will be further developed and defined in the next design phase, but the following general control sequences will be incorporated to provide appropriate control and reduced energy usage:

A. Variable air volume supply and return airflow.
B. Unoccupied supply and return air flow reduction.
C. Unoccupied temperature set-back, AHU off.
D. Heating water supply temperature reset.
E. Variable speed pumping.
F. Lockout of simultaneous heating and cooling.
G. Static pressure reset for air handling unit supply fan.
Temperature control logic, sensors, and communications will be via DDC communication and electric actuators. Safety controls, such as freeze-stats and high static cutouts, will be hard-wired interlocks.

Line voltage power (120V) will be provided in centralized locations to transformers to provide low voltage power (24V) to several VAV boxes in the vicinity.

**PART 8 - PLUMBING SYSTEMS**

8.01 Water Service: The building addition will be served by a new 6" combined water/fire service routed into the basement level mechanical room.

8.02 Backflow Prevention: A reduced-pressure type backflow preventer will be provided for the domestic water service to the building. Vacuum breaker type backflow protection will be provided at equipment connections, janitorial faucets, and hose bibbs.

8.03 Pressure Reducing Station: A domestic water pressure reducing station will be provided downstream of the backflow preventer to reduce the water pressure as required. It has been reported that the water pressure on site is approximately 100 psi.

8.04 Electric water heaters are generally located at each restroom group to supply hot water. Distributed electric water heaters are used in lieu of a central gas-fired system to eliminate the need for a recirculation system and associated energy costs and losses.

8.05 Roof drains and storm drain piping will be provided for the building. It is assumed that the invert elevations of the existing storm drain system on site will be adequate for gravity flow without a sump pump system. It is currently anticipated that the roof drains will be located near the perimeter of the building and also in the vicinity of the roof-top air handling unit.

8.06 Gas service to the building will be required for the boilers and water heaters. The anticipated gas load is approximately 1,209 MBH. The gas meter is currently located outside the east wall of the mechanical room, but this location will need to be further coordinated in the next design phase.

8.07 A sanitary sewer system will be provided for the building addition and will connect to the existing sanitary sewer system outside the building. A new duplex sewage ejector will be provided to pump the basement level waste water as the existing site invert elevations may not accommodate gravity drain for the basement level drains. This will be further reviewed in the next design phase to verify the need for the sewage ejector.

8.08 All domestic water pipe will be Type K copper. Sanitary waste and vent piping above grade will be copper or no-hub cast iron. Below grade waste and storm drainage piping will be hub and spigot type cast iron. Above grade storm drainage piping will be cast-iron, no-hub type with Neoprene gaskets and "super duty" stainless steel couplings.

8.09 Loose-keyed non-freeze wall hydrants will be provided at exterior locations near building entrances for wash down and grounds crew.

8.10 Bi-level drinking fountains (non-refrigerated) will be provided at the restroom groups as indicated on the drawings. Additionally, each drinking fountain will have a “goose neck” type faucet for filling of water bottles.

8.11 Trap primers or waterless trap devices (e.g. ProSet Trapguard) will be provided at each floor drain to maintain the water seal on the trap. Waterless trap devices will only be used in locations where water is unlikely to be on the floor.
8.12 Ultra-low-flow urinals (1/8 gallon per flush) will be provided to reduce water consumption.

PART 9 - FIRE PROTECTION SYSTEM

9.01 A new combined 6" fire protection/domestic water service will supply a 6" fire service to the building. A double check backflow-preventer will be provided with flow and tamper switches.

9.02 The new automatic fire sprinkler system will be installed with full fire sprinkler coverage on each floor. Sprinkler coverage will comply with NFPA 13, and the UCB standards.

9.03 A stand pipe system with hose valves will be provided in each exiting stair enclosure.

PART 10 - MECHANICAL SPACE REQUIREMENTS

10.01 The building mechanical equipment is primarily located in a basement mechanical room on the east side of the building. This includes the boilers, pumps, and backflow preventers.

10.02 The central air handling unit serving the building is located on the roof. Further coordination of the roof layout will be done in the next design phase to accommodate the size and access requirements of the air handling unit. Additionally, it is anticipated that the south and east sides of the air handling unit will be used to support the architectural screen wall.

10.03 A general building exhaust fan is located on the roof.

END OF SECTION
SECTION 21 05 00

COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following:
   1. Piping materials and installation instructions common to most piping systems.
   2. Mechanical sleeve seals.
   3. Sleeves.
   4. Escutcheons.
   5. Fire-suppression equipment.
   6. Equipment installation requirements common to equipment sections.
   7. Painting and finishing.
   8. Supports and anchorages.

1.03 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for rubber materials:
   1. EPDM: Ethylene-propylene-diene terpolymer rubber.
   2. NBR: Acrylonitrile-butadiene rubber.

1.04 SUBMITTALS

A. Product Data: For the following:
1. Mechanical sleeve seals.
2. Escutcheons.

1.05 QUALITY ASSURANCE

A. Electrical Characteristics for Fire-Suppression Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

1.07 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for fire-suppression installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for fire-suppression items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.02 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 21 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.
2.03 JOINING MATERIALS

A. Refer to individual Division 21 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
      a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
   2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

2.04 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
   1. Manufacturers:
      a. Advance Products & Systems, Inc.
      b. Calpico, Inc.
      c. Metraflex Co.
      d. Pipeline Seal and Insulator, Inc.
   2. Sealing Elements: [EPDM] [NBR] interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   3. Pressure Plates: [Carbon steel] [Stainless steel]. Include two for each sealing element.
   4. Connecting Bolts and Nuts: [Carbon steel with corrosion-resistant coating] [Stainless steel] of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.05 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   1. Underdeck Clamp: Clamping ring with set screws.
2.06 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw.
   1. Finish: Polished chrome-plated.

D. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.

E. One-Piece, Floor-Plate Type: Cast-iron floor plate.

PART 3 - EXECUTION

3.01 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 21 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

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

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

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

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

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

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
1. New Piping:
   a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
   b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
   c. Insulated Piping: One-piece, stamped-steel type with spring clips.
   d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
   e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
   f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with rough-brass finish.
   g. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
   h. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

M. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
1. Cut sleeves to length for mounting flush with both surfaces.
   a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
   a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
   b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
   c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.
      1) Seal space outside of sleeve fittings with grout.
4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials.

N. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

O. Verify final equipment locations for roughing-in.

P. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.02 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 21 Sections specifying piping systems.
B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. 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. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
   1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.

3.03 PAINTING

A. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.04 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor fire-suppression materials and equipment.

C. Field Welding: Comply with AWS D1.1.

END OF SECTION
SECTION 21 10 00
WATER-BASED FIRE-SUPPRESSION SYSTEMS

PART 1 - GENERAL

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

1.02 SUMMARY
   A. This Section includes the following fire-suppression piping inside the building:
      1. Manual wet-type, Class I standpipe systems.
      2. Wet-pipe sprinkler systems.
   B. Related Sections include the following:
      1. Division 10 Section "Fire Extinguisher Cabinets" and "Fire Extinguishers" for
         cabinets and fire extinguishers.
      2. Division 28 Section "Fire Detection and Alarm" for alarm devices not specified in
         this Section.

1.03 SYSTEM DESCRIPTIONS
   A. Combined Standpipe and Sprinkler System: Fire-suppression system with both
      standpipe and sprinkler systems. Sprinkler system is supplied from standpipe system.
   B. Manual Wet-Type, Class I Standpipe System: Includes NPS 2-1/2 hose connections.
      Has small water supply to maintain water in standpipes. Piping is wet, but water must be
      pumped into standpipes to satisfy demand.
   C. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water
      and that is connected to water supply. Water discharges immediately from sprinklers
      when they are opened. Sprinklers open when heat melts fusible link or destroys frangible
      device. Hose connections are included if indicated.

1.04 PERFORMANCE REQUIREMENTS
   B. Fire-suppression standpipe system design shall be approved by authorities having
      jurisdiction.
      1. Minimum residual pressure at each hose-connection outlet is the following:
         a. NPS 1-1/2 Hose Connections: [65 psig] <Insert other>.
         b. NPS 2-1/2 Hose Connections: [100 psig] <Insert other>.
      2. Unless otherwise indicated, the following is maximum residual pressure at
         required flow at each hose-connection outlet:
a. NPS 1-1/2 Hose Connections: [100 psig] <Insert other>.
b. NPS 2-1/2 Hose Connections: [175 psig] <Insert other>.

C. Fire-suppression sprinkler system design shall be approved by authorities having jurisdiction.
1. Margin of Safety for Available Water Flow and Pressure: [10] [20] <Insert other> percent, including losses through water-service piping, valves, and backflow preventers.
2. Sprinkler Occupancy Hazard Classifications: Refer to drawings.
3. Minimum Density for Automatic-Sprinkler Piping Design:
   a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
   b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.
4. Maximum Protection Area per Sprinkler: Per UL listing.
5. Maximum Protection Area per Sprinkler:
   a. Office Spaces: [120 sq. ft.] [225 sq. ft.] <Insert other>.
   b. Storage Areas: [130 sq. ft.] <Insert other>.
   c. Mechanical Equipment Rooms: [130 sq. ft.] <Insert other>.
   d. Electrical Equipment Rooms: [130 sq. ft.] <Insert other>.
   e. Other Areas: According to NFPA 13 recommendations, unless otherwise indicated.
6. Total Combined Hose-Stream Demand Requirement: According to NFPA 13, unless otherwise indicated:
   a. Light-Hazard Occupancies: [100 gpm for 30 minutes] <Insert other>.
   b. Ordinary-Hazard Occupancies: [250 gpm for 60 to 90 minutes] <Insert other>.

1.05 SUBMITTALS

A. Product Data: For the following:
   1. Piping materials, including sprinkler specialty fittings.
   2. Pipe hangers and supports.
   3. Valves, including listed fire-protection valves, unlisted general-duty valves, and specialty valves and trim.
   4. Sprinklers, escutcheons, and guards. Include sprinkler flow characteristics, mounting, finish, and other pertinent data.
   5. Hose connections, including size, type, and finish.
   6. Fire department connections, including type; number, size, and arrangement of inlets; caps and chains; size and direction of outlet; escutcheon and marking; and finish.
   7. Alarm devices, including electrical data.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Fire-hydrant flow test report.

D. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations, if applicable.

F. Welding certificates.

G. Field quality-control test reports.

H. Operation and Maintenance Data: For standpipe and sprinkler specialties to include in emergency, operation, and maintenance manuals.

1.06 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Installer’s responsibilities include designing, fabricating, and installing fire-suppression systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
      a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.

B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

C. NFPA Standards: Fire-suppression-system equipment, specialties, accessories, installation, and testing shall comply with the following:
   1. NFPA 13, "Installation of Sprinkler Systems."
   2. NFPA 14, "Installation of Standpipe, Private Hydrant, and Hose Systems."

1.07 COORDINATION

A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

1.08 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Sprinkler Cabinets: Finished, wall-mounting, steel cabinet with hinged cover, with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler on Project.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
2.02 STEEL PIPE AND FITTINGS

A. Threaded-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, with factory- or field-formed threaded ends.
   5. Steel Threaded Couplings: ASTM A 865.

B. Grooved-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, with [factory- or field-formed, square-cut] [factory- or field-formed, square-cut- or roll] [factory- or field-formed, roll]-grooved ends.
   1. Grooved-Joint Piping Systems:
      a. Manufacturers:
         1) Anvil International, Inc.
         2) Central Sprinkler Corp.
         3) Ductlic, Inc.
         4) JDH Pacific, Inc.
         5) National Fittings, Inc.
         6) Shurjoint Piping Products, Inc.
         7) Southwestern Pipe, Inc.
         8) Star Pipe Products; Star Fittings Div.
         9) Victaulic Co. of America.
      b. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.
      c. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, [prelubricated] rubber gasket listed for use with housing, and steel bolts and nuts.

C. Grooved-End, Schedule 10 Steel Pipe: ASTM A 135 or ASTM A 795, Schedule 10 in NPS 5 and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10; with factory- or field-formed, roll-grooved ends.
   1. Grooved-Joint Piping Systems:
      a. Manufacturers:
         1) Anvil International, Inc.
         2) Central Sprinkler Corp.
         3) Ductlic, Inc.
         4) JDH Pacific, Inc.
         5) National Fittings, Inc.
         6) Shurjoint Piping Products, Inc.
         7) Southwestern Pipe, Inc.
         8) Star Pipe Products; Star Fittings Div.
         9) Victaulic Co. of America.
      b. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.
      c. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD.
Include ductile-iron housing with keys matching steel-pipe and fitting grooves, [prelubricated] rubber gasket listed for use with housing, and steel bolts and nuts.

2.03 SPRINKLER SPECIALTY FITTINGS

A. Sprinkler specialty fittings shall be UL listed or FMG approved, with 175-psig minimum working-pressure rating, and made of materials compatible with piping.

B. Sprinkler Drain and Alarm Test Fittings: Cast- or ductile-iron body; with threaded or locking-lug inlet and outlet, test valve, and orifice and sight glass.
   1. Manufacturers:
      a. Central Sprinkler Corp.
      b. Fire-End and Croker Corp.
      c. Viking Corp.
      d. Victaulic Co. of America.

C. Sprinkler Inspector's Test Fitting: Cast- or ductile-iron housing with threaded inlet and drain outlet and sight glass.
   1. Manufacturers:
      a. AGF Manufacturing Co.
      b. Central Sprinkler Corp.
      c. G/J Innovations, Inc.
      d. Triple R Specialty of Ajax, Inc.

2.04 LISTED FIRE-PROTECTION VALVES

A. Valves shall be UL listed or FMG approved, with 175-psig minimum pressure rating.

B. Gate Valves with Wall Indicator Posts:
   1. Gate Valves: UL 262, cast-iron body, bronze mounted, with solid disc, nonrising stem, operating nut, and flanged ends.
   2. Indicator Posts: UL 789, horizontal-wall type, cast-iron body, with [operating wrench] [hand wheel], extension rod, locking device, and cast-iron barrel.
   3. Manufacturers:
      b. McWane, Inc.; Kennedy Valve Div.
      c. NIBCO.
      d. Stockham.

C. Ball Valves: Comply with UL 1091, except with ball instead of disc.
   1. NPS 1-1/2 and Smaller: Bronze body with threaded ends.
   2. NPS 2 and NPS 2-1/2: Bronze body with threaded ends or ductile-iron body with grooved ends.
   3. NPS 3: Ductile-iron body with grooved ends.
   4. Manufacturers:
      a. NIBCO.
      b. Victaulic Co. of America.

D. Butterfly Valves: UL 1091.
   1. NPS 2 and Smaller: Bronze body with threaded ends.
      a. Manufacturers:
         1) Global Safety Products, Inc.
2) Milwaukee Valve Company.

2. NPS 2-1/2 and Larger: Bronze, cast-iron, or ductile-iron body; wafer type or with flanged or grooved ends.
   a. Manufacturers:
      1) Central Sprinkler Corp.
      2) Global Safety Products, Inc.
      3) McWane, Inc.; Kennedy Valve Div.
      4) Mueller Company.
      5) NIBCO.
      6) Pratt, Henry Company.
      7) Victaulic Co. of America.

E. Check Valves NPS 2 and Larger: UL 312, swing type, cast-iron body with flanged or grooved ends.
   1. Manufacturers:
      a. Central Sprinkler Corp.
      b. Crane Co.; Crane Valve Group; Crane Valves.
      c. Crane Co.; Crane Valve Group; Jenkins Valves.
      d. Globe Fire Sprinkler Corporation.
      e. Grinnell Fire Protection.
      f. Hammond Valve.
      g. Mueller Company.
      h. NIBCO.
      i. Potter-Roemer; Fire Protection Div.
      j. Reliable Automatic Sprinkler Co., Inc.
      k. Star Sprinkler Inc.
      l. Stockham.
      m. Victaulic Co. of America.

F. Gate Valves: UL 262, OS&Y type.
   1. NPS 2 and Smaller: Bronze body with threaded ends.
      a. Manufacturers:
         1) Crane Co.; Crane Valve Group; Crane Valves.
         2) Hammond Valve.
         3) NIBCO.
         4) United Brass Works, Inc.
   2. NPS 2-1/2 and Larger: Cast-iron body with flanged ends.
      a. Manufacturers:
         1) Clow Valve Co.
         2) Crane Co.; Crane Valve Group; Crane Valves.
         3) Crane Co.; Crane Valve Group; Jenkins Valves.
         4) Hammond Valve.
         5) Milwaukee Valve Company.
         6) Mueller Company.
         7) NIBCO.
         8) Red-White Valve Corp.
         9) United Brass Works, Inc.

G. Indicating Valves: UL 1091, with integral indicating device and ends matching connecting piping.
   1. Indicator: [Electrical, 115-V ac, prewired, single-circuit, supervisory switch]
      [Visual].
   2. NPS 2 and Smaller: Ball or butterfly valve with bronze body and threaded ends.
2.05 SPECIALTY VALVES

A. Sprinkler System Control Valves: UL listed or FMG approved, cast- or ductile-iron body with flanged or grooved ends, and 175-psig minimum pressure rating.
   1. Manufacturers:
      a. Central Sprinkler Corp.
      c. Grinnell Fire Protection.
      d. Reliable Automatic Sprinkler Co., Inc.
      e. Star Sprinkler Inc.
      f. Victaulic Co. of America.
      g. Viking Corp.

   2. Alarm Check Valves: UL 193, designed for horizontal or vertical installation, with bronze grooved seat with O-ring seals, single-hinge pin, and latch design. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, [retarding chamber,] and fill-line attachment with strainer.
      a. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
      b. Drip Cup Assembly: Pipe drain with check valve to main drain piping.

B. Automatic Drain Valves: UL 1726, NPS 3/4, ball-check device with threaded ends.
   1. Manufacturers:
      a. AFAC Inc.
      b. Grinnell Fire Protection.

2.06 SPRINKLERS

A. Sprinklers shall be UL listed or FMG approved, with 175-psig minimum pressure rating.

B. Manufacturers:
   2. Reliable Automatic Sprinkler Co., Inc.
   3. Viking Corp.

C. Automatic Sprinklers: With heat-responsive element complying with the following:
   1. UL 199, for nonresidential applications.
2. UL 1767, for early-suppression, fast-response applications.

D. Sprinkler Types and Categories: Nominal 1/2-inch orifice for "Ordinary" temperature classification rating, unless otherwise indicated or required by application.

E. Sprinkler types, features, and options as follows:
1. Pendent sprinklers.
2. Quick-response sprinklers.
3. Recessed sprinklers, including escutcheon.
4. Sidewall sprinklers.
5. Upright sprinklers.

F. Sprinkler Finishes: Chrome plated, bronze, and painted.

G. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for recessed-type sprinklers are specified with sprinklers.
1. Ceiling Mounting: [Chrome-plated steel, one piece, flat] [Chrome-plated steel, 2 piece, with 1-inch vertical adjustment] Plastic, white finish, one piece, flat.
2. Sidewall Mounting: [Chrome-plated steel] [Plastic, white finish, one piece, flat.

H. Sprinkler Guards: Wire-cage type, including fastening device for attaching to sprinkler.

2.07 HOSE CONNECTIONS

A. Manufacturers:
2. Potter-Roemer; Fire-Protection Div.

B. Description: UL 668, brass or bronze, 300-psig minimum pressure rating, hose valve for connecting fire hose. Include gatepattern design; female NPS inlet and male hose outlet; and lugged cap, gasket, and chain. Include NPS 1-1/2 or NPS 2-1/2 as indicated, and hose valve threads according to NFPA 1963 and matching local fire department threads.
1. Valve Operation: [Nonadjustable type] [Nonadjustable type, unless pressure-regulating type is indicated] [Pressure-regulating type].
2. Finish: Rough [metal] [metal or chrome-plated] [chrome-plated].

2.08 ROOF HOSE CABINETS

A. Manufacturers:
1. Fire-End and Croker Corp.
2. GMR International Equipment Corporation.
3. Metal Cabinet Co.
4. Potter-Roemer; Fire-Protection Div.
5. Van Loon Industries, Inc.

B. Description: FMG-approved, low-profile-type cabinet for roof-mounting hose station. Include the following:
1. Housing: Sheet-steel construction with steel reinforcement and modified to hold not less than length of fire hose indicated.
2. Shutoff Valve: UL 262, NPS 1-1/2, bronze-body gate valve with extended stem.
3. Hose Connection: UL 668, NPS 1-1/2, brass or bronze valve.
5. Hose: NPS 1-1/2, lined and suitable for exterior service. Include two 75-foot lengths coupled together. Include wrench.
6. Nozzle: UL 401, NPS 1-1/2, brass, adjustable from fog spray to straight stream to shutoff.
7. Drain Valve: NPS 1/2, unlisted, bronze gate valve with extended stem.
9. Roof Curb: Matching housing dimensions.

2.09 FIRE DEPARTMENT CONNECTIONS

A. Manufacturers:
   2. Croker Corp.
   3. Potter-Roemer; Fire-Protection Div.

B. Wall-Type, Fire Department Connection: UL 405, 175-psig minimum pressure rating; with corrosion-resistant-metal body with brass inlets, brass wall escutcheon plate, brass lugged caps with gaskets and brass chains, and brass lugged swivel connections. Include inlets with threads according to NFPA 1963 and matching local fire department sizes and threads, outlet with pipe threads, extension pipe nipples, check devices or clappers for inlets, and escutcheon plate with marking similar to "AUTO SPKR & STANDPIPE."
   1. Type: Flush, with two inlets and square or rectangular escutcheon plate.
   2. Finish: [Polished chrome-plated] [Rough chrome-plated] [Polished brass].

2.10 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Water-Flow Indicator: UL 346, electrical-supervision, paddle-operated-type, water-flow detector with 250-psig pressure rating and designed for horizontal or vertical installation. Include two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
   1. Manufacturers:
      b. System Sensor.

C. Valve Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled valve is in other than fully open position.
   1. Manufacturers:
      b. System Sensor.
2.11 PRESSURE GAGES
   A. Description: UL 393, 3-1/2- to 4-1/2-inch- diameter, dial pressure gage with range of 0 to 250 psig minimum.
      1. Water System Piping: Include caption "WATER" or "AIR/WATER" on dial face.

PART 3 - EXECUTION

3.01 PREPARATION
   A. Perform fire-hydrant flow test according to NFPA 13, NFPA 14, and NFPA 291. Use results for system design calculations required in Part 1 "Quality Assurance" Article.
   B. Report test results promptly and in writing.

3.02 EXAMINATION
   A. Examine roughing-in for hose connections and stations to verify actual locations of piping connections before installation.
   B. Examine walls and partitions for suitable thicknesses, fire- and smoke-rated construction, framing for hose-station cabinets, and other conditions where hose connections and stations are to be installed.
   C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.03 PIPING APPLICATIONS, GENERAL
   A. Shop weld pipe joints where welded piping is indicated.
   B. Flanges, flanged fittings, unions, nipples, and transition and special fittings with finish and pressure ratings same as or higher than system's pressure rating may be used in aboveground applications, unless otherwise indicated.
   C. Piping between Fire Department Connections and Check Valves: Galvanized, standard-weight steel pipe with [threaded ends; cast- or malleable-iron threaded fittings; and threaded] [grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved] joints.

3.04 STANDPIPE SYSTEM PIPING APPLICATIONS
   A. Standard-Pressure, Wet-Type Standpipe System, 175-psig Maximum Working Pressure:
      1. NPS 4 and Smaller: Grooved-end, [black] [black or galvanized] [galvanized], standard-weight steel pipe with [square-cut] [square-cut- or roll] [roll]-grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.
      2. NPS 4 and Smaller: Grooved-end, Schedule 10 steel pipe; grooved-end fittings; groove-
         end-pipe couplings; and grooved joints. Schedule 10 pipe shall only be acceptable for pipe sizes 2-1/2” and larger.
      3. NPS 5 and NPS 6: Grooved-end, Schedule 10 steel pipe; grooved-end fittings; groove-
         end-pipe couplings; and grooved joints.
B. Standard-Pressure, Dry-Type Standpipe System, 175-psig Maximum Working Pressure:
1. NPS 4 and Smaller: Threaded-end, galvanized, standard-weight steel pipe; galvanized, cast- or malleable-iron threaded fittings; and threaded joints.
2. NPS 4 and Smaller: Grooved-end, galvanized, standard-weight steel pipe with square-cut or roll-grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.
3. NPS 4 and Smaller: Grooved-end, galvanized, Schedule 30 steel pipe; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.
4. NPS 4 and Smaller: Plain-end, Type K, Type L, hard copper tube; wrought-copper fittings; and brazed joints.
5. NPS 4 and Smaller: Grooved-end, Type K, Type L, hard copper tube with factory- or field-grooved, roll-grooved ends; grooved-end copper fittings; grooved-end-tube couplings; and grooved joints.
6. NPS 5 and NPS 6: Threaded-end, galvanized, standard-weight steel pipe; galvanized, cast- or malleable-iron threaded fittings; and threaded joints.
7. NPS 5 and NPS 6: Grooved-end, galvanized, standard-weight steel pipe with square-cut or roll-grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.
8. NPS 5 and NPS 6: Grooved-end, galvanized, Schedule 30 steel pipe; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.
9. NPS 5 and NPS 6: Plain-end, Type K, Type L, hard copper tube; wrought-copper fittings; and brazed joints.
10. NPS 5 and NPS 6: Grooved-end, Type K, Type L, hard copper tube with factory- or field-grooved, roll-grooved ends; grooved-end copper fittings; grooved-end-tube couplings; and grooved joints.

3.05 SPRINKLER SYSTEM PIPING APPLICATIONS

A. Standard-Pressure, Wet-Pipe Sprinkler System, 175-psig Maximum Working Pressure:
1. NPS 1-1/2 and Smaller: Threaded-end, black or galvanized, standard-weight steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
2. NPS 2: Threaded-end, black or galvanized, standard-weight steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
3. NPS 2: Grooved-end, black or galvanized, standard-weight steel pipe; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.
4. NPS 2-1/2 to NPS 3-1/2: Threaded-end, black or galvanized, standard-weight steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
5. NPS 2-1/2 to NPS 3-1/2: Grooved-end, Schedule 10 steel pipe; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.
6. NPS 4 to NPS 6: Threaded-end, black or galvanized, standard-weight steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
7. NPS 4 to NPS 6: Grooved-end, Schedule 10 steel pipe; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.

3.06 VALVE APPLICATIONS

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
1. Listed Fire-Protection Valves: UL listed and FMG approved for applications where required by NFPA 13 and NFPA 14.
a. Shutoff Duty: Use ball, butterfly, or gate valves.

3.07 JOINT CONSTRUCTION

A. Refer to Division 21 Section "Common Work Results for Fire Suppression" for basic piping joint construction.

B. Threaded Joints: Comply with NFPA 13 for pipe thickness and threads. Do not thread pipe smaller than NPS 8 with wall thickness less than Schedule 40 unless approved by authorities having jurisdiction and threads are checked by a ring gage and comply with ASME B1.20.1.

C. Grooved Joints: Assemble joints with listed coupling and gasket, lubricant, and bolts.
   2. Steel Pipe: Square-cut or roll-groove piping as indicated. Use grooved-end fittings and rigid, grooved-end-pipe couplings, unless otherwise indicated.
   4. Dry-Pipe Systems: Use fittings and gaskets listed for dry-pipe service.

D. Dissimilar-Metal Piping Joints: Construct joints using dielectric fittings compatible with both piping materials.
   1. NPS 2 and Smaller: Use dielectric unions, couplings, or nipples.
   2. NPS 2-1/2 to NPS 4: Use dielectric flanges.
   3. NPS 5 and Larger: Use dielectric flange insulation kits.

3.08 WATER-SUPPLY CONNECTION

A. Connect fire-suppression piping to building's interior water distribution piping. Refer to Division 22 Section "Domestic Water Piping" for interior piping.

B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water distribution piping. Refer to Division 22 Section "Domestic Water Piping Specialties" for backflow preventers.

3.09 PIPING INSTALLATION

A. Refer to Division 21 Section "Common Work Results for Fire Suppression" for basic piping installation.

B. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
   1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.

C. Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
D. Install unions adjacent to each valve in pipes NPS 2 and smaller. Unions are not required on flanged devices or in piping installations using grooved joints.

E. Install flanges or flange adapters on valves, apparatus, and equipment having NPS 2-1/2 and larger connections.

F. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, sized and located according to NFPA 13.

G. Install sprinkler piping with drains for complete system drainage.

H. Install sprinkler zone control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

I. Install drain valves on standpipes.

J. Install ball drip valves to drain piping between fire department connections and check valves. Drain to floor drain or outside building.

K. Install alarm devices in piping systems.

L. Hangers and Supports: Comply with NFPA 13 for hanger materials.
   1. Install standpipe system piping according to NFPA 14.
   2. Install sprinkler system piping according to NFPA 13.

M. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.

N. Pressurize and check dry-pipe sprinkler system piping and.

O. Fill wet-standpipe system piping with water.

P. Fill wet-pipe sprinkler system piping with water.

3.10 VALVE INSTALLATION

A. Install listed fire-protection valves, unlisted general-duty valves, specialty valves and trim, controls, and specialties according to NFPA 13 and NFPA 14 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Valves for Wall-Type Fire Hydrants: Install nonrising-stem gate valve in water-supply pipe.

D. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water supply sources.

E. Specialty Valves:
1. Alarm Check Valves: Install in vertical position for proper direction of flow, including bypass check valve and retarding chamber drain-line connection.

3.11 SPRINKLER APPLICATIONS

A. Drawings indicate sprinkler types to be used. Where specific types are not indicated, use the following sprinkler types:
   1. Rooms without Ceilings: Upright sprinklers.
   2. Rooms with Suspended Ceilings: Recessed sprinklers.
   4. Sprinkler Finishes:
      a. Upright, Pendant, and Sidewall Sprinklers: **Chrome plated** in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view.
      b. Recessed Sprinklers: **Bright chrome, with bright chrome escutcheon.**

3.12 SPRINKLER INSTALLATION

A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels and tiles as indicated on drawings.

B. Do not install pendant or sidewall, wet-type sprinklers in areas subject to freezing. Use dry-type sprinklers with water supply from heated space.

3.13 HOSE-CONNECTION INSTALLATION

A. Install hose connections adjacent to standpipes, unless otherwise indicated.

B. Install freestanding hose connections for access and minimum passage restriction.

C. Install NPS 2-1/2 hose connections with quick-disconnect NPS 2-1/2 by NPS 1-1/2 reducer adapter and flow-restricting device, unless otherwise indicated.

3.14 ROOF HOSE CABINET INSTALLATION

A. Install cabinets, and install shutoff valve inside building in heated space.

3.15 FIRE DEPARTMENT CONNECTION INSTALLATION

A. Install wall-type, fire department connections in vertical wall.

B. Install ball drip valve at each check valve for fire department connection.

3.16 CONNECTIONS

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

B. Install piping adjacent to equipment to allow service and maintenance.
C. Connect water-supply piping to fire-suppression piping. Include backflow preventer between potable-water piping and fire-suppression piping. Refer to Division 22 Section "Domestic Water Piping Specialties" for backflow preventers.

D. Install ball drip valves at each check valve for fire department connection. Drain to floor drain or outside building.

E. Connect piping to specialty valves, hose valves, specialties, fire department connections, and accessories.

F. Electrical Connections: Power wiring is specified in Division 26.

G. Connect alarm devices to fire alarm.

H. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

I. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

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

3.17 LABELING AND IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13 and NFPA 14.

3.18 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   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. Energize circuits to electrical equipment and devices.
   4. Start and run excess-pressure pumps.
   5. Start and run air compressors.
   7. Flush, test, and inspect standpipe systems according to NFPA 14, "System Acceptance" Chapter.
   8. Coordinate with fire alarm tests. Operate as required.
   9. Coordinate with fire-pump tests. Operate as required.
   10. Verify that equipment hose threads are same as local fire department equipment.

B. Report test results promptly and in writing to Architect and authorities having jurisdiction.

3.19 CLEANING AND PROTECTION

A. Clean dirt and debris from sprinklers.
B. Remove and replace sprinklers with paint other than factory finish.
C. Protect sprinklers from damage until Substantial Completion.

3.20 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specialty valves. Refer to Division 01 Section "Demonstration and Training."

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. This Section includes the following:
   1. Piping materials and installation instructions common to most piping systems.
   2. Transition fittings.
   3. Dielectric fittings.
   4. Mechanical sleeve seals.
   5. Sleeves.
   7. Grout.
   8. Equipment installation requirements common to equipment sections.
   10. Concrete bases.
   11. Supports and anchorages.

1.03 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
F. The following are industry abbreviations for plastic materials:
   2. CPVC: Chlorinated polyvinyl chloride plastic.
   3. PE: Polyethylene plastic.
   4. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:
   1. EPDM: Ethylene-propylene-diene terpolymer rubber.
   2. NBR: Acrylonitrile-butadiene rubber.

1.04 SUBMITTALS

A. Product Data: For the following:
   1. Dielectric fittings.
   2. Mechanical sleeve seals.
   3. Escutcheons.

1.05 QUALITY ASSURANCE

A. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.07 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."
PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.02 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.03 JOINING MATERIALS

A. Refer to individual Division 22 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
   2. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
   3. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
   4. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

F. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.04 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
D. Manufacturers:
   Capitol Manufacturing Co.
   Central Plastics Company.
   Eclipse, Inc.
   Epco Sales, Inc.
   Watts Industries, Inc.; Water Products Div.
   Zurn Industries, Inc.; Wilkins Div.

E. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
   1. Manufacturers:
      Capitol Manufacturing Co.
      Central Plastics Company.
      Epco Sales, Inc.
      Watts Industries, Inc.; Water Products Div.

F. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
   1. Manufacturers:
      Advance Products & Systems, Inc.
      Calpico, Inc.
      Central Plastics Company.
      Pipeline Seal and Insulator, Inc.
      Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.
   1. Manufacturers:
      Perfection Corp.
      Precision Plumbing Products, Inc.
      Sioux Chief Manufacturing Co., Inc.
      Victaulic Co. of America.

2.05 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch(0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
2.06 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw.
   1. Finish: Polished chrome-plated.

D. One-Piece, Stamped-Steel Type: With set screw and chrome-plated finish.

E. One-Piece, Floor-Plate Type: Cast-iron floor plate.

2.07 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
      Design Mix: 5000-psi, 28-day compressive strength.
   2. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.01 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

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

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

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

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.
J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
   1. New Piping:
      1. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
      2. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
      3. Insulated Piping: One-piece, stamped-steel type with spring clips.
      4. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
      5. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
      6. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with rough-brass finish.
      7. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type.
      8. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
   1. Cut sleeves to length for mounting flush with both surfaces.

   Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

   2. Install sleeves in new walls and slabs as new walls and slabs are constructed.

   Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

   Steel Pipe Sleeves: For pipes smaller than NPS 6.
   Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.

N. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

O. Verify final equipment locations for roughing-in.

P. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.
3.02 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA’s "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.


F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.03 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:
   - Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
   - Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
   1. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
   2. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.04 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.05 PAINTING

A. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.06 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project. Construct concrete bases of dimensions indicated, but not less than 6 inches larger in both directions than supported unit. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
   1. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
   2. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   3. Install anchor bolts to elevations required for proper attachment to supported equipment.
   4. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "[Cast-in-Place Concrete] [Miscellaneous Cast-in-Place Concrete]."

3.07 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.

3.08 GROUTING

A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.
D. Avoid air entrapment during placement of grout.
E. Place grout, completely filling equipment bases.
F. Place grout on concrete bases and provide smooth bearing surface for equipment.
G. Place grout around anchors.
H. Cure placed grout.

END OF SECTION
SECTION 22 05 13
COMMON MOTOR REQUIREMENTS FOR PLUMBING 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 requirements in this Section except when stricter requirements are specified
   in plumbing equipment schedules or Sections.

B. Comply with NEMA MG 1 unless otherwise indicated.

2.02 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 5,300 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. Rotor: Random-wound, squirrel cage.

E. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

F. Temperature Rise: Match insulation rating.

G. Insulation: Class F.

2.04 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 22 05 19
METERS AND GAGES FOR PLUMBING PIPING

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. Thermometers.
2. Gages.
3. Test plugs.
B. Related Sections:
1. Division 22 Section "Facility Water Distribution Piping" for domestic and fire-protection water service meters outside the building.
2. Division 22 Section "Domestic Water Piping" for domestic and fire-protection water service meters inside the building.
3. Division 23 Section "Facility Natural-Gas Piping" for gas meters.

1.03 DEFINITIONS
A. CR: Chlorosulfonated polyethylene synthetic rubber.
B. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.04 SUBMITTALS
A. Product Data: For each type of product indicated; include performance curves.
B. Shop Drawings: Schedule for thermometers and gages indicating manufacturer's number, scale range, and location for each.

PART 2 - PRODUCTS

2.01 METAL-CASE, LIQUID-IN-GLASS THERMOMETERS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Palmer - Wahl Instruments Inc.
2. Trerice, H. O. Co.
3. Weiss Instruments, Inc.
4. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

B. Case: [Die-cast aluminum] [Die-cast aluminum or brass] [Brass] [Chrome-plated brass], [7 inches] [9 inches] <Insert other> long.

C. Tube: Red or blue reading, [mercury] [mercury or organic-liquid] [organic-liquid] filled, with magnifying lens.

D. Tube Background: Satin-faced, nonreflective aluminum with permanently etched scale markings.

E. Window: [Glass] [Glass or plastic] [Plastic] <Insert other>.

F. Connector: [Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device] [Rigid, straight type] [Rigid, angle type].

G. Stem: Copper-plated steel, aluminum, or brass for thermowell installation and of length to suit installation.

H. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.02 PLASTIC-CASE, LIQUID-IN-GLASS THERMOMETERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Ernst Gage Co.
   2. Eugene Ernst Products Co.
   3. Marsh Bellofram.
   4. Miljoco Corp.
   5. Trerice, H. O. Co.
   6. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
   7. Winters Instruments.

B. Case: Plastic, [7 inches] [9 inches] <Insert other> long.

C. Tube: Red or blue reading, mercury or organic-liquid filled, with magnifying lens.

D. Tube Background: Satin-faced, nonreflective aluminum with permanently etched scale markings.

E. Window: Glass or plastic.

F. Connector: [Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device] [Rigid, straight type] [Rigid, angle type].

G. Stem: Metal, for thermowell installation and of length to suit installation.

H. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.
2.03 THERMOWELLS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AMETEK, Inc.; U.S. Gauge Div.
3. Ernst Gage Co.
5. Miljoco Corp.
6. NANMAC Corporation.
7. Noshok, Inc.
8. Palmer - Wahl Instruments Inc.
9. REO TEMP Instrument Corporation.
10. Tel-Tru Manufacturing Company.
11. Trerice, H. O. Co.
12. Weiss Instruments, Inc.
13. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
14. WIKA Instrument Corporation.
15. Winters Instruments.

B. Manufacturers: Same as manufacturer of thermometer being used.

C. Description: Pressure-tight, socket-type metal fitting made for insertion into piping and of type, diameter, and length required to hold thermometer.

2.04 PRESSURE GAGES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AMETEK, Inc.; U.S. Gauge Div.
3. Ernst Gage Co.
4. Eugene Ernst Products Co.
5. KOBOLD Instruments, Inc.
7. Miljoco Corp.
8. Noshok, Inc.
10. REO TEMP Instrument Corporation.
11. Trerice, H. O. Co.
12. Weiss Instruments, Inc.
13. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
14. WIKA Instrument Corporation.
15. Winters Instruments.

B. Direct-Mounting, Dial-Type Pressure Gages: Indicating-dial type complying with ASME B40.100.

1. Case: [Dry] [Liquid-filled] type, [drawn steel or cast aluminum] [metal or plastic] [plastic], [4-1/2-inch] [6-inch] <Insert other> diameter.
2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
3. Pressure Connection: Brass, NPS 1/4 (DN 8), bottom-outlet type unless back-outlet type is indicated.
4. Movement: Mechanical, with link to pressure element and connection to pointer.

METERS AND GAGES FOR PLUMBING PIPING
7. Window: [Glass] [Glass or plastic] [Plastic] <Insert other>.
8. Ring: [Metal] [Brass] [Stainless steel] [Metal or plastic] [Plastic].
9. Accuracy: Grade [A, plus or minus 1 percent of middle half] [B, plus or minus 2 percent of middle half] [C, plus or minus 3 percent of middle half] [D, plus or minus 5 percent of whole] scale.
10. Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure (100 kPa of vacuum to 103 kPa of pressure).
11. Range for Fluids under Pressure: Two times operating pressure.

C. Pressure-Gage Fittings:
1. Valves: NPS 1/4 (DN 8) brass or stainless-steel needle type.
2. Snubbers: ASME B40.5, NPS 1/4 (DN 8) brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

2.05 TEST PLUGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Flow Design, Inc.
   2. MG Piping Products Co.
   4. Peterson Equipment Co., Inc.
   5. Sisco Manufacturing Co.
   6. Trerice, H. O. Co.

B. Description: Corrosion-resistant brass or stainless-steel body with core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping.

C. Minimum Pressure and Temperature Rating: [500 psig at 200 deg F] <Insert other>.

D. Core Inserts: One or two self-sealing rubber valves.
   1. Insert material for water service at 20 to 200 deg F (minus 7 to plus 93 deg C) shall be CR.
   2. Insert material for water service at minus 30 to plus 275 deg F (minus 35 to plus 136 deg C) shall be EPDM.

PART 3 - EXECUTION

3.01 THERMOMETER APPLICATIONS

A. Install liquid-in-glass thermometers in the outlet of each domestic, hot-water storage tank.

B. Install [dry] [liquid-filled]-case-type thermometers at suction and discharge of each pump.

C. Provide the following temperature ranges for thermometers:
   1. Domestic Hot Water: [30 to 180 deg F, with 2-degree scale divisions] [30 to 240 deg F, with 2-degree scale divisions] <Insert other>.
2. Domestic Cold Water: [0 to 100 deg F, with 2-degree scale divisions] [30 to 130 deg F, with 2-degree scale divisions] <Insert other>.

3.02 GAGE APPLICATIONS

A. Install dry-case-type pressure gages for discharge of each pressure-reducing valve.

B. Install [dry] [liquid-filled]-case-type pressure gages at suction and discharge of each pump.

3.03 INSTALLATIONS

A. Install direct-mounting thermometers and adjust vertical and tilted positions.

B. Install thermowells with socket extending [a minimum of 2 inches into fluid] [one-third of diameter of pipe] [to center of pipe] and in vertical position in piping tees where thermometers are indicated.

C. Install direct-mounting pressure gages in piping tees with pressure gage located on pipe at most readable position.

D. Install needle-valve and snuber fitting in piping for each pressure gage.

E. Install test plugs in tees in piping.

F. Install thermometers and gages adjacent to machines and equipment to allow service and maintenance for thermometers, gages, machines, and equipment.

G. Adjust faces of thermometers and gages to proper angle for best visibility.

END OF SECTION
SECTION 22 05 23
GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following general-duty valves:
   1. Copper-alloy ball valves.
   2. Ferrous-alloy butterfly valves.
   4. Spring-loaded, lift-disc check valves.
   5. Bronze gate valves.

B. Related Sections include the following:
   1. Division 22 Section "Identification for Plumbing Piping and Equipment" for valve tags and charts.
   2. Division 22 piping Sections for specialty valves applicable to those Sections only.

1.03 DEFINITIONS

A. The following are standard abbreviations for valves:
   1. CWP: Cold working pressure.
   2. EPDM: Ethylene-propylene-diene terpolymer rubber.
   3. NBR: Acrylonitrile-butadiene rubber.
   4. PTFE: Polytetrafluoroethylene plastic.
   5. TFE: Tetrafluoroethylene plastic.

1.04 SUBMITTALS

A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

1.05 QUALITY ASSURANCE

A. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.
B. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.06 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.
   4. Set butterfly valves closed or slightly open.
   5. 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

2.01 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.02 VALVES, GENERAL

A. Refer to Part 3 "Valve Applications" Article for applications of valves.

B. Bronze Valves: NPS 2 and smaller with threaded ends, unless otherwise indicated.

C. Ferrous Valves: NPS 2-1/2 and larger with flanged ends, unless otherwise indicated.

D. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

E. Valve Sizes: Same as upstream pipe, unless otherwise indicated.

F. Valve Actuators:
   1. Handwheel: For valves other than quarter-turn types.
   2. Lever Handle: For quarter-turn valves NPS 6 and smaller, except plug valves.
   3. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 10 plug valves, for each size square plug head.

G. Extended Valve Stems: On insulated valves.

2.03 COPPER-ALLOY BALL VALVES

A. Manufacturers:

1. Three-Piece, Copper-Alloy Ball Valves:
   b. DynaQuip Controls.
   c. Hammond Valve.
   d. Jamesbury, Inc.
   e. Kitz Corporation of America.
   f. NIBCO INC.
   g. Worcester Controls.

B. Copper-Alloy Ball Valves, General: MSS SP-110.

C. Two-Piece, Copper-Alloy Ball Valves: Bronzebody with full-port, chrome-plated bronze ball; PTFE seats; and 600-psig minimum CWP rating and blowout-proof stem.

D. Three-Piece, Copper-Alloy Ball Valves: Bronzebody with full-port, chrome-plated bronze ball; PTFE seats; and 600-psig minimum CWP rating and blowout-proof stem.

2.04 FERROUS-ALLOY BUTTERFLY VALVES

A. Manufacturers:

1. Flanged, Ferrous-Alloy Butterfly Valves:
   b. Grinnell Corporation.

B. Ferrous-Alloy Butterfly Valves, General: MSS SP-67, Type I, for tight shutoff, with disc and lining suitable for potable water, unless otherwise indicated.

C. Flanged, 150-psig CWP Rating, Ferrous-Alloy Butterfly Valves: Flanged-end type with [one] [one- or two] [two]-piece stem.

2.05 BRONZE CHECK VALVES

A. Manufacturers:

1. Type 1, Bronze, Vertical Lift Check Valves with Metal Disc:
   a. Cincinnati Valve Co.
   b. Crane Co.; Crane Valve Group; Crane Valves.
   c. Crane Co.; Crane Valve Group; Jenkins Valves.
   d. Red-White Valve Corp.

2. Type 3, Bronze, Swing Check Valves with Metal Disc:
   a. American Valve, Inc.
   b. Cincinnati Valve Co.
c. Crane Co.; Crane Valve Group; Crane Valves.
d. Crane Co.; Crane Valve Group; Jenkins Valves.
e. Crane Co.; Crane Valve Group; Stockham Div.
f. Grinnell Corporation.
g. Hammond Valve.
h. Kitz Corporation of America.
i. Legend Valve & Fitting, Inc.
j. Milwaukee Valve Company.
k. NIBCO INC.
l. Powell, Wm. Co.
m. Red-White Valve Corp.
n. Walworth Co.
o. Watts Industries, Inc.; Water Products Div.

B. Bronze Check Valves, General: MSS SP-80.

C. Type 3, Class 125, Bronze, Swing Check Valves: Bronze body with bronze disc and seat.

2.06 SPRING-LOADED, LIFT-DISC CHECK VALVES

A. Manufacturers:
   1. Type I, Wafer Lift-Disc Check Valves:
      a. Mueller Steam Specialty.

   2. Type II, Compact-Wafer, Lift-Disc Check Valves:
      a. Durabla Fluid Technology, Inc.
      b. Flomatic Valves.
      c. GA Industries, Inc.
      d. Grinnell Corporation.
      e. Hammond Valve.
      f. Metraflex Co.
      g. Milwaukee Valve Company.
      h. Mueller Steam Specialty.
      i. Multiplex Manufacturing Co.
      j. NIBCO INC.
      k. SSI Equipment, Inc.
      m. Valve and Primer Corp.

   3. Type III, Globe Lift-Disc Check Valves:
      a. Durabla Fluid Technology, Inc.
      b. Flomatic Valves.
      c. GA Industries, Inc.
      d. Grinnell Corporation.
      e. Hammond Valve.
      f. Metraflex Co.
      g. Milwaukee Valve Company.
      h. Multiplex Manufacturing Co.
      i. NIBCO INC.
      j. SSI Equipment, Inc.
      l. Valve and Primer Corp.

GENERAL-DUTY VALVES FOR PLUMBING PIPING
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4. Type IV, Threaded Lift-Disc Check Valves:
   a. Check-All Valve Mfg. Co.
   b. Durabla Fluid Technology, Inc.
   c. Grinnell Corporation.
   d. Legend Valve & Fitting, Inc.
   e. Metraflex Co.
   f. Milwaukee Valve Company.
   g. Mueller Steam Specialty.
   h. NIBCO INC.
   i. Watts Industries, Inc.; Water Products Div.

B. Lift-Disc Check Valves, General: FCI 74-1, with spring-loaded bronze or alloy disc and bronze or alloy seat.

C. Type I, Class 125, Wafer Lift-Disc Check Valves: Wafer style with cast-iron shell with diameter matching companion flanges.

D. Type I, Class 250, Wafer Lift-Disc Check Valves: Wafer style with cast-iron shell with diameter matching companion flanges.

E. Type II, Class 125, Compact-Wafer, Lift-Disc Check Valves: Compact-wafer style with cast-iron shell with diameter made to fit within bolt circle.

F. Type II, Class 250, Compact-Wafer, Lift-Disc Check Valves: Compact-wafer style with cast-iron shell with diameter made to fit within bolt circle.

G. Type III, Class 125, Globe Lift-Disc Check Valves: Globe style with cast-iron shell and flanged ends.

H. Type III, Class 250, Globe Lift-Disc Check Valves: Globe style with cast-iron shell and flanged ends.

I. Type IV, Class 125, Threaded Lift-Disc Check Valves: Threaded style with bronze shell and threaded ends.

J. Type IV, Class 150, Threaded Lift-Disc Check Valves: Threaded style with bronze shell and threaded ends.

2.07 BRONZE GATE VALVES

A. Available Manufacturers:

B. Manufacturers:
   1. Type 1, Bronze, Nonrising-Stem Gate Valves:
      a. American Valve, Inc.
      b. Cincinnati Valve Co.
      c. Crane Co.; Crane Valve Group; Crane Valves.
      d. Crane Co.; Crane Valve Group; Jenkins Valves.
      e. Crane Co.; Crane Valve Group; Stockham Div.
      f. Grinnell Corporation.
      g. Hammond Valve.
      h. Kitz Corporation of America.
      i. Legend Valve & Fitting, Inc.
      j. Milwaukee Valve Company.
2. Type 2, Bronze, Rising-Stem, Solid-Wedge Gate Valves:
   a. American Valve, Inc.
   b. Cincinnati Valve Co.
   c. Crane Co.; Crane Valve Group; Crane Valves.
   d. Crane Co.; Crane Valve Group; Jenkins Valves.
   e. Crane Co.; Crane Valve Group; Stockham Div.
   f. Grinnell Corporation.
   g. Hammond Valve.
   h. Kitz Corporation of America.
   i. Milwaukee Valve Company.
   j. NIBCO INC.
   k. Powell, Wm. Co.
   l. Red-White Valve Corp.
   m. Walworth Co.

C. Bronze Gate Valves, General: MSS SP-80, with ferrous-alloy handwheel.

D. Type 1, Class 125, Bronze Gate Valves: Bronze body with nonrising stem and bronze solid wedge [and union-ring bonnet].

E. Type 2, Class 125, Bronze Gate Valves: Bronze body with rising stem and bronze solid wedge [and union-ring bonnet].

2.08 CAST-IRON PLUG VALVES

A. Available Manufacturers:

B. Manufacturers:
   1. Lubricated-Type, Cast-Iron Plug Valves:
      a. Milliken Valve Co., Inc.
      b. Nordstrom Valves, Inc.
      c. Olson Technologies; Homestead Div.
      e. Walworth Co.

C. Cast-Iron Plug Valves, General: MSS SP-78.

D. Class 125 or 150, lubricated-type, cast-iron plug valves.

E. Class 250 or 300, lubricated-type, cast-iron plug valves.
PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

B. 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.

C. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

D. Examine threads on valve and mating pipe for form and cleanliness.

E. 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.

F. Do not attempt to repair defective valves; replace with new valves.

3.02 VALVE APPLICATIONS

A. Refer to piping Sections for specific valve applications. If valve applications are not indicated, use the following:
   1. Shutoff Service: Ball, butterfly, or gate valves.

B. If valves with specified CWP ratings are not available, the same types of valves with higher CWP ratings may be substituted.

C. Domestic Water Piping: Use the following types of valves:
   1. Ball Valves, NPS 2 and Smaller: One, Two, Three-piece, 600-psig CWP rating, copper alloy.
   2. Ball Valves, NPS 2-1/2 and Larger: Class 150, ferrous alloy.
   4. Lift Check Valves, NPS 2 and Smaller: Type 2, Class 125, horizontal or vertical, bronze.
   5. Swing Check Valves, NPS 2 and Smaller: Type 4, Class 125, bronze.
   6. Swing Check Valves, NPS 2-1/2 and Larger: Type II, Class 125, gray iron.
   7. Spring-Loaded, Lift-Disc Check Valves, NPS 2 and Smaller: Type IV, Class 125 minimum.
   8. Plug Valves, NPS 2 and Larger: Class 125 or 150, lubricated-type with FDA-approved-material sealant, cast iron.

D. Select valves, except wafer and flangeless types, with the following end connections:
   1. For Copper Tubing, NPS 2 and Smaller: Solder-joint or threaded ends.
   2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged [or threaded] ends.
   3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
3.03 VALVE INSTALLATION

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

C. Locate valves for easy access and provide separate support where necessary.

D. Install valves in horizontal piping with stem at or above center of pipe.

E. Install valves in position to allow full stem movement.

F. Install check valves for proper direction of flow and as follows:
   1. Swing Check Valves: In horizontal position with hinge pin level.
   2. Dual-Plate Check Valves: In horizontal or vertical position, between flanges.
   3. Lift Check Valves: With stem upright and plumb.

3.04 JOINT CONSTRUCTION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for basic piping joint construction.

B. Grooved Joints: Assemble joints with keyed coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

C. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.05 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.

END OF SECTION
SECTION 22 05 29
HANGERS AND SUPPORTS FOR PLUMBING 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. This Section includes the following hangers and supports for plumbing system piping and equipment:
   1. Steel pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Metal framing systems.
   4. Thermal-hanger shield inserts.
   5. Fastener systems.
   6. Pipe positioning systems.
   7. Equipment supports.
B. Related Sections include the following:
   1. List below only products that the reader might expect to find in this Section but are specified elsewhere.
   2. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
   3. Division 21 Section "Water-Based Fire-Suppression Systems" for pipe hangers for fire-suppression piping.
   4. Division 22 Section "Expansion Fittings and Loops for Plumbing Piping" for pipe guides and anchors.
   5. Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for vibration isolation devices.

1.03 DEFINITIONS
A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.
B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.04 PERFORMANCE REQUIREMENTS
A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
1.05 SUBMITTALS

A. Product Data: For the following:
   1. Steel pipe hangers and supports.
   2. Thermal-hanger shield inserts.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
   1. Trapeze pipe hangers. Include Product Data for components.
   2. Metal framing systems. Include Product Data for components.

C. Welding certificates.

1.06 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to [AWS D1.1, "Structural Welding Code--Steel."] [AWS D1.4, "Structural Welding Code--Reinforcing Steel."]

B. Welding: Qualify procedures and personnel according to the following:
   1. AWS D1.1, "Structural Welding Code--Steel.">
   3. AWS D1.4, "Structural Welding Code--Reinforcing Steel."

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

B. Manufacturers:
   2. ERICO/Michigan Hanger Co.
   3. Grinnell Corp.
   4. PHD Manufacturing, Inc.
   5. Tolco Inc.

C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.
2.03 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.04 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

B. Manufacturers:
   2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
   3. Tolco Inc.

C. Coatings: Manufacturer's standard finish unless bare metal surfaces are indicated.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.05 THERMAL-HANGER SHIELD INSERTS

A. Description: 100-psig- minimum, compressive-strength insulation insert encased in sheet metal shield.

B. Manufacturers:
   1. Pipe Shields, Inc.
   2. Value Engineered Products, Inc.

C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with vapor barrier.

D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate.

E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

G. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.06 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
   1. Manufacturers:
      a. Hilti, Inc.
      b. ITW Ramset/Red Head.
      c. Masterset Fastening Systems, Inc.
      d. MKT Fastening, LLC.
B. Mechanical-Expansion Anchors: Insert-wedge-type [zinc-coated][stainless] steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers:
   b. Empire Industries, Inc.
   c. Hilti, Inc.
   d. ITW Ramset/Red Head.
   e. MKT Fastening, LLC.
   f. Powers Fasteners.

2.07 EQUIPMENT SUPPORTS

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

2.08 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.01 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use padded hangers for piping that is subject to scratching.

F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 2, little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8.
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.
10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8.
11. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
16. 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.
17. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint 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.

J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
   a. Horizontal (MSS Type 54): Mounted horizontally.
   b. Vertical (MSS Type 55): Mounted vertically.
   c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

N. Use [powder-actuated fasteners] [or] [mechanical-expansion anchors] instead of building attachments where required in concrete construction.

O. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

3.02 HANGER AND SUPPORT INSTALLATION

A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
   2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
C. 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. Install hangers and supports complete with necessary 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. Install lateral bracing with pipe hangers and supports to prevent swaying.

J. 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.

K. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.

M. Insulated Piping: Comply with the following:
   1. Attach clamps and spacers to piping.
      a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
      b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
      c. Do not exceed pipe stress limits according to ASME B31.9 for building services piping.
   2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
      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 inserts.
6. Insert Material: Length at least as long as protective shield.
7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.03 EQUIPMENT SUPPORTS
A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
B. Grouting: Place grout under supports for equipment and make smooth bearing surface.
C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.04 METAL FABRICATIONS
A. Cut, drill, and fit miscellaneous metal fabrications for [trapeze pipe hangers] [and] [equipment supports].
B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.05 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] <Insert other>.
3.06 PAINTING

A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 [painting Sections.] [Section "High-Performance Coatings."

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION
SECTION 22 05 53
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

1.01 GENERAL

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

1.03 SUMMARY
A. Section Includes:
   1. Equipment labels.
   2. Warning signs and labels.
   3. Pipe labels.
   4. Valve tags.
   5. Warning tags.

1.04 SUBMITTALS
A. Product Data: For each type of product indicated.
B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
C. Valve numbering scheme.
D. Valve Schedules: For each piping system to include in maintenance manuals.

1.05 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. 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.
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.

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.

2.02 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] [Blue] [Red] [White] [Yellow] <Insert color>.

C. Background Color: [Black] [Blue] [Red] [White] [Yellow] <Insert color>.

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] [rivets or self-tapping screws] [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. 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.

2.04 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, 1-1/2" diameter, 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.

2.05 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] <Insert size>.
   2. Fasteners: [Brass grommet and wire] [Reinforced grommet and wire or string].
   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: Provide color coding in accordance with ANSI A13.1.

3.04 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.

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 22 07 00
PLUMBING INSULATION

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. Insulation Materials:
   a. Mineral fiber.
2. Insulating cements.
3. Adhesives.
5. Sealants.
6. Factory-applied jackets.
7. Field-applied jackets.

B. Related Sections include the following:
1. Division 21 Section "Fire-Suppression Systems Insulation."
2. Division 23 Section "HVAC Insulation."

1.03 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).

1.04 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.
1.05 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.

1.06 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application and equipment Installer for equipment insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.07 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

2.01 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Mineral-Fiber, Preformed Pipe Insulation:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Johns Manville; Micro-Lok.
      b. Knauf Insulation; 1000(Pipe Insulation.
      c. Manson Insulation Inc.; Alley-K.
      d. 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. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

D. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ [FSK jacket] complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. CertainTeed Corp.; CrimpWrap.
   b. Johns Manville; MicroFlex.
   c. Knauf Insulation; Pipe and Tank Insulation.
   d. Manson Insulation Inc.; AK Flex.
   e. Owens Corning; Fiberglas Pipe and Tank Insulation.

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. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; CP-82.
      c. ITW TACC, Division of Illinois Tool Works; S-90/80.
      d. Marathon Industries, Inc.; 225.
      e. Mon-Eco Industries, Inc.; 22-25.

C. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; CP-82.
      c. ITW TACC, Division of Illinois Tool Works; S-90/80.
      d. Marathon Industries, Inc.; 225.
      e. Mon-Eco Industries, Inc.; 22-25.

2.03 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.

2.04 SEALANTS

A. ASJ Flashing Sealants:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; CP-76.
   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.

2.05 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.06 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 PVC 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.

5. Factory-fabricated tank heads and tank side panels.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
   1. Verify that systems and equipment to be insulated have been tested and are free of defects.
   2. Verify that surfaces to be insulated are clean and dry.
   3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
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 equipment and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment and pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer’s recommended coverage rate and wet and dry film thicknesses.

L. 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.
      a. For below ambient services, apply vapor-barrier mastic over staples.
4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.

5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to 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.
   5. Handholes.
   6. Cleanouts.

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 Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

C. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
   1. Comply with requirements in Division 07 Section "Penetration Firestopping." Fire-resistive joint sealers.

D. Insulation Installation at Floor Penetrations:
   1. Pipe: Install insulation continuously through floor penetrations.
   2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."
3.05  EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

A. Mineral Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.
   1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for [100][50] <Insert percentage> percent coverage of tank and vessel surfaces.
   2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
   3. Protect exposed corners with secured corner angles.
   4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
      a. Do not weld anchor pins to ASME-labeled pressure vessels.
      b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
      c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
      d. Do not overcompress insulation during installation.
      e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
      f. Impale insulation over anchor pins and attach speed washers.
      g. 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.
   5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
   6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
   7. Stagger joints between insulation layers at least 3 inches.
   8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
   9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
  10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

3.06  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, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches 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.

3.07 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
   2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
   4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
   4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, 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.
3.08 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:
   1. Draw jacket material smooth and tight.
   2. Install lap or joint strips with same material as jacket.
   3. Secure jacket to insulation with manufacturer's recommended adhesive.
   4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
   5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
   1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

3.09 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
   1. Drainage piping located in crawl spaces.
   2. Underground piping.
   3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.10 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water:
   1. [NPS 1] <Insert pipe size> and Smaller: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: [1/2 inch] [1 inch] <Insert thickness> thick.

2. [NPS 1-1/4] <Insert pipe size> and Larger: Insulation shall be the following:
   a. Mineral-Fiber, Preformed Pipe Insulation, Type I: [1 inch] <Insert thickness> thick.

B. Domestic Hot and Recirculated Hot Water:
   1. [NPS 1-1/4] <Insert pipe size> and Smaller: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: [1/2 inch] [1 inch] <Insert thickness> thick.

2. [NPS 1-1/2] <Insert pipe size> and Larger: Insulation shall be the following:
   a. Mineral-Fiber, Preformed Pipe Insulation, Type I: [1 inch] <Insert thickness> thick.

C. Stormwater and Overflow:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: [1 inch] <Insert thickness> thick.
D. Roof Drain and Overflow Drain Bodies:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: [1 inch] <Insert thickness> thick.

E. Condensate and Equipment Drain Water below 60 Deg F:
   1. All Pipe Sizes: Insulation shall be [one of] the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: [1/2 inch] [1 inch] <Insert thickness> thick.

END OF SECTION
SECTION 22 11 16
DOMESTIC WATER PIPING

PART 1 - GENERAL

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

1.02 SUMMARY
   A. This Section includes domestic water piping and water meters inside the building.
   B. Water meters will be furnished and installed by utility company.
   C. Water meters will be furnished by utility company for installation by Contractor.
   D. Related Sections include the following:
      1. Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers,
         pressure gages, and fittings.
      2. Division 22 Section "Facility Water Distribution Piping" for water-service
         piping and water meters outside the building from source to the point where
         water-service piping enters the building.
      3. Division 22 Section "Domestic Water Piping Specialties" for water distribution
         piping specialties.

1.03 PERFORMANCE REQUIREMENTS
   A. Provide components and installation capable of producing domestic water piping systems
      with 125 psig, unless otherwise indicated.

1.04 SUBMITTALS
   A. Product Data: For pipe, tube, fittings, and couplings and water meters.
   C. Field quality-control test reports.

1.05 QUALITY ASSURANCE
   A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
   B. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1
      through 9," for potable domestic water piping and components.
PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 PIPING MATERIALS

A. Refer to Part 3 "Pipe and Fitting Applications" Article for applications of pipe, tube, fitting, and joining materials.

B. Transition Couplings for Aboveground Pressure Piping: Coupling or other manufactured fitting the same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

2.03 COPPER TUBE AND FITTINGS

A. Soft Copper Tube: ASTM B 88, Types K and L, water tube, annealed temper.
   2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Furnish Class 300 flanges if required to match piping.
   3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

B. Hard Copper Tube: ASTM B 88, Types L and M, water tube, drawn temper.
   2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Furnish Class 300 flanges if required to match piping.
   3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
   4. Copper, Grooved-End Fittings: ASTM B 75 copper tube or ASTM B 584 bronze castings.
      a. Grooved-End-Tube Couplings: Copper-tube dimensions and design similar to AWWA C606. Include ferrous housing sections, gasket suitable for hot water, and bolts and nuts.

2.04 VALVES

A. Bronze and cast-iron, general-duty valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

B. Balancing and drain valves are specified in Division 22 Section "Domestic Water Piping Specialties."
2.05 WATER METERS

A. Displacement-Type Water Meters NPS 2 and Smaller: AWWA C700, nutating-disc totalization meter with bronze case and 150-psig minimum working-pressure rating; with registration in gallons or cubic feet as required by utility; and with threaded end connections.

1. Manufacturers:
   a. ABB.
   b. Badger Meter, Inc.
   c. Carlon Meter Company Inc.
   e. Mueller Company.
   f. Schlumberger Limited; Water Div.
   g. Venture Measurement.

B. Turbine-Type Water Meters: AWWA C701, totalization meter with \([150\text{-psig}]\) minimum working-pressure rating; with registration in gallons or cubic feet as required by utility; and with the following end connections:

1. NPS 2 and Smaller: Threaded.
2. NPS 2-1/2 and Larger: Flanged.

3. Manufacturers:
   a. ABB.
   b. Badger Meter, Inc.
   c. Hays Fluid Controls.
   e. Master Meter, Inc.
   f. McCrometer.
   g. Mueller Company.
   h. Schlumberger Limited; Water Div.
   i. SeaMetrics Inc.
   j. Venture Measurement.

C. Compound-Type Water Meters NPS 3 and Larger: AWWA C702, totalization meter with integral main-line and bypass meters, bronze case, and 150-psig minimum working-pressure rating; with registration in gallons or cubic feet as required by utility; and with flanged end connections.

1. Manufacturers:
   a. ABB.
   b. Badger Meter, Inc.
   d. Master Meter, Inc.
   e. Mueller Company.
   f. Schlumberger Limited; Water Div.

D. Fire-Service Water Meters: AWWA C703 and UL-listed, totalization meter with 175-psig minimum working-pressure rating; with registration in gallons or cubic feet as required by utility; and with the following end connections:

1. NPS 2 and Smaller: Threaded.
2. NPS 2-1/2 and Larger: Flanged.
3. Manufacturers:
   a. Badger Meter, Inc.
   c. Mueller Company.
   d. Schlumberger Limited; Water Div.

4. Proportional, Detector-Type Water Meters: With meter on bypass.
a. Bypass Meter: [AWWA C701, turbine] [AWWA C702, compound] type with bronze case; size not less than one-half nominal size of main-line meter.

5. Turbine-Type Water Meters: With strainer and with meter on bypass.
   a. Strainer: Full size, matching water meter.
   b. Bypass Meter: AWWA C701, turbine type with bronze case; not less than NPS 2.

E. Remote Registration System: Direct-reading type complying with AWWA C706; modified with signal transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility.

F. Remote Registration System: Encoder-type complying with AWWA C707; modified with signal transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility.

PART 3 - EXECUTION

3.01 EXCAVATION

A. Excavating, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

3.02 PIPE AND FITTING APPLICATIONS

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 may be used on aboveground piping, unless otherwise indicated.

C. Aboveground Domestic Water Piping: Use the following piping materials for each size range:
   1. NPS 1-1/2 and Smaller: Hard copper tube, [Type L] [Type K]; copper pressure fittings; and soldered joints.
   2. NPS 2 and Larger: Hard copper tube, [Type L] [Type K]; copper pressure fittings; and soldered joints.

D. Non-Potable-Water Piping: Use the following piping materials for each size range:
   1. NPS 3-1/2 and Smaller: Hard copper tube, [Type L] [Type M]; copper pressure fittings; and soldered joints.

3.03 VALVE APPLICATIONS

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
   1. Shutoff Duty: Use bronze ball or gate valves for piping NPS 2 and smaller. Use cast-iron butterfly or gate valves with flanged ends for piping NPS 2-1/2 and larger.
2. Throttling Duty: Use bronze ball or globe valves for piping NPS 2 and smaller. Use cast-iron butterfly valves with flanged ends for piping NPS 2-1/2 and larger.


B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball or gate valves for piping NPS 2 and smaller. Use butterfly or gate valves for piping NPS 2-1/2 and larger.

C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping.
   1. Install hose-end drain valves at low points in water mains, risers, and branches.
   2. Install stop-and-waste drain valves where indicated.

3.04 PIPING INSTALLATION

A. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."

B. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Pressure gages are specified in Division 22 Section "Meters and Gages for Plumbing Piping," and drain valves and strainers are specified in Division 22 Section "Domestic Water Piping Specialities."

C. Install water-pressure regulators downstream from shutoff valves. Water-pressure regulators are specified in Division 22 Section "Domestic Water Piping Specialities."

D. Install domestic water piping level and plumb.

E. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

3.05 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."

B. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.06 WATER METER INSTALLATION

A. Rough-in domestic water piping [for water meter installation] [and install water meters] according to utility company's requirements.

B. Water meters will be furnished and installed by utility company.

C. Install water meters according to AWWA M6 and utility's requirements.
   1. Install displacement-type water meters with shutoff valve on water-meter inlet. Install valve on water-meter outlet and valved bypass around meter unless prohibited by authorities having jurisdiction.
2. Install turbine-type water meters with shutoff valve on water-meter inlet. Install valve on water-meter outlet and valved bypass around meter unless prohibited by authorities having jurisdiction.

3. Install compound-type water meters with shutoff valves on water-meter inlet and outlet and on valved bypass around meter. Support meters, valves, and piping on brick or concrete piers.

4. Install fire-service water meters with shutoff valves on water-meter inlet and outlet and on full-size valved bypass around meter. Support meter, valves, and piping on brick or concrete piers.

5. Install remote registration system according to standards of utility and of authorities having jurisdiction.

3.07 HANGER AND SUPPORT INSTALLATION

A. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Pipe hanger and support devices are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:
1. Vertical Piping: MSS Type 8 or Type 42, clamps.
2. Individual, Straight, Horizontal Piping Runs: According to the following:
   a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
   c. Longer Than 100 Feet: MSS Type 49, spring cushion rolls, if indicated.
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. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

D. Support vertical piping and tubing at base and at each floor.

E. Rod diameter may be reduced 1 size for double-rod hangers, to a minimum of 3/8 inch.

F. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
2. NPS 1-1/2: 108 inches with 3/8-inch rod.
3. NPS 2: 10 feet with 3/8-inch rod.
4. NPS 2-1/2: 11 feet with 1/2-inch rod.
5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
7. NPS 6: 12 feet with 3/4-inch rod.
8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.

G. Install supports for vertical steel piping every 15 feet.

H. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
4. NPS 2-1/2: 108 inches with 1/2-inch rod.
5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
6. NPS 6: 10 feet with 5/8-inch rod.
7. NPS 8: 10 feet with 3/4-inch rod.

I. Install supports for vertical copper tubing every 10 feet.

J. Install hangers for CPVC piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1 and Smaller: 36 inches with 3/8-inch rod.
   2. NPS 1-1/4 to NPS 2: 48 inches with 3/8-inch rod.
   3. NPS 2-1/2 to NPS 3-1/2: 48 inches with 1/2-inch rod.
   4. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
   5. NPS 6: 48 inches with 3/4-inch rod.
   6. NPS 8: 48 inches with 7/8-inch rod.

K. Install supports for vertical CPVC piping every 60 inches for NPS 1 and smaller, and every 72 inches for NPS 1-1/4 and larger.

L. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 2 and Smaller: 48 inches with 3/8-inch rod.
   2. NPS 2-1/2 to NPS 3-1/2: 48 inches with 1/2-inch rod.
   3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
   4. NPS 6: 48 inches with 3/4-inch rod.
   5. NPS 8: 48 inches with 7/8-inch rod.

M. Install supports for vertical PVC piping every 48 inches.

N. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.08 CONNECTIONS

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

B. Install piping adjacent to equipment and machines to allow service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve, and extend and connect to the following:
   1. Water Heaters: Cold-water supply and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
   2. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Refer to Division 22 Section "Plumbing Fixtures."
   3. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.
3.09  FIELD QUALITY CONTROL

A. Inspect domestic water piping as follows:
1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
2. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
   a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
   b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
3. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

B. Test domestic water piping as follows:
1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
4. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

3.10  ADJUSTING

A. Perform the following adjustments before operation:
1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
   a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
   b. Adjust calibrated balancing valves to flows indicated.
5. Remove plugs used during testing of piping and plugs used for temporary sealing of piping during installation.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.
3.11 CLEANING

A. Clean and disinfect potable and non-potable domestic water piping as follows:
   1. Purge new piping and parts of existing domestic water piping that have been altered, extended, or repaired before using.
   2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction or, if methods are not prescribed, procedures described in either AWWA C651 or AWWA C652 or as described below:
      a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
      b. Fill and isolate system according to either of the following:
         1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
         2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
      c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
      d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

B. Prepare and submit reports of purging and disinfecting activities.

C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

END OF SECTION
SECTION 22 11 19
DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following domestic water piping specialties:
   1. Backflow preventers.
   2. Water pressure-reducing valves.
   3. Temperature-actuated water mixing valves.
   4. Strainers.
   5. Outlet boxes.
   6. Hose stations.
   7. Wall hydrants.
   8. Drain valves.
   10. Trap-seal primer valves.

B. Related Sections include the following:
   1. Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers, pressure gages, and flow meters in domestic water piping.
   2. Division 22 Section "Domestic Water Piping" for water meters.
   3. Division 22 Section "Drinking Fountains and Water Coolers" for water filters for water coolers.

1.03 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.04 SUBMITTALS

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

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.
1.05 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. NSF Compliance:
2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

PART 2 - PRODUCTS

2.01 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers <Insert drawing designation if any>:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. FEBCO; SPX Valves & Controls.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: [12 psig] <Insert pressure> maximum, through middle 1/3 of flow range.
5. Size: <Insert NPS.>
7. Selected Unit Flow Range Limits: <Insert gpm.>
8. Pressure Loss at Design Flow Rate: <Insert psig> for sizes NPS 2 and smaller; <Insert psig> for NPS 2-1/2 and larger.
9. Body: Bronze for NPS 2 and smaller; [cast iron with interior lining complying with AWWA C550 or that is FDA approved] [steel with interior lining complying with AWWA C550 or that is FDA approved] [stainless steel] for NPS 2-1/2 and larger.
10. End Connections: Threaded for NPS 2 and smaller; [flanged] <Insert type> for NPS 2-1/2 and larger.
11. Configuration: Designed for [horizontal, straight through] [vertical inlet, horizontal center section, and vertical outlet] [vertical] <Insert configuration> flow.
12. Accessories:
   a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.

B. Double-Check, Detector-Assembly Backflow Preventers <Insert drawing designation if any>:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. FEBCO; SPX Valves & Controls.
2. Standard: ASSE 1048 and FMG approved or UL listed.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: [5 psig] <Insert pressure> maximum, through middle 1/3 of flow range.
5. Size: <Insert NPS.>
7. Selected Unit Flow Range Limits: <Insert gpm.>
8. Pressure Loss at Design Flow Rate: <Insert psig.>
9. Body: [Cast iron with interior lining complying with AWWA C550 or that is FDA approved] [Steel with interior lining complying with AWWA C550 or that is FDA approved] [Stainless steel].
11. Configuration: Designed for [horizontal, straight through] [vertical inlet, horizontal center section, and vertical outlet] [vertical] <Insert configuration> flow.
12. Accessories:
   a. Valves: Outside screw and yoke gate-type with flanged ends on inlet and outlet.
   b. Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.

2.02 WATER PRESSURE-REDUCING VALVES

A. Water Regulators <Insert drawing designation if any>:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Cash Acme.
   b. Conbraco Industries, Inc.
   c. Honeywell Water Controls.
   e. Zurn Plumbing Products Group; Wilkins Div.
4. Size: <Insert NPS.>
5. Design Flow Rate: <Insert gpm.>
8. Body: Bronze [with chrome-plated finish] for NPS 2 and smaller; cast iron [with interior lining complying with AWWA C550 or that is FDA approved] for NPS 2-1/2 and NPS 3.
10. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and NPS 3.

2.03 TEMPERATURE-ACTUATED WATER MIXING VALVES

A. Water-Temperature Limiting Devices <Insert drawing designation if any>:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Cash Acme.
   c. Conbraco Industries, Inc.
   d. Honeywell Water Controls.
   e. Legend Valve.
   f. Leonard Valve Company.
   g. Powers; a Watts Industries Co.
   h. Symmons Industries, Inc.
i. Taco, Inc.


k. Zurn Plumbing Products Group; Wilkins Div.


4. Type: Thermostatically controlled water mixing valve.

5. Material: Bronze body with corrosion-resistant interior components.


7. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.

8. Tempered-Water Setting: <Insert deg F.>


10. Valve Finish: [Chrome plated] [Rough bronze].

B. Individual-Fixture, Water Tempering Valves <Insert drawing designation if any>:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Cash Acme.
   b. Conbraco Industries, Inc.
   c. Honeywell Water Controls.
   d. Lawler Manufacturing Company, Inc.
   e. Leonard Valve Company.
   f. Powers; a Watts Industries Co.
   g. Watts Industries, Inc.; Water Products Div.
   h. Zurn Plumbing Products Group; Wilkins Div.


3. Pressure Rating: 125 psig minimum, unless otherwise indicated.


5. Temperature Control: Adjustable.

6. Inlets and Outlet: Threaded.

7. Finish: Rough or chrome-plated bronze.

8. Tempered-Water Setting: <Insert deg F.>


2.04 STRainers FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers <Insert drawing designation if any>:

1. Pressure Rating: 125 psig minimum, unless otherwise indicated.

2. Body: Bronze for NPS 2 and smaller; cast iron[ with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and] for NPS 2-1/2 and larger.

3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.

4. Screen: Stainless steel with round perforations, unless otherwise indicated.

5. Perforation Size:
   a. Strainers NPS 2 and Smaller: [0.020 inch] [0.033 inch] [0.062 inch] <Insert size>.
   b. Strainers NPS 2-1/2 to NPS 4: [0.045 inch] [0.062 inch] [0.125 inch] <Insert size>.
   c. Strainers NPS 5 and Larger: [0.10 inch] [0.125 inch] [0.25 inch] <Insert size>.

6. Drain: [Pipe plug] [Factory-installed, hose-end drain valve].
2.05 OUTLET BOXES

A. Icemaker Outlet Boxes <Insert drawing designation if any>:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. IPS Corporation.
      c. LSP Products Group, Inc.
      d. Oatey.
      e. Plastic Oddities; a division of Diverse Corporate Technologies.
   4. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 or smaller copper tube outlet.
   5. Supply Shutoff Fitting: NPS 1/2 gate, globe, or ball valve and NPS 1/2 copper, water tubing.

2.06 WALL HYDRANTS

A. Vacuum Breaker Wall Hydrants <Insert drawing designation if any>:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Arrowhead Brass Products, Inc.
      b. Mansfield Plumbing Products LLC.
      d. Prier Products, Inc.
      g. Woodford Manufacturing Company.
      h. Zum Plumbing Products Group; Light Commercial Operation.
   2. Standard: ASSE 1019, Type A or Type B.
   3. Type: Freeze-resistant, automatic draining with integral air-inlet valve.
   4. Classification: Type A, for automatic draining with hose removed or Type B, for automatic draining with hose removed or with hose attached and nozzle closed.
   6. Operation: Loose key or wheel handle.
   7. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
   8. Inlet: NPS 1/2 or NPS 3/4.

2.07 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves <Insert drawing designation if any>:
   2. Pressure Rating: 400-psig minimum CWP.
   4. Body: Copper alloy.
   5. Ball: Chrome-plated brass.
8. Inlet: Threaded or solder joint.

2.08 WATER HAMMER ARRESTERS

A. Water Hammer Arresters <Insert drawing designation if any>:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. AMTROL, Inc.
      b. Josam Company.
      c. MIFAB, Inc.
      d. PPP Inc.
      e. Sioux Chief Manufacturing Company, Inc.
      g. Tyler Pipe; Wade Div.
      h. Watts Drainage Products Inc.
      i. Zurn Plumbing Products Group; Specification Drainage Operation.
   3. Type: [Metal bellows] [Copper tube with piston].
   4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

2.09 TRAP-SEAL PRIMER VALVES

A. Supply-Type, Trap-Seal Primer Valves <Insert drawing designation if any>:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. MIFAB, Inc.
      b. PPP Inc.
      c. Sioux Chief Manufacturing Company, Inc.
      e. Watts Industries, Inc.; Water Products Div.
   5. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
   6. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.
   7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
   1. Locate backflow preventers in same room as connected equipment or system.
   2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
   3. Do not install bypass piping around backflow preventers.

C. Install water regulators with inlet and outlet shutoff valves[ and bypass with memory-stop balancing valve]. Install pressure gages on inlet and outlet.

D. Install water control valves with inlet and outlet shutoff valves[ and bypass with globe valve]. Install pressure gages on inlet and outlet.

E. Install balancing valves in locations where they can easily be adjusted.

F. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
   1. Install thermometers and water regulators if specified.
   2. Install cabinet-type units recessed in or surface mounted on wall as specified.

G. Install Y-pattern strainers for water on supply side of each [control valve,] [water pressure-reducing valve,] [solenoid valve,] [and pump].

H. Install outlet boxes recessed in wall. Install 2-by-4-inch fire-retardant-treated-wood blocking wall reinforcement between studs. Fire-retardant-treated-wood blocking is specified in Division 06 Section "Rough Carpentry."

I. Install water hammer arresters in water piping according to PDI-WH 201.

J. 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.

3.02 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties.

3.03 FIELD QUALITY CONTROL

A. Perform the following tests and prepare test reports:
   1. Test each reduced-pressure-principle backflow preventer double-check, detector-assembly backflow preventer according to authorities having jurisdiction and the device’s reference standard.

B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.
3.04 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable flow set points of balancing valves.

C. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

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. This Section includes the following for soil, waste, and vent piping inside the building:
   1. Pipe, tube, and fittings.
   2. Special pipe fittings.

B. Related Sections include the following:
   1. Division 22 Section "Sanitary Sewerage Pumps."

1.03 DEFINITIONS


B. EPDM: Ethylene-propylene-diene terpolymer rubber.

C. LLDPE: Linear, low-density polyethylene plastic.

D. NBR: Acrylonitrile-butadiene rubber.

E. PE: Polyethylene plastic.

F. PVC: Polyvinyl chloride plastic.

G. TPE: Thermoplastic elastomer.

1.04 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:
   1. Soil, Waste, and Vent Piping: \(10\text{-foot head of water}\).
   2. Sanitary Sewer, Force-Main Piping: \(50\ \text{psig}\) \(100\ \text{psig}\) \(150\ \text{psig}\).

1.05 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.
B. Field quality-control inspection and test reports.

1.06 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.03 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Serviceclass(es).

B. Gaskets: ASTM C 564, rubber.

C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.04 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.
   1. Standard, Shielded, Stainless-Steel Couplings: CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve.
      a. Manufacturers:
         1) ANACO.
         2) Fernco, Inc.
         3) Ideal Div.; Stant Corp.
         4) Mission Rubber Co.
         5) Tyler Pipe; Soil Pipe Div.
      a. Manufacturers:
         1) ANACO.
         2) Clamp-All Corp.
         3) Ideal Div.; Stant Corp.
2.05 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade A or B, Standard Weight or Schedule 40, galvanized. Include ends matching joining method.

B. Drainage Fittings: ASME B16.12[, galvanized], threaded, cast-iron drainage pattern.

C. Pressure Fittings:

2.06 SPECIAL PIPE FITTINGS

A. Flexible, Nonpressure Pipe Couplings: Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition pattern. Include shear ring, ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.
   1. Manufacturers:
      b. Fernco, Inc.
      c. Logan Clay Products Company (The).
      d. Mission Rubber Co.
      e. NDS, Inc.
      f. Plastic Oddities, Inc.
   2. Sleeve Materials:
      b. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
      c. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

B. Shielded Nonpressure Pipe Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
   1. Manufacturers:
      b. Mission Rubber Co.
PART 3 - EXECUTION

3.01 EXCAVATION
   A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.02 PIPING APPLICATIONS
   A. Aboveground, soil and waste piping NPS 4 and smaller shall be the following:
      1. Hubless cast-iron soil pipe and fittings; standard, shielded, stainless-steel couplings; and hubless-coupling joints.
   B. Aboveground, vent piping NPS 4 and smaller shall be the following:
      1. Hubless cast-iron soil pipe and fittings; standard, shielded, stainless-steel couplings; and hubless-coupling joints.
   C. Underground, soil, waste, and vent piping NPS 4 and smaller shall be the following:
      1. Service class, cast-iron soil piping; gaskets; and gasketed joints.
   D. Aboveground sanitary-sewage force mains [NPS 1-1/2 and NPS 2] shall be the following:
      1. Steel pipe, pressure fittings, and threaded joints.
   E. Aboveground sanitary-sewage force mains [NPS 2-1/2 to NPS 6] shall be the following:
      1. Steel pipe, pressure fittings, and threaded joints.

3.03 PIPING INSTALLATION
   A. Sanitary sewer piping outside the building is specified in Division 22 Section "Facility Sanitary Sewers."
   B. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."
   C. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.
   D. Install cleanout fitting with closure plug inside the building in sanitary force-main piping.
   E. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
      1. Install encasement on underground piping according to ASTM A 674 or AWWA C105.
   F. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
G. Lay buried building drainage piping beginning at low point of each system. Install true to
grades and alignment indicated, with unbroken continuity of invert. Place hub ends of
piping upstream. Install required gaskets according to manufacturer's written instructions
for use of lubricants, cements, and other installation requirements. Maintain swab in
piping and pull past each joint as completed.

H. Install soil and waste drainage and vent piping at the following minimum slopes, unless
otherwise indicated:
1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3
   and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

I. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-
grade if slab is without membrane waterproofing.

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

3.04 JOINT CONSTRUCTION
A. Basic piping joint construction requirements are specified in Division 22 Section
   "Common Work Results for Plumbing."
B. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast
C. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe
   and Fittings Handbook" for hubless-coupling joints.

3.05 VALVE INSTALLATION
A. General valve installation requirements are specified in Division 22 Section "General-
   Duty Valves for Plumbing Piping."
B. Shutoff Valves: Install shutoff valve on each sewage pump discharge.
   1. Install gate or full-port ball valve for piping NPS 2 and smaller.
   2. Install gate valve for piping NPS 2-1/2 and larger.
C. Check Valves: Install swing check valve, between pump and shutoff valve, on each
   sewage pump discharge.

3.06 HANGER AND SUPPORT INSTALLATION
A. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports
   for Plumbing Piping and Equipment." Install the following:
   1. Vertical Piping: MSS Type 8 or Type 42, clamps.
   2. Install individual, straight, horizontal piping runs according to the following:
      a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
      b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
      c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
   2. NPS 3: 60 inches with 1/2-inch rod.
   3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
   4. NPS 6: 60 inches with 3/4-inch rod.
   5. NPS 8 to NPS 12: 60 inches with 7/8-inch rod.

F. Install supports for vertical cast-iron soil piping every 15 feet.

G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/4: 84 inches with 3/8-inch rod.
   2. NPS 1-1/2: 108 inches with 3/8-inch rod.
   3. NPS 2: 10 feet with 3/8-inch rod.
   4. NPS 2-1/2: 11 feet with 1/2-inch rod.
   5. NPS 3: 12 feet with 1/2-inch rod.
   6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
   7. NPS 6: 12 feet with 3/4-inch rod.
   8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.

H. Install supports for vertical steel piping every 15 feet.

I. Install hangers for stainless-steel piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 2: 84 inches with 3/8-inch rod.
   2. NPS 3: 96 inches with 1/2-inch rod.
   3. NPS 4: 108 inches with 1/2-inch rod.
   4. NPS 6: 10 feet with 5/8-inch rod.

J. Install supports for vertical stainless-steel piping every 10 feet.

K. 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 to NPS 5: 10 feet with 1/2-inch rod.
   5. NPS 6: 10 feet with 5/8-inch rod.
   6. NPS 8: 10 feet with 3/4-inch rod.

L. Install supports for vertical copper tubing every 10 feet.
M. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

### 3.07 CONNECTIONS

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

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

C. Connect drainage and vent piping to the following:
   1. **Plumbing Fixtures**: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
   2. **Plumbing Fixtures and Equipment**: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
   3. **Plumbing Specialties**: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
   4. **Equipment**: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

D. Connect force-main piping to the following:
   1. **Sanitary Sewer**: To exterior force main or sanitary manhole.
   2. **Sewage Pumps**: To sewage pump discharge.

### 3.08 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.

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

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.

2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.

3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

4. Prepare reports for tests and required corrective action.

3.09 CLEANING

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

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

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

END OF SECTION
SECTION 22 13 19
SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

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

1.02 SUMMARY
A. This Section includes the following sanitary drainage piping specialties:
   1. Cleanouts.
   2. Floor drains.
B. Related Sections include the following:
   1. Division 22 Section "Storm Drainage Piping Specialties" for trench drains for storm water, channel drainage systems for storm water, roof drains, and catch basins.

1.03 SUBMITTALS
A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for the following:
B. Field quality-control test reports.
C. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.04 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.

1.05 COORDINATION
A. Coordinate size and location of roof penetrations.
PART 2 - PRODUCTS

2.01 CLEANOUTS

A. Exposed Metal 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 Inc.
      g. <Insert manufacturer's name.>
      h. Josam Company; Blucher-Josam Div.
      i. <Insert manufacturer's name.>

   2. Standard: [ASME A112.36.2M for cast iron] [ASME A112.3.1 for stainless
      steel] for cleanout test tee.
   3. Size: Same as connected drainage piping
   4. Body Material: [Hub-and-spigot, cast-iron soil pipe T-branch] [Hubless, cast-
      iron soil pipe test tee] [Stainless-steel tee with side cleanout] as required to
      match connected piping.
   5. Closure: [Countersunk] [Countersunk or raised-head] [Raised-head, [brass]
      [cast-iron] [plastic] plug.
   6. Closure Plug Size: Same as or not more than one size smaller than cleanout
      size.

B. Metal Floor Cleanouts <Insert drawing designation if any>:
   1. Manufacturers: Subject to compliance with requirements, provide products by
      one of the following:
      b. Oatey.
      c. Sioux Chief Manufacturing Company, Inc.
      e. Tyler Pipe; Wade Div.
      f. Watts Drainage Products Inc.
      g. Zum Plumbing Products Group; Light Commercial Operation.
      h. Zum Plumbing Products Group; Specification Drainage Operation.
      i. Josam Company; Josam Div.
      j. Kusel Equipment Co.
      l. Josam Company; Blucher-Josam Div.

   2. Standard: ASME A112.36.2M for [adjustable housing] [cast-iron soil pipe
      with cast-iron ferrule] [heavy-duty, adjustable housing] [threaded, adjustable
      housing] cleanout.
   3. Size: Same as connected branch.
   4. Type: [Adjustable housing] [Cast-iron soil pipe with cast-iron ferrule]
      [Heavy-duty, adjustable housing] [Threaded, adjustable housing].
   5. Body or Ferrule: [Cast iron] [Stainless steel] <Insert material>.
   6. Clamping Device: [Not required] [Required].
   7. Outlet Connection: [Inside calk] [Spigot] [Threaded].
8. Closure: [Brass plug with straight threads and gasket] [Brass plug with tapered threads] [Cast-iron plug] [Plastic plug].
9. Adjustable Housing Material: [Cast iron] [Plastic] <Insert material> with [threads] [set-screws or other device].
10. Frame and Cover Material and Finish: [Nickel-bronze, copper alloy] [Painted cast iron] [Polished bronze] [Rough bronze] [Stainless steel] <Insert material and finish>.
11. Frame and Cover Shape: [Round] [Square] <Insert shape>.
12. Top Loading Classification: [Extra Heavy] [Heavy] [Light] [Medium] Duty.
13. Riser: ASTM A 74, [Extra-Heavy] [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 Inc.
2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: [Hub-and-spigot, cast-iron soil pipe T-branch] [Hubless, cast-iron soil pipe test tee] as required to match connected piping.
5. Closure: [Countersunk] [Countersunk or raised-head] [Raised-head], [drilled-and-threaded] [brass] [cast-iron] plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
8. Wall Access: [Round] [Square], [nickel-bronze, copper-alloy, or stainless-steel] <Insert material> wall-installation frame and cover.

2.02 FLOOR DRAINS

A. Cast-Iron Floor Drains:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Commercial Enameling Co.
   b. Josam Company; Josam Div.
   c. MIFAB, Inc.
   d. Prier Products, Inc.
   e. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   f. Tyler Pipe; Wade Div.
   g. Watts Drainage Products Inc.
   h. Zum Plumbing Products Group; Light Commercial Operation.
   i. Zum Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.6.3 [with backwater valve].
3. Pattern: [Area] [Floor] [Funnel floor] [Sanitary] <Insert pattern> drain.
5. Seepage Flange: [Not required] [Required].
6. Anchor Flange: [Not required] [Required].
7. Clamping Device: [Not required] [Required].
8. Outlet: [Bottom] [Side] <Insert type>.
9. Backwater Valve: [Drain-outlet type] [Integral, ASME A112.14.1, swing-check type] [Not required].
10. Coating on Interior and Exposed Exterior Surfaces: [Acid-resistant enamel] [Not required] <Insert material>.
12. Top or Strainer Material: [Bronze] [Gray iron] [Nickel bronze] [Stainless steel] <Insert material>.
13. Top of Body and Strainer Finish: [Nickel bronze] [Polished bronze] [Rough bronze] [Stainless steel] <Insert finish>.
14. Top Shape: [Round] [Square] <Insert shape>.
15. Dimensions of Top or Strainer: <Insert dimensions and describe body, sump, and grate>.
16. Top Loading Classification: [Extra Heavy-Duty] [Heavy Duty] [Light Duty] [Medium Duty] <Delete if not applicable>.
17. Funnel: [Not required] [Required] <Insert description and dimensions>.
18. Inlet Fitting: [Not required] [Gray iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection].
19. Trap Material: [Bronze] [Cast iron] [Copper] [Not required] <Insert material>.
20. Trap Pattern: [Deep-seal P-trap] [Standard P-trap] [Not required] <Insert pattern>.
21. Trap Features: [Cleanout] [Trap-seal primer valve drain connection] [Cleanout and trap-seal primer valve drain connection] [Not required] <Insert type>.

2.03 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Deep-Seal Traps <Insert drawing designation if any>:
   1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
   2. Size: Same as connected waste piping.
      a. NPS 2: 4-inch- minimum water seal.
      b. NPS 2-1/2 and Larger: 5-inch- minimum water seal.

B. Floor-Drain, Trap-Seal Primer Fittings <Insert drawing designation if any>:
   1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
   2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

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

D. Sleeve Flashing Device <Insert drawing designation if any>:
1. Description: Manufactured, cast-iron fitting, with clamping device, that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend [1 inch] [2 inches] 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.

E. Vent Caps [Insert drawing designation if any]:
1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
2. Size: Same as connected stack vent or vent stack.

2.04 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

3.01 INSTALLATION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
   1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
4. Locate at base of each vertical soil and waste stack.

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

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

E. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
   1. Position floor drains for easy access and maintenance.
   2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
      a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
      b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
      c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.

3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

F. Install through-penetration firestop assemblies in plastic [conductors] [and] [stacks] at floor penetrations.

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

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

I. 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.

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

K. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

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

M. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.
N. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.02 CONNECTIONS
A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Install piping adjacent to equipment to allow service and maintenance.

3.03 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 Division 07 Section "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.

3.04 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
SECTION 22 13 29
SANITARY SEWERAGE PUMPS

PART 1 - GENERAL

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

1.02 SUMMARY
A. This Section includes the following sewage pumps and accessories for sanitary drainage piping systems in buildings:
   1. Wet-pit-mounted, vertical sewage pumps.
   2. Sewage pump [basins] [basins and pits] [pits].
B. Related Sections include the following:
   1. Division 22 Section "Facility Packaged Sewage Pumping Stations" for applications in site-construction sewage pumping.

1.03 SUBMITTALS
A. Product Data: For each type and size of sewage pump specified. Include certified performance curves with operating points plotted on curves; and rated capacities of selected models, furnished specialties, and accessories.
B. Shop Drawings: Diagram power, signal, and control wiring.
C. Operation and Maintenance Data: For each sewage pump to include in emergency, operation, and maintenance manuals.

1.04 QUALITY ASSURANCE
A. Product Options: Drawings indicate size, profiles, and dimensional requirements of sewage pumps and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
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.

1.05 DELIVERY, STORAGE, AND HANDLING
A. Retain shipping flange protective covers and protective coatings during storage.
B. Protect bearings and couplings against damage.
C. Comply with pump manufacturer’s written rigging instructions for handling.

1.06 COORDINATION

A. Coordinate size and location of concrete bases and pits. Concrete, reinforcement, and formwork requirements are specified in Division 03.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 WET-PIT-MOUNTED, VERTICAL SEWAGE PUMPS

A. Manufacturers:

1. Armstrong Pumps Inc.
2. Weil Pump Company, Inc.

B. Description: Factory-assembled and -tested, single-stage, centrifugal, end-suction sewage pumps complying with UL 778. Vertical, separately coupled, suspended pumps complying with HI 1.1-1.2 and HI 1.3 for wet-pit-volute sewage pumps and with reverse-flow assembly.

1. Pump Arrangement: Duplex.
2. Casing: Cast iron, with open inlet and threaded connection for NPS 2 and smaller and flanged connection for NPS 2-1/2 and larger discharge piping.
3. Impeller: ASTM A 48/A 48M, Class No. 25 A or higher cast iron, ASTMB 532/A 532M, abrasion-resistant cast iron, ASTM B 584, cast bronze; statically and dynamically balanced, open or semiopen, nonclog design for solids handling; overhung, single suction, and keyed and secured to shaft.
4. Pump Shaft and Sleeve Bearings: Stainless-steel or stainless-steel or steel shaft with bronze sleeve bearings. Include oil-lubricated, intermediate sleeve bearings at 48-inch maximum intervals if basin depth is more than 48 inches, and grease-lubricated, ball-type thrust bearings.
5. Pump and Motor Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.

C. Pump Discharge Piping: Manufacturer’s standard galvanized-steel or bronze pipe.

D. Basin/Pit Cover: Cast iron or coated steel and strong enough to support pumps, motors, and controls. See Part 2 “Sewage Pump Basins/Pits” Article for requirements.

E. Cover Shaft Seal: Stuffing box, with graphite-impregnated braided-yarn rings and bronze packing gland.
F. Motor: Single-speed; grease-lubricated ball bearings. Comply with requirements in Division 22 Section "Common Motor Requirements for Plumbing Equipment."

G. Controls: NEMA 250, [Type 1] <Insert other> enclosure, pedestal-mounted float switches; with floats, float rods, and rod buttons. Include automatic alternator to alternate operation of pump units on successive cycles and to operate multiple units if one pump cannot handle load.
   1. Float Guide: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches.
   2. High-Water Alarm: Cover-mounted, [compression-probe] [mechanical-float-switch] [mercury-float-switch] [micropressure-switch] alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

H. Capacities and Characteristics: Refer to drawings.

2.03 SEWAGE PUMP PITS

A. Description: Concrete pit with sump, pipe connections, curb frame, and separate cover.

B. Sump: Construct of watertight, cast-in-place, reinforced concrete with sidewall openings for pipe connections. Cast-in-place concrete, formwork, and reinforcement are specified in Division 03 "[Cast-in-Place Concrete] [Miscellaneous Cast-in-Place Concrete]."
   1. Pipe Connections: Sleeved openings large enough for mechanical sleeve seals for drainage piping. Sleeves and mechanical sleeve seals are specified in Division 22 Section "Common Work Results for Plumbing" and drainage piping is specified in Division 22 Section "Sanitary Waste and Vent Piping."

C. Curb Frame and Cover:
   1. Curb Frame Material: Galvanized steel or steel with bituminous coating.
      a. Pattern: [Angle-cross-section shape with flat top surface] [Z-cross-section shape with raised outer rim of height matching cover, for recessed mounting with installed cover flush with top of floor slab].
   2. Cover: Fabricate with openings having gaskets, seals, and bushings; for access to pumps, pump shafts, control rods, discharge piping, vent connections, and power cables.
      a. Material: [Cast iron] [Cast iron or steel with bituminous coating] [Steel with bituminous coating].
      b. Reinforcement: Steel or cast iron, capable of supporting foot traffic for basins installed in foot-traffic areas.

D. Capacities and Characteristics: Refer to drawings.

2.04 FLEXIBLE CONNECTORS

A. Manufacturers:
   1. Anamet, Inc.
   2. Flex-Hose Co., Inc.
   3. Flexicraft Industries.
   4. Flex-Pression, Ltd.
5. Flex-Weld, Inc.
6. Hyspan Precision Products, Inc.
8. Metraflex, Inc.
9. Proco Products, Inc.
10. Tozen America Corporation.
11. Unaflex Inc.

B. Description: [125-psig] <Insert other> minimum working-pressure rating and ends matching pump connections:
1. Bronze Flexible Connectors: Corrugated, bronze inner tubing covered with bronze wire braid. Include copper-tube ends or bronze flanged ends, brazed-welded to tubing.
2. Stainless-Steel Flexible Connectors: Corrugated, stainless-steel inner tubing covered with stainless-steel wire braid. Include stainless-steel nipples or flanges, welded to tubing.

2.05 BUILDING AUTOMATION SYSTEM INTERFACE

A. Provide auxiliary contacts in pump controllers for interface to building automation system. Include the following:
1. On-off status of each pump.
2. Alarm status.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine roughing-in for plumbing piping to verify actual locations of sanitary drainage and vent piping connections before sewage pump installation.

3.02 CONCRETE

A. Install concrete bases of dimensions indicated for pumps and controllers. Refer to Division 22 Section "Common Work Results for Plumbing."
1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Cast-in-place concrete materials and placement requirements are specified in Division 03.

3.03 INSTALLATION

A. Excavating, trenching, and backfilling are specified in Division 31 Section "Earth Moving."
B. Install sewage pumps according to applicable requirements in HI 1.4.

C. Install pumps and arrange to provide access for maintenance including removal of motors, impellers, couplings, and accessories.

D. Suspend wet-pit-mounted, vertical sewage pumps from [basin] [basin and pit] [pit] covers. Make direct connections to sanitary drainage piping.

E. Construct sewage pump pits and connect to drainage and vent piping. Set pit curb frame recessed in and anchored to concrete. Fasten pit cover to pit curb flange. Install cover so top surface is flush with finished floor.

F. Support piping so weight of piping is not supported by pumps.

3.04 CONNECTIONS

A. Piping installation requirements are specified in Division 22 Section "Sanitary Waste and Vent Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to sewage pumps to allow service and maintenance.

C. Connect sanitary drainage and vent piping to pumps. Install discharge piping equal to or greater than size of pump discharge piping. Install vent piping equal to or greater than size of pump basin vent connection. Refer to Division 22 Section "Sanitary Drainage and Vent Piping."
   1. Install flexible connectors adjacent to pumps in discharge piping.
   2. Install check and shutoff valves on discharge piping from each pump. Install unions on pumps having threaded pipe connections. Install valves same size as connected piping. Refer to Division 22 Section "General-Duty Valves for Plumbing Piping" for general-duty valves for sanitary waste piping.

D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.05 STARTUP SERVICE

A. Start pumps without exceeding safe motor power:
   1. Start motors.
   2. Open discharge valves slowly.
   3. Check general mechanical operation of pumps and motors.

B. Test and adjust controls and safeties.

C. Remove and replace damaged and malfunctioning components.
   1. Pump Controls: Set pump controls for automatic start, stop, and alarm operation as required for system application.
   2. Set field-adjustable switches and circuit-breaker trip ranges as indicated, or if not indicated, for normal operation.
D. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project outside normal occupancy hours for this purpose.

3.06 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain [controls and] pumps. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION
SECTION 22 14 13
FACILITY STORM DRAINAGE PIPING

PART 1 - GENERAL

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

1.02 SUMMARY
   A. This Section includes the following storm drainage piping inside the building:
      1. Pipe, tube, and fittings.
      2. Special pipe fittings.

1.03 PERFORMANCE REQUIREMENTS
   A. Components and installation shall be capable of withstanding the following minimum
      working-pressure, unless otherwise indicated:
      1. Storm Drainage Piping: [10-foot head of water].

1.04 SUBMITTALS
   A. Product Data: For pipe, tube, fittings, and couplings.
   B. Field quality-control inspection and test reports.

1.05 QUALITY ASSURANCE
   A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.01 MANUFACTURERS
   A. In other Part 2 articles where titles below introduce lists, the following requirements apply
      to product selection:
      1. Manufacturers: Subject to compliance with requirements, provide products by
         one of the manufacturers specified.
2.02 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.03 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.
      a. Manufacturers:
         1) ANACO.
         2) Clamp-All Corp.
         3) Ideal Div.; Stant Corp.
         4) Mission Rubber Co.
         5) Tyler Pipe; Soil Pipe Div.

PART 3 - EXECUTION

3.01 PIPING APPLICATIONS

A. Aboveground storm drainage piping shall be the following:
   1. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and coupled joints.

3.02 PIPING INSTALLATION

A. Storm sewer and drainage piping outside the building are specified in Division 33 Section "Storm Utility Drainage Piping."

B. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."

C. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers. Cleanouts are specified in Division 22 Section "Storm Drainage Piping Specialties."

D. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 22 Section "Common Work Results for Fire Plumbing."

E. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
   1. Install encasement on underground piping according to ASTM A 674 or AWWA C105.
F. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

G. Install storm drainage piping at the following minimum slopes, unless otherwise indicated:
   1. Building Storm Drain: 1 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
   2. Horizontal Storm-Drainage Piping: 2 percent downward in direction of flow.

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

3.03 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results Plumbing."


3.04 HANGER AND SUPPORT INSTALLATION

A. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:
   1. Vertical Piping: MSS Type 8 or Type 42, clamps.
   2. Individual, Straight, Horizontal Piping Runs: According to the following:
      a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
      b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
      c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
   3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
   4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
   2. NPS 3: 60 inches with 1/2-inch rod.
   3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
   4. NPS 6: 60 inches with 3/4-inch rod.
   5. NPS 8 to NPS 12: 60 inches with 7/8-inch rod.
   6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
F. Install supports for vertical cast-iron soil piping every 15 feet.

3.05 CONNECTIONS

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

B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.

C. Connect storm drainage piping to roof drains and storm drainage specialties.

D. Connect force-main piping to the following:
   1. Storm Sewer: To exterior force main or storm manhole.

3.06 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
   1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
   2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

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

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

D. Test storm drainage piping 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 storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   3. Test Procedure: Test storm drainage 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. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
   5. Prepare reports for tests and required corrective action.

3.07 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.
B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

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

END OF SECTION
SECTION 22 14 23
STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

A. RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following storm drainage piping specialties:
   1. Cleanouts.
   2. Roof drains.
   3. Miscellaneous storm drainage piping specialties.
   4. Flashing materials.

B. Related Sections include the following:
   1. Division 22 Section "Sanitary Waste Piping Specialties" for backwater valves, floor drains, trench drains and channel drainage systems connected to sanitary sewer, air admittance valves, FOG disposal systems, grease interceptors and removal devices, oil interceptors, and solid interceptors.

1.03 SUBMITTALS

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

1.04 QUALITY ASSURANCE

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

1.05 COORDINATION

A. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.01 CLEANOUTS

A. Exposed Metal Cleanouts <Insert drawing designation if any>:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. MIFAB, Inc.
STORM DRAINAGE PIPING SPECIALTIES

2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
3. Size: Same as connected drainage piping
4. Body Material: [Hub-and-spigot, cast-iron soil pipe T-branch] [Hubless, cast-iron soil pipe test tee] as required to match connected piping.
5. Closure: [Countersunk] [Countersunk or raised-head] [Raised-head], [brass] [cast-iron] [plastic] plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Metal Floor Cleanouts <Insert drawing designation if any>:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Oatey.
   c. Sioux Chief Manufacturing Company, Inc.
   e. Tyler Pipe; Wade Div.
   f. Watts Drainage Products Inc.
   g. Zum Plumbing Products Group; Light Commercial Operation.
   h. Zum Plumbing Products Group; Specification Drainage Operation.

C. Cast-Iron Wall Cleanouts <Insert drawing designation if any>:
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 Inc.

   2. Standard: ASME A112.36.2M. Include wall access.
   3. Size: Same as connected drainage piping.
   4. Body: [Hub-and-spigot, cast-iron soil pipe T-branch] [Hubless, cast-iron soil pipe test tee] as required to match connected piping.
   5. Closure: [Countersunk] [Countersunk or raised-head] [Raised-head], [drilled-and-threaded] [brass] [cast-iron] plug.
   6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
   8. Wall Access: [Round] [Square], [nickel-bronze, copper-alloy, or stainless-steel] <Insert material> wall-installation frame and cover.

2.02 ROOF DRAINS

A. Metal Roof Drains <Insert drawing designation if any>:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
b. Marathon Roofing Products.
c. MIFAB, Inc.
d. Portals Plus, Inc.
e. Prier Products, Inc.
g. Tyler Pipe; Wade Div.
h. Watts Drainage Products Inc.
i. Zum Plumbing Products Group; Light Commercial Operation.
j. Zum Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.21.2M.
3. Pattern: [Balcony] [Canopy] [Cornice] [Promenade-deck] [Roof] [Scupper] <Insert pattern> drain.
4. Body Material: [Aluminum] [Cast iron] [Copper] <Insert material>.
5. Dimensions of Body: <Insert dimensions and describe body and sump if required>.
6. Combination Flashing Ring and Gravel Stop: [Not required] [Required] <Insert other>.
7. Flow-Control Weirs: [Not required] [Required].
8. Outlet: [Bottom] [Side] [Angle] <Insert outlet>.
9. Dome Material: [Aluminum] [Cast iron] [PE] [Stainless steel] <Insert material>.
10. Extension Collars: [Not required] [Required].
11. Underdeck Clamp: [Not required] [Required].
12. Sump Receiver: [Not required] [Required].

2.03 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

A. Downspout Boots <Insert drawing designation if any>:
   1. Description: Manufactured, ASTM A 48/A 48M, gray-iron casting, with strap or ears for attaching to building; NPS 4 outlet; and shop-applied bituminous coating.
   2. Size: Inlet size to match downspout.
   3. Description: ASTM A 74, Service class, hub-and-spigot, cast-iron soil pipe.
   4. Size: Same as or larger than connected downspout.

B. Conductor Nozzles <Insert drawing designation if any>:
   1. Description: Bronze body with threaded inlet and bronze wall flange with mounting holes.
   2. Size: Same as connected conductor.

2.04 FLASHING MATERIALS

A. Copper Sheet: ASTM B 152/B 152M, 12 oz./sq. ft. thickness.

B. 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.


D. Fasteners: Metal compatible with material and substrate being fastened.
E. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

F. Solder: ASTM B 32, lead-free alloy.

G. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
   1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
   2. Locate at each change in direction of piping greater than 45 degrees.
   3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
   4. Locate at base of each vertical soil and waste stack.

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

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

E. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions. Roofing materials are specified in Division 07.
   1. Install roof-drain flashing collar or flange so that there will be no leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
   2. Position roof drains for easy access and maintenance.

F. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

G. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

H. Install manufactured, gray-iron downspout boots at grade with top [6 inches (152 mm)] [12 inches (305 mm)] [18 inches (457 mm)] <Insert dimension> above grade. Secure to building wall.

I. Install cast-iron soil pipe downspout boots at grade with top of hub [6 inches (152 mm)] [12 inches (305 mm)] [18 inches (457 mm)] <Insert dimension> above grade.

J. Install conductor nozzles at exposed bottom of conductors where they spill onto grade.
K. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.02 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

3.03 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. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.04 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
SECTION 22 33 00

ELECTRIC DOMESTIC WATER HEATERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following electric water heaters:
   1. Flow-control, instantaneous electric water heaters.
   2. Thermostat-control, instantaneous electric water heaters.
   3. Commercial, storage electric water heaters.
   4. Compression tanks.
   5. Water heater accessories.

1.03 SUBMITTALS

A. Product Data: For each type and size of water heater indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Diagram power, signal, and control wiring.
   1. Product Certificates: For each type of [commercial] [and] [instantaneous] electric water heater, signed by product manufacturer.

C. Source quality-control test reports.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For electric water heaters to include in emergency, operation, and maintenance manuals.

F. Warranty: Special warranty specified in this Section.

1.04 QUALITY ASSURANCE

A. Source Limitations: Obtain same type of electric water heaters through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
C. ASME Compliance: Where indicated, fabricate and label commercial water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

D. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," for all components that will be in contact with potable water.

1.05 COORDINATION

A. Coordinate size and location of concrete bases with Architectural and Structural Drawings.

1.06 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric water heaters that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Structural failures including storage tank and supports.
   b. Faulty operation of controls.
   c. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Period(s): From date of Substantial Completion:

   a. Instantaneous Electric Water Heaters: [One] [Two] [Five] <Insert number> year(s).

   b. Light-Commercial Electric Water Heaters:
      1) Storage Tank: [Three] [Five] <Insert number> years.
      2) Controls and Other Components: [Two] [Three] <Insert number> years.

   c. Commercial Electric Water Heaters:
      1) Storage Tank: [Three] [Five] <Insert number> years.
      2) Controls and Other Components: [Three] [Five] <Insert number> years.

   d. Compression Tanks: [One] <Insert number> year(s).

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
2.02 INSTANTANEOUS ELECTRIC WATER HEATERS

A. Flow-Control, Instantaneous Electric Water Heaters: Comply with UL 499 for tankless electric (water heater) heating appliance.

1. Manufacturers:
   a. Chronomite Laboratories, Inc.
   b. Controlled Energy Corporation.
   c. Eemax, Inc.
   d. Hot Aqua, Inc.
   e. IMI Waterheating, Ltd.
   f. Stiebel Eltron, Inc.

2. Construction: Copper piping or tubing complying with NSF 61 barrier materials for potable water, without storage capacity.
   b. Pressure Rating: \[150 \text{ psig} \leq \text{(kPa)}\].
   c. Heating Element: Resistance heating system.
   d. Temperature Control: Flow-control fitting.
   e. Safety Control: High-temperature-limit cutoff device or system.
   f. Jacket: Aluminum or steel with enameled finish or plastic.


B. Thermostat-Control, Instantaneous Electric Water Heaters: Comply with UL 499 for tankless electric (water heater) heating appliance.

1. Manufacturers:
   a. Chronomite Laboratories, Inc.
   b. IMI Waterheating, Ltd.
   c. Keltech, Inc.
   d. Niagara Industries, Inc.

2. Construction: Copper piping or tubing complying with NSF 61 barrier materials for potable water, without storage capacity.
   b. Pressure Rating: \[150 \text{ psig} \leq \text{(kPa)}\].
   c. Heating Element: Resistance heating system.
   d. Temperature Control: Thermostat.
   e. Safety Control: High-temperature-limit cutoff device or system.
   f. Jacket: Aluminum or steel with enameled finish or plastic.


2.03 COMMERCIAL ELECTRIC WATER HEATERS

A. Commercial, Storage Electric Water Heaters: Comply with UL 1453 requirements for storage-tank-type water heaters.

1. Manufacturers:
d. Smith, A. O. Water Products Company.
e. State Industries, Inc.

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] <Insert psig (kPa)>.
c. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.

3. Factory-Installed Storage-Tank Appurtenances:
a. Anode Rod: Replaceable magnesium.
b. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
c. Insulation: Comply with ASHRAE/IESNA 90.1.
d. Jacket: Steel with enameled finish.
e. Heating Elements: Electric, screw-in or bolt-on immersion type arranged in multiples of three.
   1) Staging: Input not exceeding [18 kW] <Insert kW> per step.
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 and complying with ASME PTC 25.3, 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 water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

4. Special Requirements: NSF 5 construction.

2.04 COMPRESSION TANKS

A. Description: Steel pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.

1. Manufacturers:
   a. AMTROL Inc.
   b. Smith, A. O.; Aqua-Air Div.
   c. State Industries, Inc.
   d. Wessels Co.

2. Construction:
   a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1, pipe thread.
b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.

c. Air-Charging Valve: Factory installed.

3. Capacity and Characteristics: Refer to drawings.

2.05 WATER HEATER ACCESSORIES

A. Combination Temperature and Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.

B. Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include pressure setting less than water heater working-pressure rating.

1. Water Heater Stand and Drain-Pan Units: High-density-polyethylene-plastic, 18-inch-high, enclosed-base stand complying with IAPMO PS 103 and IAS No. 2. Include integral or separate drain pan with raised edge and NPS 1 drain outlet with ASME B1.20.1 pipe thread.

2. Water Heater Stands: Water heater manufacturer's factory-fabricated steel stand for floor mounting and capable of supporting water heater and water. Include dimension that will support bottom of water heater a minimum of 18 inches above the floor.

C. Water Heater Mounting Brackets: Water heater manufacturer's factory-fabricated steel bracket for wall mounting and capable of supporting water heater and water.

1. Drain Pans: Corrosion-resistant metal with raised edge. Include dimensions not less than base of water heater and include drain outlet not less than NPS 3/4.

D. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1 or ASHRAE 90.2.


E. Shock Absorbers: ASSE 1010 or PDI WH 201, Size A water hammer arrester.

2.06 SOURCE QUALITY CONTROL

A. Test and inspect water heater storage tanks, specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Prepare test reports.

PART 3 - EXECUTION

3.01 WATER HEATER INSTALLATION

A. Install commercial water heaters on concrete bases.

1. Exception: Omit concrete bases for commercial water heaters if installation on stand, bracket, suspended platform, or direct on floor is indicated.
2. Concrete base construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."

B. Install water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

C. Install combination temperature and pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
   1. Install combination temperature and pressure relief valves in water piping for water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

D. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for water heaters that do not have tank drains. Refer to Division 22 Section "Domestic Water Piping Specialties" for hose-end drain valves.

E. Install thermometer on outlet piping of water heaters. Refer to Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers.
   1. Install pressure gage(s) on inlet and outlet of commercial electric water-heater piping. Refer to Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages.

F. Install piping-type heat traps on inlet and outlet piping of water heater storage tanks without integral or fitting-type heat traps.

G. Fill water heaters with water.

H. Charge compression tanks with air.

3.02 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to water heaters to allow service and maintenance. Arrange piping for easy removal of water heaters.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.03 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, confirm proper operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace water heaters that do not pass tests and inspections and retest as specified above.

END OF SECTION
SECTION 22 40 00
PLUMBING FIXTURES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following conventional plumbing fixtures and related components:
   1. Faucets for lavatories and sinks.
   2. Flushometers.
   3. Toilet seats.
   4. Protective shielding guards.
   5. Fixture supports.
   6. Dishwasher air-gap fittings.
   7. Disposers.
   8. Water closets.
   9. Urinals.
  10. Lavatories.
  11. Individual showers.
  13. Service basins.

B. Related Sections include the following:
   1. Division 10 Section "Toilet, Bath, and Laundry Accessories."
   2. Division 22 Section "Domestic Water Piping Specialties" for backflow preventers, floor drains, and specialty fixtures not included in this Section.
   3. Division 22 Section "Drinking Fountains and Water Coolers."

1.03 DEFINITIONS


B. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

C. Cast Polymer: Cast-filled-polymer-plastic material. This material includes cultured-marble and solid-surface materials.

D. Cultured Marble: Cast-filled-polymer-plastic material with surface coating.
E. **Fitting:** Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.

F. **FRP:** Fiberglass-reinforced plastic.

G. **PMMA:** Polymethyl methacrylate (acrylic) plastic.

H. **PVC:** Polyvinyl chloride plastic.

I. **Solid Surface:** Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.

1.04 **SUBMITTALS**

A. **Product Data:** For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.

B. **Shop Drawings:** Diagram power, signal, and control wiring.

C. **Operation and Maintenance Data:** For plumbing fixtures to include in emergency, operation, and maintenance manuals.

D. **Warranty:** Special warranty specified in this Section.

1.05 **QUALITY ASSURANCE**

A. **Source Limitations:** Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.

1. **Exception:** If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.

B. **Electrical Components, Devices, and Accessories:** Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.


E. **NSF Standard:** Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
F. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

G. Comply with the following applicable standards and other requirements specified for plumbing fixtures:
   1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
  10. Porcelain-Enameled, Formed-Steel Fixtures: ASME A112.19.4M.
  15. Vitreous-China Fixtures: ASME A112.19.2M.
  17. Water-Closet, Flushometer Tank Trim: ASSE 1037.
  18. Whirlpool Bathtub Fittings: ASME A112.19.8M.

H. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:
   1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.
   2. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
   5. Hose-Connection Vacuum Breakers: ASSE 1011.

I. Comply with the following applicable standards and other requirements specified for shower faucets:
   1. Backflow Protection Devices for Hand-Held Showers: ASME A112.18.3M.
   2. Combination, Pressure-Equalizing and Thermostatic-Control Antiscald Faucets: ASSE 1016.

J. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:
2. Brass and Copper Supplies: ASME A112.18.1.

K. Comply with the following applicable standards and other requirements specified for miscellaneous components:
1. Disposers: ASSE 1008 and UL 430.
4. Floor Drains: ASME A112.6.3.
5. Grab Bars: ASTM F 446.
8. Off-Floor Fixture Supports: ASME A112.6.1M.

1.06 WARRANTY

A. Special Warranties: Manufacturer's standard form in which manufacturer agrees to repair or replace components of whirlpools that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
   a. Structural failures of unit shell.
   b. Faulty operation of controls, blowers, pumps, heaters, and timers.
   c. Deterioration of metals, metal finishes, and other materials beyond normal use.
2. Warranty Period for Commercial Applications: Five years from date of Substantial Completion.

1.07 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.
3. Flushometer Valve, Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than 12 of each type.
4. Provide hinged-top wood or metal box, or individual metal boxes, with separate compartments for each type and size of extra materials listed above.
5. Toilet Seats: Equal to 5 percent of amount of each type installed.

PART 2 - PRODUCTS

2.01 LAVATORY FAUCETS

A. Lavatory Faucets:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Zurn Plumbing Products Group.
   b. Chicago Faucets.
   c. Delta Faucet Company.
2. Description: Two-handle mixing valve. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.
   b. Finish: Polished chrome plate .5 GPM.
   c. Centers: 4 inches (102 mm).
   d. Mounting: Deck, exposed.
   e. Valve Handle(s): Wrist blade, 4 inches (102 mm).
   f. Inlet(s): NPS 1/2 (DN 15) male shank.
   g. Spout: Rigid type.
   h. Spout Outlet: Aerator.
   i. Operation: Compression, manual.
   j. Drain: Grid.
   k. Tempering Device: Thermostatic.

   Product Description: Chicago Faucet Model 802-317-CP with .5 gpm aerator.

2.02 SHOWER FAUCETS

A. Shower Faucets:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Delta Faucet Company.
   b. Kohler Co.
   c. Leonard Valve Company.
2. Description: Single-handle pressure-balance valve. Include hot- and cold-water indicators; check stops; and shower head, arm, and flange. Coordinate faucet inlets with supplies and outlet with diverter valve.
   b. Finish: Polished chrome plate.
   c. Maximum Flow Rate: 2.5 gpm (9.5 L/min.), unless otherwise indicated.
   d. Diverter Valve: Not required.
e. Mounting: Exposed.
g. Antiscald Device: Integral with mixing valve.
h. Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.
i. Supply Connections: NPS 1/2 (DN 15).
j. Shower Head Type: Integral with mounting flange.
k. Shower Head Material: Metallic with chrome-plated finish.
l. Spray Pattern: Adjustable.
m. Integral Volume Control: Not required.

2.03 SINK FAUCETS

A. Sink Faucets:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Chicago Faucets.
      b. Delta Faucet Company.
      c. Zurn Plumbing Products Group; Commercial Brass Operation.
   2. Description: Kitchen faucet without spray. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.
      a. Body Material: Commercial, solid brass
      b. Finish: Polished chrome plate.
      c. Maximum Flow Rate: 2.5 gpm (9.5 L/min.), unless otherwise indicated.
      d. Mixing Valve: Two-lever handle.
      e. Centers: 8 inches (203 mm).
      f. Mounting: Deck.
      g. Handle(s): Wrist blade, 4 inches (102 mm).
      h. Inlet(s): NPS 1/2 (DN 15) male shank.
      i. Spout Type: Swing, solid brass.
      j. Spout Outlet: Aerator.
      k. Vacuum Breaker: Not required.
      m. Drain: Not required.

Product Reference: Chicago Faucet Model 1100-317CP.

2.04 FLUSHOMETERS

A. Flushometers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Sloan Valve Company.
      b. Zurn Plumbing Products Group; Commercial Brass Operation.
   2. Description: Flushometer for urinal or water-closet-type fixture. Include brass body with corrosion-resistant internal components, non-hold-open feature, control stop with check valve, vacuum breaker, copper or brass tubing, and polished chrome-plated finish on exposed parts.
      a. Internal Design: Diaphragm or piston operation.
b. Style: Exposed.
c. Inlet Size: NPS 1 (DN 25).
d. Trip Mechanism: Oscillating, lever-handle actuator
e. Consumption: 1.6 gal./flush (6.0 L/flush).
f. Tailpiece Size: Standard.

2.05 TOILET SEATS

A. Toilet Seats:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Beneke
   c. Church Seats.
   d. Olsonite Corp.

2. Description: Toilet seat for water-closet-type fixture.
   a. Material: Molded, solid plastic with antimicrobial agent.
   b. Configuration: Open front without cover.
   c. Size: Elongated.
   d. Hinge Type: SS, self-sustaining.
   e. Class: Standard commercial.
   f. Color: White

2.06 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Engineered Brass Co.
   b. Insul-Tect Products Co.; a Subsidiary of MVG Molded Products.
   c. McGuire Manufacturing Co., Inc.
   d. Plumberex Specialty Products Inc.
   e. TCI Products.
   f. TRUEBRO, Inc.
   g. Zum Plumbing Products Group; Tubular Brass Plumbing Products Operation.

3. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

B. Protective Shielding Piping Enclosures:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. TRUEBRO, Inc.
3. **Description:** Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

### 2.07 FIXTURE SUPPORTS

**A. Available Manufacturers:** Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

**B. Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
1. Josam Company.
3. Tyler Pipe; Wade Div.
4. Zurn Plumbing Products Group; Specification Drainage Operation.

**C. Water-Closet Supports:**
1. **Description:** Combination carrier designed for accessible and standard mounting height of wall-mounting, water-closet-type fixture. Include single or double, vertical or horizontal, hub-and-spigot or hubless waste fitting as required for piping arrangement; faceplates; couplings with gaskets; feet; and fixture bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.

**D. Urinal Supports:**
1. **Description:** Type I, urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture for wall-mounting, urinal-type fixture. Include steel uprights with feet.
2. **Accessible-Fixture Support:** Include rectangular steel uprights.

**E. Lavatory Supports:**
1. **Description:** Type II, lavatory carrier with concealed arms and tie rod for wall-mounting, lavatory-type fixture. Include steel uprights with feet.
2. **Accessible-Fixture Support:** Include rectangular steel uprights.

### 2.08 DISHWASHER AIR-GAP FITTINGS

**A. Dishwasher Air-Gap Fittings:**
1. **Available Manufacturers:** Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
   a. B & K Industries, Inc.
   c. Brasstech Inc.; Newport Brass Div.
   d. Dearborn Brass; a div. of Moen, Inc.
   e. Geberit Manufacturing, Inc.
   f. JB Products; a Federal Process Corporation Company.
   g. Sioux Chief Manufacturing Company, Inc.
   h. Watts Brass & Tubular; a division of Watts Regulator Co.
3. Description: Fitting suitable for use with domestic dishwashers and for deck mounting; with plastic body[, chrome-plated brass cover]; and capacity of at least 5 gpm (0.32 L/s); and inlet pressure of at least 5 psig (35 kPa) at a temperature of at least 140 deg F (60 deg C). Include 5/8-inch- (16-mm-) ID inlet and 7/8-inch- (22-mm-) ID outlet hose connections.

4. Hoses: Rubber and suitable for temperature of at least 140 deg F (60 deg C).
   a. Inlet Hose: 5/8-inch (16-mm) ID and [48 inches (1219 mm)] long.
   b. Outlet Hose: 7/8-inch (22-mm) ID and [48 inches (1219 mm)] long.

2.09 DISPOSERS

A. Disposers, GD-1

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. In-Sink-Erator; a div. of Emerson Electric Co.
   b. Waste King

2. Description: Continuous-feed household, food-waste disposer. Include reset button; wall switch; corrosion-resistant chamber with jam-resistant, cutlery- or stainless-steel grinder or shredder; NPS 1-1/2 (DN 40) outlet; quick-mounting, stainless-steel sink flange; antisplash guard; and combination cover/stopper.
   a. Type: Continuous-feed household.
   b. Model: Sound-insulated chamber and stainless-steel outer shell.

2.10 WATER CLOSETS

A. Water Closets: WC-1 & WC-2 (Accessible)

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. American Standard Companies, Inc.
   c. Kohler Co.


   a. Style: Flushometer valve.
      1) Bowl Type Elongated with siphon-jet design.
      2) Design Consumption: 1.6 gal./flush (6 L/flush).
      Product Reference: Sloan Regal 110-YB.

   b. Toilet Seat:

   c. Fixture Support: Water-closet support combination carrier.
      Product Reference: Josam 12000.
2.11 URINALS

A. Urinals: UR-1
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Standard Companies, Inc.
   b. Crane Plumbing, L.L.C./Fiat Products.
   c. Zurn.

2. Description: Accessible, Wall-mouuting, back-outlet, vitreous-china fixture designed for flushometer valve operation.
   a. Type: Washout with extended shields.
   b. Strainer or Trapway: Integral cast strainer with integral trap.
   c. Design Consumption: 18 gal/flush.
   f. Outlet Size: NPS 2
   g. Flushometer:
   h. Fixture Support: Urinal chair carrier.

   Product Reference: Zurn 25798.

2.12 LAVATORIES

A. Lavatories, L-1
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Kohler Co.
   b. American Standard Companies, Inc.
   c. Kohler, Co.

2. Description: Accessible, Counter-mouuting, enameled, cast-iron fixture.
   a. Type: Self –rimming.
   b. Round Lavatory Size: 19 inches (483 mm) in diameter.
   c. Faucet Hole Punching: Two holes, 4-inch (102-mm) centers.
   d. Faucet Hole Location: Top.
   e. Color: White.
   f. Faucet: Lavatory, See 2.01.
   g. Supplies: NPS 3/8 (DN 10) chrome-plated copper with stops.
   h. Drain:
      1) Location: Near back of bowl.

   i. Drain Piping: NPS 1-1/4 (DN 32) chrome-plated, cast-brass P-trap; thick tubular brass waste to wall; and wall escutcheon.

B. Lavatories, L-2
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Standard Companies, Inc.
   b. Kohler Co.
   c. American Standard Companies, Inc.
   d. Crane Plumbing, L.L.C./Fiat Products.
2. Description: Accessible, wall mounting, enameled, cast-iron fixture.
   a. Type: [With back] [Ledge back] [Shelf back] [Slab] [Pedestal].
   b. Size: [18 by 15 inches] [19 by 16 inches] [20 by 18 inches] [24 by 20 inches] <Insert dimensions> rectangular.
   c. Faucet Hole Punching: [One hole] [Three holes, 2-inch centers] [Three holes, 4-inch centers].
   d. Faucet Hole Location: [Top] [Front wall] [Inclined panel].
   e. Color: White.
   f. Faucet: Lavatory; See 2.01
   g. Supplies: NPS 3/8 (DN 10) chrome-plated copper with stops.
   h. Drain: [See faucet] [Grid] [Grid with offset waste] <Insert drain>.
      1) Location: [Not applicable] [Near back of bowl] <Insert location>.
   i. Drain Piping: [NPS 1-1/4] [NPS 1-1/4 by NPS 1-1/2] chrome-plated, cast-brass P-trap; [NPS 1-1/4] [NPS 1-1/2], [0.032-inch]-[0.045-inch]-thick tubular brass waste to wall; and wall escutcheon.
   j. Drain Piping: Schedule 40 [ABS] or [PVC], [NPS 1-1/4] [NPS 1-1/4 by NPS 1-1/2] P-trap; [NPS 1-1/4] [NPS 1-1/2], tubular waste to wall; and wall escutcheon.
      1) Exception: Omit P-trap if hair interceptor is required.
   k. Protective Shielding Guard(s):
   l. Fixture Support: Lavatory

2.13 INDIVIDUAL SHOWERS

A. Individual Showers: SH-1
   1. Description: Components for built-up shower. See Architectural.
      a. Shower Faucet: See 2.04
      b. Drain

2.14 KITCHEN SINKS

A. Bar Sinks: S-1
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Bradley
      b. Elkay
      c. Just

   2. Description: Single-bowl, residential, counter-mounting, stainless steel bar sink.
      a. Overall Dimensions:
      b. Bowl See 2.05
      c. Supplies: NPS 1/2 (DN 15) chrome-plated copper with stops.
      d. Drain: 3-1/2-inch (89-mm).
      e. Drain Piping: NPS 1-1/2 (DN 40) chrome-plated, cast-brass P-trap; 0.045-inch- (1.1-mm-) thick tubular brass waste to wall; and wall escutcheon.
      f. Drain Piping: Schedule 40 ABS or PVC, NPS 1-1/2 (DN 40) P-trap; tubular waste to wall; and wall escutcheon.
      g. Protective Shielding Guard(s):
2.15 SERVICE BASINS

A. Service Basins: MSB-1
1. Available Manufacturers: Subject to compliance with requirements,
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Precast Terrazzo Enterprises, Inc.
   b. Bradley
   c. Fiat

3. Description: Flush-to-wall, floor-mounting, precast terrazzo fixture with rim guard.
   a. Shape: Five Sided.
   b. Size: 24 by 24 inches (610 by 610 mm)
   c. Height: 12 inches (305 mm) with dropped front.
   d. Tiling Flange: On two sides.
   e. Rim Guard: On all top surfaces.
   f. Color: White
   g. Faucet: Sink <Insert designation>. Product Reference: Chicago 897
   h. Drain: Grid with Stainless Steel NPS 3 (DN 80) outlet.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.

B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.

B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.
   1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
   2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
   3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.

D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.

E. Install wall-mounting fixtures with tubular waste piping attached to supports.
F. Install floor-mounting, back-outlet water closets attached to building floor substrate and wall bracket and onto waste fitting seals.

G. Install counter-mounting fixtures in and attached to casework.

H. Install fixtures level and plumb according to roughing-in drawings.

I. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
   1. Exception: Use ball, gate, or globe valves if supply stops are not specified with fixture. Valves are specified in Division 22 Section “General-Duty Valves for Plumbing Piping.”

J. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

K. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.

L. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.

M. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.

N. Install toilet seats on water closets.

O. Install trap-seal liquid in dry urinals.

P. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

Q. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.

R. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

S. Install shower flow-control fittings with specified maximum flow rates in shower arms.

T. Install traps on fixture outlets.
   1. Exception: Omit trap on fixtures with integral traps.
   2. Exception: Omit trap on indirect wastes, unless otherwise indicated.

U. Install disposer in outlet of each sink indicated to have disposer. Install switch where indicated or in wall adjacent to sink if location is not indicated.

V. Install dishwasher air-gap fitting at each sink indicated to have air-gap fitting. Install in sink deck. Connect inlet hose to dishwasher and outlet hose to disposer.

W. Install hot-water dispensers in back top surface of sink or in countertop with spout over sink.
X. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."

Y. Set service basins in leveling bed of cement grout. Grout is specified in Division 22 Section "Common Work Results for Plumbing."

Z. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

3.03 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.04 FIELD QUALITY CONTROL

A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.

B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

E. Install fresh batteries in sensor-operated mechanisms.

3.05 ADJUSTING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Operate and adjust disposers. Replace damaged and malfunctioning units.

C. Delete fixture types in first paragraph below not in Project.
D. Adjust water pressure at faucets and flushometer valves to produce proper flow and stream.
E. Replace washers and seals of leaking and dripping faucets and stops.
F. Install fresh batteries in sensor-operated mechanisms.

3.06 CLEANING
A. Clean fixtures, faucets, and other fittings with manufacturers’ recommended cleaning methods and materials. Do the following:
   1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
   2. Remove sediment and debris from drains.
B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.07 PROTECTION
A. Provide protective covering for installed fixtures and fittings.
B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION
SECTION 22 47 00
DRINKING FOUNTAINS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

   A. This Section includes the following drinking fountains and related components:
      1. Drinking fountains.
      2. Fixture supports.

1.03 DEFINITIONS

   A. Accessible Drinking Fountain: Fixture that can be approached and used by people with
      disabilities.
   B. Cast Polymer: Dense, cast-filled-polymer plastic.
   C. Drinking Fountain: Fixture with nozzle for delivering stream of water for drinking.
   D. Fitting: Device that controls flow of water into or out of fixture.
   E. Fixture: Drinking fountain or water cooler unless one is specifically indicated.

1.04 SUBMITTALS

   A. Product Data: For each fixture indicated. Include rated capacities, furnished specialties,
      and accessories.
   B. Shop Drawings: Diagram power, signal, and control wiring.
   C. Field quality-control test reports.
   D. Operation and Maintenance Data: For fixtures to include in emergency, operation, and
      maintenance manuals.

1.05 QUALITY ASSURANCE

   A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in
      NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction,
      and marked for intended use.
B. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

C. ARI Standard: Comply with ARI's "Directory of Certified Drinking Water Coolers" for style classifications.

1.06 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Filter Cartridges: Equal to 10 percent of amount installed for each type and size indicated, but no fewer than 5 of each.

PART 2 - PRODUCTS

2.01 DRINKING FOUNTAINS

A. Drinking Fountains:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Halsey Taylor
      b. Haws Corporation.
      c. Oasis Corporation

B. DF-1: Drinking Fountains
   1. Description: Accessible, wall-mounted Hi-Lo drinking fountain.
      b. Receptor Shape: Rectangular.
      d. Bubblers: Two, with adjustable stream regulator, located on deck.
      e. Control: Push Button.
      f. Supply: NPS 3/8 with ball, gate, or globe valve.
      g. Drain: Grid with NPS 1-1/4 minimum horizontal waste and trap complying with ASME A112.18.2.
      h. Support: Type I, water cooler carrier. Refer to "Fixture Supports" Article.
      i. Product Reference: Haws Model 1119.14A

2.02 Fixture Supports

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Josam Co.
   3. Tyler Pipe; Wade Div.
   5. Zurn Plumbing Products Group; Specification Drainage Operation.

B. Description: ASME A112.6.1M, water cooler carriers. Include vertical, steel uprights with feet and tie rods and bearing plates with mounting studs matching fixture to be supported.
1. Type I: Hanger-type carrier with two vertical uprights.
2. Type II: Bilevel, hanger-type carrier with three vertical uprights.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before fixture installation. Verify that sizes and locations of piping and types of supports match those indicated.

B. Examine walls and floors for suitable conditions where fixtures are to be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 APPLICATIONS

A. Use carrier off-floor supports for wall-mounting fixtures, unless otherwise indicated.

B. Use mounting frames for recessed water coolers, unless otherwise indicated.

C. Set freestanding and pedestal drinking fountains on floor.

D. Use chrome-plated brass or copper tube, fittings, and valves in locations exposed to view. Plain copper tube, fittings, and valves may be used in concealed locations.

3.03 INSTALLATION

A. Install off-floor supports affixed to building substrate and attach wall-mounting fixtures, unless otherwise indicated.

B. Install mounting frames affixed to building construction and attach recessed water coolers to mounting frames, unless otherwise indicated.

C. Install fixtures level and plumb. For fixtures indicated for children, install at height required by authorities having jurisdiction.

D. Install water-supply piping with shutoff valve on supply to each fixture to be connected to water distribution piping. Use ball, gate, or globe valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

E. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.

F. Install pipe escutcheons at wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding pipe fittings. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."
G. Seal joints between fixtures and walls and floors using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

3.04 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

3.05 ADJUSTING

A. Adjust fixture flow regulators for proper flow and stream height.

B. Adjust water cooler temperature settings.

3.06 CLEANING

A. After completing fixture installation, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.

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. This Section includes the following:
   1. Piping materials and installation instructions common to most piping systems.
   2. Dielectric fittings.
   3. Sleeves.
   4. Escutcheons.
   5. Equipment installation requirements common to equipment sections.
   6. Painting and finishing.
   7. Concrete bases.
   8. Supports and anchorages.

1.03 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:
   1. CPVC: Chlorinated polyvinyl chloride plastic.
   2. PE: Polyethylene plastic.
   3. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:
   1. EPDM: Ethylene-propylene-diene terpolymer rubber.
   2. NBR: Acrylonitrile-butadiene rubber.
1.04 SUBMITTALS

A. Product Data: For the following:
   1. Dielectric fittings.
   2. Mechanical sleeve seals.
   3. Escutcheons.

B. Welding certificates.

1.05 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

1.07 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.02 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.03 JOINING MATERIALS

A. Refer to individual Division 23 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
      a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
   2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.04 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
   1. Manufacturers:
D. **Dielectric Flanges**: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
   1. Manufacturers:
      a. Capitol Manufacturing Co.
      b. Central Plastics Company.
      c. Epco Sales, Inc.
      e. Watts Industries, Inc.; Water Products Div.
      f. Zurn Industries, Inc.; Wilkins Div.

E. **Dielectric-Flange Kits**: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
   1. Manufacturers:
      a. Advance Products & Systems, Inc.
      b. Calpico, Inc.
      c. Central Plastics Company.
      d. Pipeline Seal and Insulator, Inc.
   2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

F. **Dielectric Couplings**: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
   1. Manufacturers:
      a. Calpico, Inc.
      b. Lochinvar Corp.

G. **Dielectric Nipples**: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.
   1. Manufacturers:
      a. Perfection Corp.
      b. Precision Plumbing Products, Inc.
      c. Sioux Chief Manufacturing Co., Inc.
      d. Victaulic Co. of America.

2.05 SLEEVES

A. **Galvanized-Steel Sheet**: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. **Steel Pipe**: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
2.06 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw.
   1. Finish: Polished chrome-plated.

D. One-Piece, Stamped-Steel Type: With set screw and chrome-plated finish.

E. One-Piece, Floor-Plate Type: Cast-iron floor plate.

2.07 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.01 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

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

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

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

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.
I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
   1. New Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
      b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
      c. Insulated Piping: One-piece, stamped-steel type with spring clips.
      d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
      e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
      f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with rough-brass finish.
      g. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
      h. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
   1. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
   2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
   3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
      a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
      b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
   4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

N. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

O. Verify final equipment locations for roughing-in.

P. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.
3.02 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA’s “Copper Tube Handbook,” using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS’s “Brazing Handbook,” “Pipe and Tube” Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 “Quality Assurance” Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.03 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:
   1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
   2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
   3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.

3.04 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.05 PAINTING

A. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.06 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer’s written instructions and according to seismic codes at Project.
   1. Construct concrete bases of dimensions indicated, but not less than 6 inches larger in both directions than supported unit.
   2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
   3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
   4. Place and secure anchorage devices. Use supported equipment manufacturer’s setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   5. Install anchor bolts to elevations required for proper attachment to supported equipment.
   6. Install anchor bolts according to anchor-bolt manufacturer’s written instructions.
   7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "[Cast-in-Place Concrete] [Miscellaneous Cast-in-Place Concrete]."

3.07 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.08 GROUTING

A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.
E. Place grout, completely filling equipment bases.
F. Place grout on concrete bases and provide smooth bearing surface for equipment.
G. Place grout around anchors.
H. Cure placed grout.

END OF SECTION
SECTION 23 05 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 requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.

B. Comply with NEMA MG 1 unless otherwise indicated.

2.02 MOTOR CHARACTERISTICS
A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 5,300 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. Rotor: Random-wound, squirrel cage.

E. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

F. Temperature Rise: Match insulation rating.

G. Insulation: Class F.

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.

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 19
METERS AND GAGES FOR HVAC PIPING

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. Thermometers.
      2. Gages.
      3. Test plugs.
      4. Flowmeters.
      5. Thermal-energy meters.

1.03 DEFINITIONS
   A. CR: Chlorosulfonated polyethylene synthetic rubber.
   B. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.04 SUBMITTALS
   A. Product Data: For each type of product indicated; include performance curves.
   B. Shop Drawings: Schedule for thermometers, gages, flowmeters, and thermal-energy meters indicating manufacturer's number, scale range, and location for each.
   C. Operation and Maintenance Data: For flowmeters and thermal-energy meters to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.01 METAL-CASE, LIQUID-IN-GLASS THERMOMETERS
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1. Palmer - Wahl Instruments Inc.
      2. Trerice, H. O. Co.
      3. Weiss Instruments, Inc.
      4. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
B. Case: [Die-cast aluminum] [Die-cast aluminum or brass] [Brass] [Chrome-plated brass], [7 inches] [9 inches] <Insert other> long.

C. Tube: Red or blue reading, [mercury] [mercury or organic-liquid] [organic-liquid] filled, with magnifying lens.

D. Tube Background: Satin-faced, nonreflective aluminum with permanently etched scale markings.

E. Window: [Glass] [Glass or plastic] [Plastic] <Insert other>.

F. Connector: [Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device] [Rigid, straight type] [Rigid, angle type].

G. Stem: Copper-plated steel, aluminum, or brass for thermowell installation and of length to suit installation.

H. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.02 PLASTIC-CASE, LIQUID-IN-GLASS THERMOMETERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Ernst Gage Co.
   2. Eugene Ernst Products Co.
   3. Marsh Bellofram.
   4. Miljoco Corp.
   5. Trerice, H. O. Co.
   6. Wexler Instruments Operating Unit; Dresser Industries; Instrument Div.
   7. Winters Instruments.

B. Case: Plastic, [7 inches] [9 inches] <Insert other> long.

C. Tube: Red or blue reading, mercury or organic-liquid filled, with magnifying lens.

D. Tube Background: Satin-faced, nonreflective aluminum with permanently etched scale markings.

E. Window: Glass or plastic.

F. Connector: [Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device] [Rigid, straight type] [Rigid, angle type].

G. Stem: Metal, for thermowell installation and of length to suit installation.

H. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.03 THERMOWELLS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AMETEK, Inc.; U.S. Gauge Div.
3. Ernst Gage Co.
5. Miljoco Corp.
6. NANMAC Corporation.
7. Noshok, Inc.
8. Palmer - Wahl Instruments Inc.
9. REO TEMP Instrument Corporation.
10. Tel-Tru Manufacturing Company.
11. Trerice, H. O. Co.
12. Weiss Instruments, Inc.
13. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
14. WIKA Instrument Corporation.
15. Winters Instruments.

B. Manufacturers: Same as manufacturer of thermometer being used.

C. Description: Pressure-tight, socket-type metal fitting made for insertion into piping and of type, diameter, and length required to hold thermometer.

2.04 PRESSURE GAGES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AMETEK, Inc.; U.S. Gauge Div.
3. Ernst Gage Co.
4. Eugene Ernst Products Co.
5. KOBOLD Instruments, Inc.
7. Miljoco Corp.
8. Noshok, Inc.
10. REO TEMP Instrument Corporation.
11. Trerice, H. O. Co.
12. Weiss Instruments, Inc.
13. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
14. WIKA Instrument Corporation.
15. Winters Instruments.

B. Direct-Mounting, Dial-Type Pressure Gages: Indicating-dial type complying with ASME B40.100.
1. Case: [Dry] [Liquid-filled] type, [drawn steel or cast aluminum] [metal or plastic] [plastic]. [4-1/2-inch] [6-inch] <Insert other> diameter.
2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
3. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.
4. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Pointer: Red or other dark-color metal.
7. Window: [Glass] [Glass or plastic] [Plastic] <Insert other>.
8. Ring: [Metal] [Brass] [Stainless steel] [Metal or plastic] [Plastic].
9. Accuracy: Grade [A, plus or minus 1 percent of middle half] [B, plus or minus 2 percent of middle half] [C, plus or minus 3 percent of middle half] [D, plus or minus 5 percent of whole] scale.

10. Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure.

11. Range for Fluids under Pressure: Two times operating pressure.

C. Pressure-Gage Fittings:
   1. Valves: NPS 1/4 brass or stainless-steel needle type.
   2. Syphons: NPS 1/4 coil of brass tubing with threaded ends.
   3. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

2.05 TEST PLUGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Flow Design, Inc.
   2. MG Piping Products Co.
   4. Peterson Equipment Co., Inc.
   5. Sisco Manufacturing Co.
   6. Treerice, H. O. Co.

B. Description: Corrosion-resistant brass or stainless-steel body with core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping.

C. Minimum Pressure and Temperature Rating: [500 psig at 200 deg F] <Insert other>.

D. Core Inserts: One or two self-sealing rubber valves.
   1. Insert material for air, water, oil, or gas service at 20 to 200 deg F shall be CR.
   2. Insert material for air or water service at minus 30 to plus 275 deg F shall be EPDM.

2.06 WAFFER-ORIFICE FLOWMETERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. ABB, Inc.; ABB Instrumentation.
   2. Armstrong Pumps, Inc.
   4. Bell & Gossett; ITT Industries.
   5. Meriam Instruments Div.; Scott Fetzer Co.

B. Description: Differential-pressure-design orifice insert for installation between pipe flanges; with calibrated flow-measuring element, separate flowmeter, hoses or tubing, valves, fittings, and conversion chart compatible with flow-measuring element, flowmeter, and system fluid.

C. Construction: Cast-iron body, brass valves with integral check valves and caps, and calibrated nameplate.
D. Pressure Rating: [300 psig] <Insert other>.

E. Temperature Rating: [250 deg F] <Insert other>.

F. Range: Flow range of flow-measuring element and flowmeter shall cover operating range of equipment or system served.

G. Permanent Indicators: Suitable for wall or bracket mounting, calibrated for connected flowmeter element, and having 6-inch-diameter, or equivalent, dial with fittings and copper tubing for connecting to flowmeter element.
   1. Scale: Gallons per minute.
   2. Accuracy: Plus or minus 1 percent between 20 and 80 percent of range.

H. Portable Indicators: Differential-pressure type calibrated for connected flowmeter element and having two 12-foot hoses in carrying case.
   1. Scale: Gallons per minute.
   2. Accuracy: Plus or minus 2 percent between 20 and 80 percent of range.

I. Operating Instructions: Include complete instructions with each flowmeter.

2.07 VENTURI FLOWMETERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Armstrong Pumps, Inc.
   2. Badger Meter, Inc.; Industrial Div.
   5. Gerand Engineering Co.
   6. Hyspan Precision Products, Inc.
   8. McCrometer, Inc.
   10. Victaulic Co. of America.

B. Description: Differential-pressure design for installation in piping; with calibrated flow-measuring element, separate flowmeter, hoses or tubing, valves, fittings, and conversion chart compatible with flow-measuring element, flowmeter, and system fluid.

C. Construction: Bronze, brass, or factory-primed steel; with brass fittings and attached tag with flow conversion data.

D. Pressure Rating: 250 psig.

E. Temperature Rating: 250 deg F.

F. End Connections for NPS 2 and Smaller: Threaded.

G. End Connections for NPS 2-1/2 and Larger: Flanged or welded.

H. Range: Flow range of flow-measuring element and flowmeter shall cover operating range of equipment or system served.
I. Portable Indicators: Differential-pressure type calibrated for connected flowmeter element and having two 12-foot hoses in carrying case.
   1. Scale: Gallons per minute.
   2. Accuracy: Plus or minus 2 percent between 20 and 80 percent of range.

J. Operating Instructions: Include complete instructions with each flowmeter.

2.08 INSERTION-TURBINE, THERMAL-ENERGY METER SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Data Industrial Corp.
   2. ONICON Incorporated.
   3. Thermo Measurement Ltd.

B. Description: Flow sensor, [strainer], two temperature sensors, transmitter, meter, and connecting wiring.

C. Flow Sensor: Insertion-type turbine or paddle-wheel element with corrosion-resistant-metal body and transmitter.
   1. Pressure Rating: [125 psig] <Insert other>.
   2. Temperature Range: [40 to 250 deg F] <Insert other>.

D. Meter: Solid-state integrating type [with integral battery pack].
   1. Data Output: Six-digit electromechanical counter with readout in kilowatts per hour or British thermal units.
   2. Accuracy: Plus or minus [1] <Insert other> percent.

E. Strainer: Full size of main line piping.

PART 3 - EXECUTION

3.01 THERMOMETER APPLICATIONS

A. Install liquid-in-glass thermometers in the following locations:
   1. Inlet and outlet of each hydronic zone.
   2. Inlet and outlet of each hydronic boiler and chiller.
   3. Inlet and outlet of each hydronic coil in air-handling units and built-up central systems.
   4. Inlet and outlet of each hydronic heat exchanger.
   5. Inlet and outlet of each hydronic heat-recovery unit.
   6. Inlet and outlet of each thermal storage tank.
   7. Outside-air, return-air, and mixed-air ducts.

B. Install direct-mounting, vapor-actuated dial thermometers in the following locations:
   1. Inlet and outlet of each hydronic zone.
   2. Inlet and outlet of each hydronic boiler and chiller.
   3. Inlet and outlet of each hydronic coil in air-handling units and built-up central systems.
   4. Inlet and outlet of each hydronic heat exchanger.
   5. Inlet and outlet of each hydronic heat-recovery unit.
   6. Inlet and outlet of each thermal storage tank.
C. Install dry [liquid-filled]-case-type, [vapor] [bimetallic]-actuated dial thermometers at suction and discharge of each pump.

D. Provide the following temperature ranges for thermometers:
1. Heating Hot Water: [30 to 240 deg F, with 2-degree scale divisions] [50 to 400 deg F, with 5-degree scale divisions] <Insert other>.
2. Condenser Water: [0 to 160 deg F, with 2-degree scale divisions] [30 to 240 deg F, with 2-degree scale divisions] <Insert other>.
3. Chilled Water: [0 to 100 deg F, with 2-degree scale divisions] [0 to 160 deg F, with 2-degree scale divisions] <Insert other>.
4. Steam and Condensate: [30 to 300 deg F, with 5-degree scale divisions] [50 to 400 deg F, with 5-degree scale divisions] <Insert other>.
5. Air Ducts: [Minus 40 to plus 110 deg F, with 2-degree scale divisions] [30 to 240 deg F, with 2-degree scale divisions] [50 to 400 deg F, with 5-degree scale divisions] <Insert other>.

3.02 GAGE APPLICATIONS

A. Install dry-case-type pressure gages for discharge of each pressure-reducing valve.

B. Install dry [liquid-filled]-case-type pressure gages at chilled- and condenser-water inlets and outlets of chillers.

C. Install dry [liquid-filled]-case-type pressure gages at suction and discharge of each pump.

3.03 INSTALLATIONS

A. Install direct-mounting thermometers and adjust vertical and tilted positions.

B. Install thermowells with socket extending [a minimum of 2 inches into fluid] [one-third of diameter of pipe] [to center of pipe] and in vertical position in piping tees where thermometers are indicated.

C. Install direct-mounting pressure gages in piping tees with pressure gage located on pipe at most readable position.

D. Install needle-valve and snubber fitting in piping for each pressure gage for fluids (except steam).

E. Install test plugs in tees in piping.

F. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters as prescribed by manufacturer’s written instructions.

G. Install flowmeter elements in accessible positions in piping systems.

H. Install differential-pressure-type flowmeter elements with at least minimum straight lengths of pipe upstream and downstream from element as prescribed by manufacturer’s written instructions.

I. Install wafer-orifice flowmeter elements between pipe flanges.
J. Install connection fittings for attachment to portable indicators in accessible locations.

K. Install flowmeters at discharge of hydronic system pumps and at inlet of hydronic air coils.

L. Assemble components and install thermal-energy meters.

M. Mount meters on wall if accessible; if not, provide brackets to support meters.

3.04 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance for meters, gages, machines, and equipment.

B. Connect flowmeter-system elements to meters.

C. Connect flowmeter transmitters to meters.

D. Connect thermal-energy-meter transmitters to meters.

3.05 ADJUSTING

A. Calibrate meters according to manufacturer’s written instructions, after installation.

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

END OF SECTION
SECTION 23 05 23
GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following general-duty valves:
   1. Copper-alloy ball valves.
   2. Ferrous-alloy butterfly valves.
   5. Ferrous-alloy wafer check valves.
   7. Resilient-seated, cast-iron, eccentric plug valves.

B. Related Sections include the following:
   1. Division 23 piping Sections for specialty valves applicable to those Sections only.
   2. Division 23 Section "Identification for HVAC Piping and Equipment" for valve tags and charts.
   3. Division 23 Section "Instrumentation and Control for HVAC" for control valves and actuators.

1.03 DEFINITIONS

A. The following are standard abbreviations for valves:
   1. CWP: Cold working pressure.
   2. EPDM: Ethylene-propylene-diene terpolymer rubber.
   3. PTFE: Polytetrafluoroethylene plastic.
   4. SWP: Steam working pressure.
   5. TFE: Tetrafluoroethylene plastic.

1.04 SUBMITTALS

A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.
1.05 QUALITY ASSURANCE

A. ASME Compliance: ASME B31.9 for building services piping valves.

B. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.

C. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, grooves, and weld ends.
   3. Set ball and plug valves open to minimize exposure of functional surfaces.
   4. Set butterfly valves closed or slightly open.
   5. 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

2.01 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.02 VALVES, GENERAL

A. Refer to Part 3 "Valve Applications" Article for applications of valves.

B. Bronze Valves: NPS 2 and smaller with threaded ends, unless otherwise indicated.

C. Ferrous Valves: NPS 2-1/2 and larger with flanged ends, unless otherwise indicated.

D. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

E. Valve Sizes: Same as upstream pipe, unless otherwise indicated.

F. Valve Actuators:
1. Chainwheel: For attachment to valves, of size and mounting height, as indicated in the “Valve Installation” Article in Part 3.
2. Handwheel: For valves other than quarter-turn types.
3. Lever Handle: For quarter-turn valves NPS 6 and smaller, except plug valves.
4. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 10 plug valves, for each size square plug head.

G. Extended Valve Stems: On insulated valves.


2.03 COPPER-ALLOY BALL VALVES

A. Available Manufacturers:

B. Manufacturers:
  1. Copper-Alloy Ball Valves:
     b. DynaQuip Controls.
     c. Hammond Valve.
     d. Jamesbury, Inc.
     e. NIBCO INC.
     f. Worcester Controls.

C. Copper-Alloy Ball Valves, General: MSS SP-110.

D. Two-Piece, Copper-Alloy Ball Valves: Bronze body with full-port, chrome-plated bronze ball; PTFE seats; and 600-psig minimum CWP rating and blowout-proof stem.

E. Three-Piece, Copper-Alloy Ball Valves: Bronze body with full-port, chrome-plated bronze ball; PTFE seats; and 600-psig minimum CWP rating and blowout-proof stem.

2.04 FERROUS-ALLOY BUTTERFLY VALVES

A. Manufacturers:
  1. Flanged, Ferrous-Alloy Butterfly Valves:
     b. Grinnell Corporation.

B. Ferrous-Alloy Butterfly Valves, General: MSS SP-67, Type I, for tight shutoff, with disc and lining suitable for potable water, unless otherwise indicated.

C. Flanged, 150-psig CWP Rating, Ferrous-Alloy Butterfly Valves: Flanged-end type with [one] [one- or two] [two]-piece stem.
2.05 BRONZE CHECK VALVES

A. Manufacturers:

1. Type 2, Bronze, Horizontal Lift Check Valves with Nonmetallic Disc:
   a. Cincinnati Valve Co.
   b. Crane Co.; Crane Valve Group; Crane Valves.
   c. Crane Co.; Crane Valve Group; Jenkins Valves.
   d. Crane Co.; Crane Valve Group; Stockham Div.
   e. Walworth Co.

2. Type 2, Bronze, Vertical Lift Check Valves with Nonmetallic Disc:
   a. Grinnell Corporation.
   b. Kitz Corporation of America.
   c. Milwaukee Valve Company.

3. Type 4, Bronze, Swing Check Valves with Nonmetallic Disc:
   a. Cincinnati Valve Co.
   b. Crane Co.; Crane Valve Group; Crane Valves.
   c. Crane Co.; Crane Valve Group; Jenkins Valves.
   d. Crane Co.; Crane Valve Group; Stockham Div.
   e. Grinnell Corporation.
   f. Hammond Valve.
   g. McWane, Inc.; Kennedy Valve Div.
   h. Milwaukee Valve Company.
   i. NIBCO INC.
   j. Red-White Valve Corp.
   k. Walworth Co.
   l. Watts Industries, Inc.; Water Products Div.

B. Bronze Check Valves, General: MSS SP-80.

C. Type 2, Class 125, Bronze, Horizontal Lift Check Valves: Bronze body with nonmetallic disc and bronze seat.

D. Type 2, Class 125, Bronze, Vertical Lift Check Valves: Bronze body with nonmetallic disc and bronze seat.

E. Type 4, Class 125, Bronze, Swing Check Valves: Bronze body with nonmetallic disc and bronze seat.

2.06 GRAY-IRON SWING CHECK VALVES

A. Manufacturers:

1. Type II, Gray-Iron Swing Check Valves with Composition to Metal Seats:
   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Crane Co.; Crane Valve Group; Stockham Div.
   c. Mueller Co.


C. Type II, Class 125, gray-iron, swing check valves with composition to metal seats.
2.07 FERROUS-ALLOY WAFER CHECK VALVES

A. Manufacturers:
   1. Dual-Plate, Ferrous-Alloy, Double-Flanged-Type Check Valves:
      a. Crane Co.; Crane Valve Group; Crane Valves.
      b. Gulf Valve Co.
      c. Techno Corp.

B. Ferrous-Alloy Wafer Check Valves, General: API 594, spring loaded.

C. Dual-Plate, Class 125 or 150, Ferrous-Alloy, Double-Flanged Check Valves: Flanged-end body.

2.08 SPRING-LOADED, LIFT-DISC CHECK VALVES

A. Manufacturers:
   1. Type I, Wafer Lift-Disc Check Valves:
      a. Mueller Steam Specialty.

   2. Type II, Compact-Wafer, Lift-Disc Check Valves:
      a. Durabla Fluid Technology, Inc.
      b. Flomatic Valves.
      c. GA Industries, Inc.
      d. Grinnell Corporation.
      e. Hammond Valve.
      f. Metraflex Co.
      g. Milwaukee Valve Company.
      h. Mueller Steam Specialty.
      i. Multiplex Manufacturing Co.
      j. NIBCO INC.
      k. SSI Equipment, Inc.
      m. Valve and Primer Corp.

   3. Type III, Globe Lift-Disc Check Valves:
      a. Durabla Fluid Technology, Inc.
      b. Flomatic Valves.
      c. GA Industries, Inc.
      d. Grinnell Corporation.
      e. Hammond Valve.
      f. Metraflex Co.
      g. Milwaukee Valve Company.
      h. Multiplex Manufacturing Co.
      i. NIBCO INC.
      j. SSI Equipment, Inc.
      l. Valve and Primer Corp.

   4. Type IV, Threaded Lift-Disc Check Valves:
      a. Check-All Valve Mfg. Co.
      b. Durabla Fluid Technology, Inc.
      c. Grinnell Corporation.
      d. Legend Valve & Fitting, Inc.
      e. Metraflex Co.
      f. Milwaukee Valve Company.
B. Lift-Disc Check Valves, General: FCI 74-1, with spring-loaded bronze or alloy disc and bronze or alloy seat.

C. Type I, Class 125, Wafer Lift-Disc Check Valves: Wafer style with cast-iron shell with diameter matching companion flanges.

D. Type I, Class 250, Wafer Lift-Disc Check Valves: Wafer style with cast-iron shell with diameter matching companion flanges.

E. Type II, Class 125, Compact-Wafer, Lift-Disc Check Valves: Compact-wafer style with cast-iron shell with diameter made to fit within bolt circle.

F. Type III, Class 125, Globe Lift-Disc Check Valves: Globe style with cast-iron shell and flanged ends.

G. Type IV, Class 125, Threaded Lift-Disc Check Valves: Threaded style with bronze shell and threaded ends.

2.09 RESILIENT-SEATED, CAST-IRON, ECCENTRIC PLUG VALVES

A. Manufacturers:
   1. General Signal; DeZurik Unit.
   2. Keystone
   4. Resilient Seating Material: Suitable for potable-water service, unless otherwise indicated.

B. Resilient-Seated, Cast-Iron, Eccentric Plug Valves, NPS 2-1/2 and Larger: MSS SP-108, and rated for 175-psig minimum CWP.
   1. Resilient Seating Material: Suitable for potable-water service, unless otherwise indicated.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

B. 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.

C. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
D. Examine threads on valve and mating pipe for form and cleanliness.

E. 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.

F. Do not attempt to repair defective valves; replace with new valves.

3.02 VALVE APPLICATIONS

A. Refer to piping Sections for specific valve applications. If valve applications are not indicated, use the following:
1. Shutoff Service: Ball or butterfly valves.
2. Throttling Service: Calibrated balancing valve or eccentric plug valve.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.

C. Heating Water Piping: Use the following types of valves:
1. Ball Valves, NPS 2 and Smaller: [One] [Two] [Three]-piece, [400-psig] [600-psig] <Insert other> CWP rating, copper alloy.
2. Ball Valves, NPS 2-1/2 and Larger: Class [150] [300], ferrous alloy.
3. Butterfly Valves, NPS 2-1/2 and Larger: [Flangeless] [Single-flange] [Flanged], [150-psig] [175-psig] [200-psig] [250-psig] [300-psig] CWP rating, ferrous alloy, with [EPDM] <Insert other> liner.
4. Lift Check Valves, NPS 2 and Smaller: Type 2, Class [125] [150] [200], [horizontal] [vertical], bronze.
5. Swing Check Valves, NPS 2 and Smaller: Type 4, Class [125] [150] [200], bronze.
6. Swing Check Valves, NPS 2-1/2 and Larger: Type II, Class [125] [250], gray iron.
7. Wafer Check Valves, NPS 2-1/2 and Larger: [Single] [Dual]-plate, [wafer] [wafer-lug] [double-flanged], Class [125 or 150] [250 or 300], ferrous alloy.
8. Spring-Loaded, Lift-Disc Check Valves, NPS 2 and Smaller: Type IV, Class [125 minimum] [150] [200].
9. Spring-Loaded, Lift-Disc Check Valves, NPS 2-1/2 and Larger: Type [I] [I or II] [II] [III], Class [125] [250], cast iron.

D. Select valves, except wafer and flangeless types, with the following end connections:
1. For Copper Tubing, NPS 2 and Smaller: Solder-joint or threaded ends, except provide valves with threaded ends for heating hot water services.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.
3.03 VALVE INSTALLATION

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

C. Locate valves for easy access and provide separate support where necessary.

D. Install valves in horizontal piping with stem at or above center of pipe.

E. Install valves in position to allow full stem movement.

F. Install check valves for proper direction of flow and as follows:
   1. Swing Check Valves: In horizontal position with hinge pin level.
   2. Dual-Plate Check Valves: In horizontal or vertical position, between flanges.
   3. Lift Check Valves: With stem upright and plumb.

3.04 JOINT CONSTRUCTION

A. Refer to Division 23 Section “Common Work Results for HVAC” for basic piping joint construction.

B. Grooved Joints: Assemble joints with keyed coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer’s written instructions.

C. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.05 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.

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 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following hangers and supports for HVAC system piping and
   equipment:
   1. Steel pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Metal framing systems.
   4. Thermal-hanger shield inserts.
   5. Fastener systems.
   6. Equipment supports.

B. Related Sections include the following:
   1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for
      trapeze hangers for pipe and equipment supports.
   2. Division 21 Section "Water-Based Fire-Suppression Systems" for pipe hangers
      for fire-protection piping.
   3. Division 23 Section "Vibration and Seismic Controls for HVAC Piping and
      Equipment" for vibration isolation devices.
   4. Division 23 Section(s) "Metal Ducts " for duct hangers and supports.

1.03 DEFINITIONS

A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.

B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and
   Supports."

1.04 PERFORMANCE REQUIREMENTS

A. Design supports for multiple pipes, including pipe stands, capable of supporting combined
   weight of supported systems, system contents, and test water.

B. Design equipment supports capable of supporting combined operating weight of
   supported equipment and connected systems and components.
1.05 SUBMITTALS

A. Product Data: For the following:
1. Steel pipe hangers and supports.
2. Thermal-hanger shield inserts.
3. Powder-actuated fastener systems.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
1. Trapeze pipe hangers. Include Product Data for components.
2. Metal framing systems. Include Product Data for components.
3. Pipe stands. Include Product Data for components.
4. Equipment supports.

C. Welding certificates.

1.06 QUALITY ASSURANCE


B. Welding: Qualify procedures and personnel according to the following:
1. AWS D1.1, "Structural Welding Code--Steel."
4. AWS D1.4, "Structural Welding Code--Reinforcing Steel."

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

B. Manufacturers:
2. ERICO/Michigan Hanger Co.
3. Grinnell Corp.
4. PHD Manufacturing, Inc.
5. Tolco Inc.

C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.
D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.03 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.04 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

B. Manufacturers:
   2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
   3. Tolco Inc.

C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.05 THERMAL-HANGER SHIELD INSERTS

A. Description: 100-psig- minimum, compressive-strength insulation insert encased in sheet metal shield.

B. Manufacturers:
   1. Pipe Shields, Inc.
   2. Value Engineered Products, Inc.

C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with vapor barrier.

D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate.

E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

G. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.
2.06 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
   1. Manufacturers:
      a. Hilti, Inc.
      b. ITW Ramset/Red Head.
      c. Masterset Fastening Systems, Inc.
      d. MKT Fastening, LLC.
      e. Powers Fasteners.

B. Mechanical-Expansion Anchors: Insert-wedge-type [zinc-coated] [stainless] steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
   1. Manufacturers:
      b. Empire Industries, Inc.
      c. Hilti, Inc.
      d. ITW Ramset/Red Head.
      e. MKT Fastening, LLC.
      f. Powers Fasteners.

2.07 EQUIPMENT SUPPORTS

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

2.08 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.01 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.
D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use padded hangers for piping that is subject to scratching.

F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8.
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.
10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8.
11. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
16. 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.
17. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint 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.

J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
   a. Horizontal (MSS Type 54): Mounted horizontally.
   b. Vertical (MSS Type 55): Mounted vertically.
   c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

N. Use [powder-actuated fasteners] [or] [mechanical-expansion anchors] instead of building attachments where required in concrete construction.

3.02 HANGER AND SUPPORT INSTALLATION

A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

C. 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-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
   2. Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. Refer to Division 07 Section “Roof Accessories” for curbs.

G. Install hangers and supports complete with necessary 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 piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.

N. Insulated Piping: Comply with the following:
   1. Attach clamps and spacers to piping.
      a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
      b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
c. Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 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 inserts.

6. Insert Material: Length at least as long as protective shield.

7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.03 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.04 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for [trapeze pipe hangers] [and] [equipment supports].

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.
3.05 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.

3.06 PAINTING

A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces. 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 [painting Sections.] [Section "High-Performance Coatings."]

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION
SECTION 23 05 48
VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

A. RELATED DOCUMENTS

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

C. SUMMARY

D. This Section includes the following:
   1. Isolation pads.
   2. Isolation mounts.

E. DEFINITIONS


H. PERFORMANCE REQUIREMENTS

I. SUBMITTALS

J. Product Data: For the following:
   1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
   2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
      a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
      b. Annotate to indicate application of each product submitted and compliance with requirements.

K. Coordination Drawings: Show coordination of seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.

L. Welding certificates.

M. Field quality-control test reports.

N. Operation and Maintenance Data: For air-mounting systems to include in operation and maintenance manuals.
PART 2 - PRODUCTS

A. VIBRATION ISOLATORS

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Amber/Booth Company, Inc.
2. Mason Industries.
3. Vibration Mountings & Controls, Inc.

C. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
1. Resilient Material: Oil- and water-resistant neoprene rubber hermetically sealed compressed fiberglass.

D. Mounts: Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.
1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

E. Spring Hangers with Vertical-Limit Stop: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.
1. 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.
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. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
8. Self-centering hanger rod cap to ensure concentricity between hanger rod and

PART 3 - EXECUTION

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

B. APPLICATIONS
1. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by [an evaluation service member of ICC-ES] [OSHPD] [an agency acceptable to authorities having jurisdiction].

2. 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.

3. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

C. VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION
1. Comply with requirements in Division 07 Section “Roof Accessories” for installation of roof curbs, equipment supports, and roof penetrations.

2. Equipment Restraints:
3. 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.

4. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).

5. Install seismic-restraint devices using methods approved by [an evaluation service member of ICC-ES] [OSHPD] [an agency acceptable to authorities having jurisdiction] providing required submittals for component.

D. Piping Restraints:
1. Comply with requirements in MSS SP-127.

2. Space lateral supports a maximum of [40 feet] <Insert dimension> o.c., and longitudinal supports a maximum of [80 feet] <Insert dimension> o.c.

3. Brace a change of direction longer than 12 feet (3.7 m).

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] [OSHPD] [an agency acceptable to authorities having jurisdiction] providing 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.

**K. ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION**

L. 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 Division 22 Section "Hydronic Piping" for piping flexible connections.

**M. FIELD QUALITY CONTROL**

N. **Testing Agency**: [Owner will engage] [Engage] a qualified testing agency to perform tests and inspections.

O. Perform tests and inspections.

P. **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 postconnection testing has been approved), and with at least seven days' advance notice.
   4. Test at least [four] [Insert number] 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.
   9. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

Q. Remove and replace malfunctioning units and retest as specified above.

R. Prepare test and inspection reports.

S. **ADJUSTING**
   1. Adjust isolators after piping system is at operating weight.
   2. 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.
   3. Adjust active height of spring isolators.
4. Adjust restraints to permit free movement of equipment within normal mode of operation.

T. DEMONSTRATION
1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-mounting systems. Refer to Division 01 Section "Demonstration And Training."

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. Valve tags.
      5. Warning tags.

1.03 SUBMITTALS
   A. Product Data: For each type of product indicated.
   B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
   C. Valve numbering scheme.
   D. 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. 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.
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.

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.

2.02 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] [Blue] [Red] [White] [Yellow] <Insert color>.

C. Background Color: [Black] [Blue] [Red] [White] [Yellow] <Insert color>.

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.


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. 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.

2.04 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, 1-1/2" diameter, 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.

2.05 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] <Insert size>.
   2. Fasteners: [Brass grommet and wire] [Reinforced grommet and wire or string].
   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: Provide color coding in accordance with ANSI A13.1.

3.04 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 HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

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. This Section includes TAB to produce design objectives for the following:
   1. Air Systems:
      a. Constant-volume air systems.
      b. Variable-air-volume systems.
   2. Hydronic Piping Systems:
      a. Constant-flow systems.
      b. Variable-flow systems.
      c. Primary-secondary systems.
   3. HVAC equipment quantitative-performance settings.
   4. Verifying that automatic control devices are functioning properly.
   5. Reporting results of activities and procedures specified in this Section.

1.03 DEFINITIONS

A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.

C. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.

D. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

E. NC: Noise criteria.

F. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

G. RC: Room criteria.
H. Report Forms: Test data sheets for recording test data in logical order.
I. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.
J. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.
K. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
L. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.
M. TAB: Testing, adjusting, and balancing.
N. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.
O. Test: A procedure to determine quantitative performance of systems or equipment.
P. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.04 SUBMITTALS
D. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.
E. Sample Report Forms: Submit two sets of sample TAB report forms.
F. Warranties specified in this Section.

1.05 QUALITY ASSURANCE
A. TAB Firm Qualifications: Engage a TAB firm certified by NEBB.
B. TAB Firms approved by the Owner for this project as are follows:
   1. Checkpoint
2. Finn & Associates
3. TAB Services
4. JPG Engineering

C. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:
   1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
   2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.


E. Instrumentation Type, Quantity, and Accuracy: As described in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."

F. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.
   1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

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. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

B. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.08 WARRANTY

A. Special Guarantee: Provide a guarantee on NEBB forms stating that NEBB will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee shall include the following provisions:
   1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
   2. Systems are balanced to optimum performance capabilities within design and installation limits.
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.
   1. Contract Documents are defined in the General and Supplementary Conditions of Contract.
   2. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

B. Examine approved submittal data of HVAC systems and equipment.

C. Examine Project Record Documents described in Division 01 Section “Project Record Documents.”

D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems’ output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine equipment performance data including fan and pump curves. 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. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.

F. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.

G. Examine system and equipment test reports.

H. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

I. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.
J. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

K. Examine terminal units, such as variable-air-volume boxes, to verify that they are accessible and their controls are connected and functioning.

L. Examine plenum ceilings used for supply air to verify that they are airtight. Verify that pipe penetrations and other holes are sealed.

M. Examine strainers for clean screens and proper perforations.

N. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

O. Examine system pumps to ensure absence of entrained air in the suction piping.

P. Examine equipment for installation and for properly operating safety interlocks and controls.

Q. Examine automatic temperature system components to verify the following:
   1. Dampers, valves, and other controlled devices are operated by the intended controller.
   2. Dampers and valves are in the position indicated by the controller.
   3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
   4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
   5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
   6. Sensors are located to sense only the intended conditions.
   7. Sequence of operation for control modes is according to the Contract Documents.
   8. Controller set points are set at indicated values.
   9. Interlocked systems are operating.
   10. Changeover from heating to cooling mode occurs according to indicated values.

R. 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 system readiness reports. Verify the following:
   1. Permanent electrical power wiring is complete.
   2. Hydronic systems are filled, clean, and free of air.
   3. Automatic temperature-control systems are operational.
   4. Equipment and duct access doors are securely closed.
   5. Balance, smoke, and fire dampers are open.
   6. Isolating and balancing valves are open and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. 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 NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.

C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, 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. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

E. Check airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling unit components.

L. Check for proper sealing of air duct system.
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 fan static pressures to determine actual static pressure as follows:
      a. Measure outlet static pressure as far downstream from the fan as practicable 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 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.

2. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
   a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.

3. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers, under final balanced conditions.

4. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.

5. 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 modes 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 static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.
      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. 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 terminal 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 terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using 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 VARIABLE-AIR-VOLUME SYSTEMS

A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a maximum set-point airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.

B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
   1. Set outside-air dampers at minimum, and return- and exhaust-air dampers at a position that simulates full-cooling load.
   2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
   3. Measure total system airflow. Adjust to within indicated airflow.
   4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
   5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow as described for constant-volume air systems.
      a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.
   6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.
   7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
   8. Record the final fan performance data.

3.07 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems’ "as-built" piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
   1. Open all manual valves for maximum flow.
   2. Check expansion tank liquid level.
   3. Check makeup-water-station pressure gage for adequate pressure for highest vent.
   4. Check flow-control valves for specified sequence of operation and set at indicated flow.
5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.

6. Set system controls so automatic valves are wide open to heat exchangers.

7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.

8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.08 PROCEDURES FOR HYDRONIC SYSTEMS

A. Measure water flow at pumps. Use the following procedures, except for positive-displacement pumps:
   1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
   2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
   3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
   4. Report flow rates that are not within plus or minus 5 percent of design.

B. Set calibrated balancing valves, if installed, at calculated presettings.

C. Measure flow at all stations and adjust, where necessary, to obtain first balance.
   1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

D. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

E. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:
   1. Determine the balancing station with the highest percentage over indicated flow.
   2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
   3. Record settings and mark balancing devices.

F. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.

G. Measure the differential-pressure control valve settings existing at the conclusions of balancing.
3.09 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS
   A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.10 PROCEDURES FOR PRIMARY-SECONDARY-FLOW HYDRONIC SYSTEMS
   A. Balance the primary system crossover flow first, then balance the secondary system.

3.11 PROCEDURES FOR MOTORS
   A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
      1. Manufacturer, model, and serial numbers.
      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 for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

3.12 PROCEDURES FOR CONDENSING UNITS
   A. Verify proper rotation of fans.
   B. Measure entering- and leaving-air temperatures.
   C. Record compressor data.

3.13 PROCEDURES FOR BOILERS
   A. If hydronic, measure entering- and leaving-water temperatures and water flow.
   B. If steam, measure entering-water temperature and flow and leaving steam pressure, temperature, and flow.

3.14 PROCEDURES FOR HEAT-TRANSFER COILS
   A. Water Coils: Measure the following data for each coil:
      1. Entering- and leaving-water temperature.
      2. Water flow rate.
      3. Water pressure drop.
      4. Dry-bulb temperature of entering and leaving air.
      5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.
7. Air pressure drop.

B. Refrigerant Coils: Measure the following data for each 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.

3.15 PROCEDURES FOR TEMPERATURE MEASUREMENTS

A. During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.

B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of two successive eight-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.

C. Measure outside-air, wet- and dry-bulb temperatures.

3.16 TEMPERATURE-CONTROL VERIFICATION

A. Verify that controllers are calibrated and commissioned.

B. Check transmitter and controller locations and note conditions that would adversely affect control functions.

C. Record controller settings and note variances between set points and actual measurements.

D. Check the operation of limiting controllers (i.e., high- and low-temperature controllers).

E. Check free travel and proper operation of control devices such as damper and valve operators.

F. Check the sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water flow measurements. Note the speed of response to input changes.

G. Check the interaction of electrically operated switch transducers.

H. Check the interaction of interlock and lockout systems.

I. Check main control supply-air pressure and observe compressor and dryer operations.

J. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or nongrounded power supply.

K. Note operation of electric actuators using spring return for proper fail-safe operations.
3.17 TOLERANCES

A. Set HVAC system airflow and water flow rates within the following tolerances:
   1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 10 to minus 5 percent of design flow quantities.
   2. Air Outlets and Inlets: Plus 10 to minus 5 percent of design flow quantities.
   3. Heating-Water Flow Rate: Plus 10 to minus 5 percent of design flow quantities.

3.18 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.

3.19 FINAL REPORT

A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.

B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
   1. Include a list of instruments used for procedures, along with proof of calibration.

C. Final Report Contents: In addition to certified field report data, include the following:
   1. Pump curves.
   2. Fan curves.
   3. Manufacturers' test data.
   4. Field test reports prepared by system and equipment installers.
   5. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.

D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:
   1. Title page.
   2. Name and address of TAB firm.
   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 firm 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, type size, and fittings.
14. Notes to explain why certain final data in the body of reports varies from indicated values.
15. Test conditions for fans and pump performance forms including the following:
   a. Settings for outside-, 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. Inlet vane settings for variable-air-volume systems.
   g. Settings for supply-air, static-pressure controller.
   h. Other system operating conditions that affect performance.

E. Air-Handling Unit Test Reports: For air-handling units with coils, include the following:
1. Unit Data: Include the following:
   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. Sheave dimensions, center-to-center, and amount of adjustments in inches.
   j. Number of belts, make, and size.
   k. Number of filters, type, and size.

2. Motor Data:
   a. 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. Sheave dimensions, center-to-center, and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):
   a. Total airflow rate in cfm (L/s).
   b. Total system static pressure in inches wg (Pa).
   c. Fan rpm.
   d. Discharge static pressure in inches wg (Pa).
   e. Filter static-pressure differential in inches wg (Pa).
   f. Preheat coil static-pressure differential in inches wg (Pa).
   g. Cooling coil static-pressure differential in inches wg (Pa).
   h. Heating coil static-pressure differential in inches wg (Pa).
   i. Outside airflow in cfm (L/s).
   j. Return airflow in cfm (L/s).
   k. Outside-air damper position.
   l. Return-air damper position.
   m. Vortex damper position.

F. 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. Sheave dimensions, center-to-center, and amount of adjustments in inches.

2. Motor Data:
a. 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. Sheave dimensions, center-to-center, and amount of adjustments in inches.
g. Number of belts, make, and size.

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.

G. 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 airflow rate in cfm.
h. Indicated velocity in fpm.
i. Actual airflow rate in cfm.
j. Actual average velocity in fpm.
k. Barometric pressure in psig.

H. Air-Terminal-Device Reports:
1. Unit Data:
a. System and air-handling unit identification.
b. Location and zone.
c. Test apparatus used.
d. Area served.
e. Air-terminal-device make.
f. Air-terminal-device number from system diagram.
g. Air-terminal-device type and model number.
h. Air-terminal-device size.
i. Air-terminal-device effective area in sq. ft.

2. Test Data (Indicated and Actual Values):
a. Airflow rate in cfm.
b. Air velocity in fpm.
c. Preliminary airflow rate as needed in cfm.
d. Preliminary velocity as needed in fpm.
e. Final airflow rate in cfm.
f. Final velocity in fpm.
g. Space temperature in deg F.

I. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
1. Unit Data:
   a. System and air-handling unit identification.
   b. Location and zone.
   c. Room or riser served.
   d. Coil make and size.
   e. Flowmeter type.

   2. Test Data (Indicated and Actual Values):
      a. Airflow rate in cfm.
      b. Entering-water temperature in deg F.
      c. Leaving-water temperature in deg F.
      d. Water pressure drop in feet of head or psig.
      e. Entering-air temperature in deg F.
      f. Leaving-air temperature in deg F.

J. Compressor and Condenser Reports: For refrigerant side of unitary systems, stand-alone refrigerant compressors, air-cooled condensing units, or water-cooled condensing units, include the following:
1. Unit Data:
   a. Unit identification.
   b. Location.
   c. Unit make and model number.
   d. Compressor make.
   e. Compressor model and serial numbers.
   f. Refrigerant weight in lb.
   g. Low ambient temperature cutoff in deg F.

   2. Test Data (Indicated and Actual Values):
      a. Inlet-duct static pressure in inches wg.
      b. Outlet-duct static pressure in inches wg.
      c. Entering-air, dry-bulb temperature in deg F.
      d. Leaving-air, dry-bulb temperature in deg F.
      e. Condenser entering-water temperature in deg F.
      f. Condenser leaving-water temperature in deg F.
      g. Condenser-water temperature differential in deg F.
      h. Condenser entering-water pressure in feet of head or psig.
      i. Condenser leaving-water pressure in feet of head or psig.
      j. Condenser-water pressure differential in feet of head or psig.
      k. Control settings.
      l. Unloader set points.
      m. Low-pressure-cutout set point in psig.
      n. High-pressure-cutout set point in psig.
      o. Suction pressure in psig.
      p. Suction temperature in deg F.
      q. Condenser refrigerant pressure in psig.
      r. Condenser refrigerant temperature in deg F.
      s. Oil pressure in psig.
t. Oil temperature in deg F.

u. Voltage at each connection.

v. Amperage for each phase.

w. Kilowatt input.

x. Crankcase heater kilowatt.

y. Number of fans.

z. Condenser fan rpm.

aa. Condenser fan airflow rate in cfm.

bb. Condenser fan motor make, frame size, rpm, and horsepower.

c. Condenser fan motor voltage at each connection.

dd. Condenser fan motor amperage for each phase.

K. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:
   a. Unit identification.
   b. Location.
   c. Service.
   d. Make and size.
   e. Model and serial numbers.
   f. Water flow rate in gpm.
   g. Water pressure differential in feet of head or psig.
   h. Required net positive suction head in feet of head or psig.
   i. Pump rpm.
   j. Impeller diameter in inches.
   k. Motor make and frame size.
   l. Motor horsepower and rpm.
   m. Voltage at each connection.
   n. Amperage for each phase.
   o. Full-load amperage and service factor.
   p. Seal type.

2. Test Data (Indicated and Actual Values):
   a. Static head in feet of head or psig.
   b. Pump shutoff pressure in feet of head or psig.
   c. Actual impeller size in inches.
   d. Full-open flow rate in gpm.
   e. Full-open pressure in feet of head or psig.
   f. Final discharge pressure in feet of head or psig.
   g. Final suction pressure in feet of head or psig.
   h. Final total pressure in feet of head or psig.
   i. Final water flow rate in gpm.
   j. Voltage at each connection.
   k. Amperage for each phase.

L. Boiler Test Reports:

1. Unit Data:
   a. Unit identification.
   b. Location.
   c. Service.
   d. Make and type.
   e. Model and serial numbers.
   f. Fuel type and input in Btuh.
   g. Number of passes.
   h. Ignition type.
   i. Burner-control types.
j. Voltage at each connection.
k. Amperage for each phase.

2. Test Data (Indicated and Actual Values):
a. Operating pressure in psig.
b. Operating temperature in deg F.
c. Entering-water temperature in deg F.
d. Leaving-water temperature in deg F.
e. Number of safety valves and sizes in NPS.
f. Safety valve settings in psig.
g. High-limit setting in psig.
h. Operating-control setting.
i. High-fire set point.
j. Low-fire set point.
k. Voltage at each connection.
l. Amperage for each phase.
m. Draft fan voltage at each connection.
n. Draft fan amperage for each phase.
o. Manifold pressure in psig.

M. Instrument Calibration Reports:
1. Report Data:
a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.20 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. Randomly check the following for each system:
a. Measure airflow of at least 10 percent of air outlets.
b. Measure water flow of at least 5 percent of terminals.
c. Measure room temperature at each thermostat/temperature sensor.
   Compare the reading to the set point.
d. Verify that balancing devices are marked with final balance position.
e. Note deviations to the Contract Documents in the Final Report.

B. Final Inspection:
1. After initial inspection is complete and evidence 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 Owner.
2. TAB firm test and balance engineer shall conduct the inspection in the presence of Owner.
3. Ownershall randomly select measurements documented in the final report to be rechecked. The 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.
4. If the rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

6. TAB firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final report.

7. Request a second final inspection. If the second final inspection also fails, Owner shall contract the services of another TAB firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment.

3.21 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional testing and balancing 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 testing, inspecting, and adjusting during near-peak summer and winter conditions.

END OF SECTION
SECTION 23 07 00
HVAC INSULATION

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. Insulation Materials:
   a. Flexible elastomeric.
   b. Mineral fiber.
2. Insulating cements.
3. Adhesives.
5. Sealants.
6. Factory-applied jackets.
7. Field-applied jackets.
B. Related Sections:
1. Division 21 Section "Fire-Suppression Systems Insulation."
2. Division 22 Section "Plumbing Insulation."
3. Division 23 Section "Metal Ducts" for duct liners.

1.03 SUBMITTALS
A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).

1.04 QUALITY ASSURANCE
A. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.
1.05 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.

1.06 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.07 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

2.01 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. 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 I] [II with factory-applied vinyl jacket] [III with factory-applied FSK jacket] [III with factory-applied FSP jacket]. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. CertainTeed Corp.; Duct Wrap.
   b. Johns Manville; Microlite.
   c. Knauf Insulation; Duct Wrap.
   d. Manson Insulation Inc.; Alley Wrap.
   e. Owens Corning; All-Service Duct Wrap.

D. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Johns Manville; Micro-Lok.
b. Knauf Insulation; 1000 Pipe Insulation.
c. Manson Insulation Inc.; Alley-K.
d. 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, [without factory-applied jacket] [with factory-applied ASJ] [with factory-applied ASJ-SSL]. Factory-applied jacket requirements are specified in “Factory-Applied Jackets” Article.

E. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied [ASJ] [FSK jacket] complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in “Factory-Applied Jackets” Article.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. CertainTeed Corp.; CrimpWrap.
   b. Johns Manville; MicroFlex.
   c. Knauf Insulation; Pipe and Tank Insulation.
   d. Manson Insulation Inc.; AK Flex.
   e. Owens Corning; Fiberglas Pipe and Tank Insulation.

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. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Products, Division of ITW; CP-82.
   c. ITW TACC, Division of Illinois Tool Works; S-90/80.
   d. Marathon Industries, Inc.; 225.
   e. Mon-Eco Industries, Inc.; 22-25.


1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Products, Division of ITW; CP-82.
   c. ITW TACC, Division of Illinois Tool Works; S-90/80.
   d. Marathon Industries, Inc.; 225.
   e. Mon-Eco Industries, Inc.; 22-25.

D. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Dow Chemical Company (The); 739, Dow Silicone.
   e. Speedline Corporation; Speedline Vinyl Adhesive.
2.03 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.

2.04 SEALANTS

A. ASJ Flashing Sealants:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; CP-76.
   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.

2.05 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
   2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
   3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
   4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
   5. PVDC Jacket for Indoor Applications: 4-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
      a. Products: Subject to compliance with requirements, provide one of the following:
         1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

2.06 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Johns Manville; Zeston.
      c. Proto PVC 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.
5. Factory-fabricated tank heads and tank side panels.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
   1. Verify that systems and equipment to be insulated have been tested and are free of defects.
   2. Verify that surfaces to be insulated are clean and dry.
   3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

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 equipment, ducts and fittings, and piping including fittings, valves, and specialties.
B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.
C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
E. Install multiple layers of insulation with longitudinal and end seams staggered.
F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer’s recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch-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.
      a. For below ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints at ends adjacent to duct and pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches 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.
5. Handholes.
6. Cleanouts.

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 Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
   4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
   1. Comply with requirements in Division 07 Section "Penetration Firestopping" and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:
   1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
   2. Pipe: Install insulation continuously through floor penetrations.
   3. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."
3.05 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

A. Mineral Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer’s recommended coverage rates per unit area, for [100] [50] percent coverage of tank and vessel surfaces.

2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.

3. Protect exposed corners with secured corner angles.

4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
   a. Do not weld anchor pins to ASME-labeled pressure vessels.
   b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
   c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
   d. Do not overcompress insulation during installation.
   e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
   f. Impale insulation over anchor pins and attach speed washers.
   g. 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.

5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.

6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.

7. Stagger joints between insulation layers at least 3 inches.

8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.

9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.

10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

3.06 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. Label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connections 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 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.

3.07 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
   2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
   4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
   4. Install jacket material with manufacturer’s recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
   3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   4. Install insulation to flanges as specified for flange insulation application.

E. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer’s recommended coverage rates per unit area, for [100] [50] 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 overcompress insulation during installation.
   e. Impale insulation over pins and attach speed washers.
   f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 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 2 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.

3.08 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:
   1. Draw jacket material smooth and tight.
   2. Install lap or joint strips with same material as jacket.
   3. Secure jacket to insulation with manufacturer’s recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

3.09 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:
1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return located in nonconditioned space.
4. Indoor, exposed return located in nonconditioned space.
5. Indoor, concealed, Type I, commercial, kitchen hood exhaust.
6. Indoor, exposed, Type I, commercial, kitchen hood exhaust.
7. Indoor, concealed oven and warewash exhaust.
8. Indoor, exposed oven and warewash exhaust.
9. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
10. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
11. Outdoor, concealed supply and return.
12. Outdoor, exposed supply and return.

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.

3.10 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, round supply-air duct insulation shall be the following:
1. Mineral-Fiber Blanket: [1-1/2 inches] [2 inches] [3 inches] <Insert thickness> thick and [0.75-lb/cu. ft.] [1.5-lb/cu. ft.] [3-lb/cu. ft.] nominal density.

3.11 EQUIPMENT INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.
C. Heating-hot-water expansion/compression tank insulation shall be the following:
   1. Mineral-Fiber Pipe and Tank: [1 inch] \(<\text{Insert thickness}>\) thick.

D. Heating-hot-water air-separator insulation shall be the following:

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. Drainage piping located in crawl spaces.
   2. Underground piping.
   3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.13 INDOOR PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water below 60 Deg F:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

B. Heating-Hot-Water Supply and Return, 200 Deg F and below:
   1. [NPS 12] \(<\text{Insert pipe size}>\) and Smaller: Insulation shall be [one of] the following:
      a. Mineral-Fiber, Preformed Pipe, Type I: [1 inch] [2 inches] \(<\text{Insert thickness}>\) thick.
   2. [NPS 14] \(<\text{Insert pipe size}>\) and Larger: Insulation shall be [one of] the following:
      a. Mineral-Fiber, Preformed Pipe, Type I: [1-1/2 inches] [2 inches] [3 inches] \(<\text{Insert thickness}>\) thick.

C. Refrigerant Suction and Hot-Gas Piping:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: [1 inch] \(<\text{Insert thickness}>\) thick.

D. Refrigerant Suction and Hot-Gas Flexible Tubing:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Flexible Elastomeric: [1 inch] \(<\text{Insert thickness}>\) thick.
      b. Polyolefin: [1 inch] \(<\text{Insert thickness}>\) thick.

END OF SECTION
SECTION 23 11 23
FACILITY NATURAL-GAS PIPING

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. Pipes, tubes, and fittings.
   2. Piping specialties.
   3. Piping and tubing joining materials.
   4. Valves.
   5. Pressure regulators.
   6. Mechanical sleeve seals.

1.03 DEFINITIONS
A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

1.04 PERFORMANCE REQUIREMENTS
A. Minimum Operating-Pressure Ratings:
   1. Piping and Valves: 100 psig minimum unless otherwise indicated.
   2. Service Regulators: [65 psig] [100 psig] minimum unless otherwise indicated.
   3. Minimum Operating Pressure of Service Meter: [5 psig] [10 psig] [20 psig] [65 psig] <Insert value>.
B. Natural-Gas System Pressure within Buildings: [0.5 psig or less] [More than 0.5 psig but not more than 2 psig] [More than 2 psig but not more than 5 psig] <Insert pressure range>.

1.05 SUBMITTALS
A. Product Data: For each type of the following:
1. Piping specialties.
2. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
3. Pressure regulators. Indicate pressure ratings and capacities.
4. Dielectric fittings.
5. Mechanical sleeve seals.

B. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
   1. Shop Drawing Scale: [1/4 inch per foot] <Insert scale>.
   2. Detail mounting, supports, and valve arrangements for [service meter assembly and] pressure regulator assembly.

C. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.

D. Welding certificates.

E. Field quality-control reports.

F. Operation and Maintenance Data: For [motorized gas valves] [pressure regulators] [and] [service meters] to include in emergency, operation, and maintenance manuals.

1.06 QUALITY ASSURANCE

A. Steel Support 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.

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

1.07 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.

B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.
1.08 PROJECT CONDITIONS

A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.

B. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:
   1. Notify Owner no fewer than two days in advance of proposed interruption of natural-gas service.
   2. Do not proceed with interruption of natural-gas service without Owner's written permission.

1.09 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.01 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
   4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
      b. End Connections: Threaded or butt welding to match pipe.
      c. Lapped Face: Not permitted underground.
      e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.

2.02 PIPING SPECIALTIES

A. Y-Pattern Strainers:
   1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
   2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: [40] [60]-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.

B. Basket Strainers:
1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: [40] [60]-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.

C. T-Pattern Strainers:
1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
2. End Connections: Grooved ends.
3. Strainer Screen: [40] [60]-mesh startup strainer, and perforated stainless-steel basket with 57 percent free area.
4. CWP Rating: 750 psig.

D. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.03 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.


C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

2.04 MANUAL GAS SHUTOFF VALVES

A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.

B. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.
1. CWP Rating: [125 psig] <Insert pressure>.
3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.
C. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.
   1. CWP Rating: [125 psig] <Insert pressure>.
   2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
   4. Service Mark: Initials "WOG" shall be permanently marked on valve body.

D. Cast-Iron, Lubricated Plug Valves: MSS SP-78.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Flowserve.
      b. Homestead Valve; a division of Olson Technologies, Inc.
      d. Milliken Valve Company.
      e. Mueller Co.; Gas Products Div.
   2. Body: Cast iron, complying with ASTM A 126, Class B.
   3. Plug: Bronze or nickel-plated cast iron.
   4. Seat: Coated with thermoplastic.
   5. Stem Seal: Compatible with natural gas.
   7. Operator: Square head or lug type with tamperproof feature where indicated.
   8. Pressure Class: 125 psig.
   9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
   10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.05 PRESSURE REGULATORS

A. General Requirements:
   1. Single stage and suitable for natural gas.
   2. Steel jacket and corrosion-resistant components.
   3. Elevation compensator.
   4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Canadian Meter Company Inc.
      b. Eaton Corporation; Controls Div.
      c. Harper Wyman Co.
      d. Maxitrol Company.
      e. SCP, Inc.
   5. Seat Disc: Nitrile rubber.
8. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Close equipment shutoff valves before turning off natural gas to premises or piping section.
B. Inspect natural-gas piping according to [NFPA 54] [the International Fuel Gas Code] to determine that natural-gas utilization devices are turned off in piping section affected.
C. Comply with [NFPA 54] [the International Fuel Gas Code] requirements for prevention of accidental ignition.

3.03 INDOOR PIPING INSTALLATION

A. Comply with [NFPA 54] [the International Fuel Gas Code] for installation and purging of natural-gas piping.
B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. 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.
C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
E. 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.
F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
G. Locate valves for easy access.
H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.

I. Install piping free of sags and bends.

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

K. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

L. Verify final equipment locations for roughing-in.

M. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

N. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

O. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

P. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

Q. Connect branch piping from top or side of horizontal piping.

R. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.

S. Do not use natural-gas piping as grounding electrode.

T. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

U. Install pressure gage [downstream] [upstream and downstream] from each line regulator. Pressure gages are specified in Division 23 Section "Meters and Gages for HVAC Piping."

3.04 VALVE INSTALLATION

A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.

B. Install underground valves with valve boxes.

C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.
D. Install earthquake valves aboveground outside buildings according to listing.
E. Install anode for metallic valves in underground PE piping.

3.05 PIPING JOINT CONSTRUCTION
A. Ream ends of pipes and tubes and remove burrs.
B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
C. Threaded Joints:
   1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
   2. Cut threads full and clean using sharp dies.
   3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
   4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
   5. 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.
D. Welded Joints:
   2. Bevel plain ends of steel pipe.
   3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

3.06 HANGER AND SUPPORT INSTALLATION
A. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
   1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
   2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
   3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
   4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
   5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

3.07 CONNECTIONS
A. Install piping adjacent to appliances to allow service and maintenance of appliances.
B. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.
C. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.
3.08 LABELING AND IDENTIFYING

A. Comply with requirements in Division 23 Section "Identification for HVAC Piping and Equipment" for piping and valve identification.

3.09 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG

A. Aboveground, branch piping [NPS 1] <Insert pipe size> and smaller shall be the following:
   1. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping shall be the following:
   1. Steel pipe with wrought-steel fittings and welded joints.

3.10 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves for pipe sizes NPS 2 and smaller at service meter shall be the following:
   1. Bronze plug valve.

B. Valves for pipe sizes NPS 2-1/2 and larger at service meter shall be the following:
   1. Cast-iron, nonlubricated plug valve.

END OF SECTION
SECTION 23 21 13
HYDRONIC PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:
   1. Hot-water heating piping.
   2. Makeup-water piping.
   3. Air-vent piping.

B. Related Sections include the following:
   1. Division 23 Section "Common Work Results for HVAC".
   2. Division 23 Section "Hydronic Pumps" for pumps, motors, and accessories for hydronic piping.
   3. Division 23 Section "HVAC Water Treatment".

1.03 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:
   1. Hot-Water Heating Piping: 150 psig at 200 deg F.
   2. Makeup-Water Piping: 80 psig at 150 deg F.
   3. Air-Vent Piping: 200 deg F.
   4. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

1.04 SUBMITTALS

A. Product Data: For each type of the following:
   1. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
   2. Air control devices.
   3. Hydronic specialties.

B. Field quality-control test reports.

C. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.
1.05 QUALITY ASSURANCE

A. Installer Qualifications:

B. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01.

PART 2 - PRODUCTS

2.01 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

B. Wrought-Copper Fittings: ASME B16.22.

C. Wrought-Copper Unions: ASME B16.22.

2.02 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; type, grade, and wall thickness as indicated in Part 3 "Piping Applications" Article.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in Part 3 "Piping Applications" Article.


E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in Part 3 "Piping Applications" Article.

F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

2. End Connections: Butt welding.
3. Facings: Raised face.

2.03 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
HYDRONIC PIPING

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

D. Solder Filler Metals: ASTM B 32, [lead-free 95-5 tin-antimony alloy] [silver-tin-copper alloy, minimum 5% silver content]. Include water-flushable flux according to ASTM B 813.

E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.


G. Solvent Cements for Joining Plastic Piping:
1. CPVC Piping: ASTM F 493.
2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

H. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

I. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.04 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper-alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Nipples:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Perfection Corporation; a subsidiary of American Meter Company.
2. Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

2.05 VALVES

A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 23 Section "General-Duty Valves for HVAC Piping."

B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Division 23 Section "Instrumentation and Control for HVAC."

C. Bronze, Calibrated-Orifice, Balancing Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong Pumps, Inc.
   b. Bell & Gossett Domestic Pump; a division of ITT Industries.
   c. Flow Design Inc.
   d. Gerand Engineering Co.
   e. Griswold Controls.
   f. Taco.

2. Body: Bronze, ball or plug type with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Plug: Resin.
5. Seat: PTFE.
6. End Connections: Threaded or socket.
8. Handle Style: Lever, with memory stop to retain set position.
10. Maximum Operating Temperature: 250 deg F.

D. Diaphragm-Operated Safety Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Amtrol, Inc.
      b. Armstrong Pumps, Inc.
      c. Bell & Gossett Domestic Pump; a division of ITT Industries.
      d. Conbraco Industries, Inc.
      e. Spence Engineering Company, Inc.
      f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

   2. Body: Bronze or brass.
   3. Disc: Glass and carbon-filled PTFE.
   5. Stem Seals: EPDM O-rings.
   6. Diaphragm: EPT.
   8. Inlet Strainer: <Insert materials>, removable without system shutdown.
   10. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

2.06 AIR CONTROL DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Amtrol, Inc.
   2. Armstrong Pumps, Inc.
   3. Bell & Gossett Domestic Pump; a division of ITT Industries.
   4. Taco.

B. Manual Air Vents:
   1. Body: Bronze.
   2. Internal Parts: Nonferrous.
   3. Operator: Screwdriver or thumbscrew.
4. Inlet Connection: NPS 1/2.
7. Maximum Operating Temperature: 225 deg F.

C. Automatic Air Vents:
   1. Body: Bronze or cast iron.
   2. Internal Parts: Nonferrous.
   4. Inlet Connection: NPS 1/2.
   7. Maximum Operating Temperature: 240 deg F.

D. **Diaphragm** [Bladder]-Type Expansion Tanks:
   1. Tank: Welded steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature. Factory test with taps fabricated and supports installed and labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
   2. **Diaphragm** [Bladder]: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.

E. Tangential-Type Air Separators:
   1. Tank: Welded steel; ASME constructed and labeled for 125-psig minimum working pressure and 375 deg F maximum operating temperature.
   2. Air Collector Tube: Perforated stainless steel, constructed to direct released air into expansion tank.
   3. Tangential Inlet and Outlet Connections: Threaded for NPS 2 and smaller; flanged connections for NPS 2-1/2 and larger.
   5. Size: Match system flow capacity.

### 2.07 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Armstrong Machine Works
      b. Hoffman Specialty ITT; Fluid Handling Div.
      c. Watts Regulator Co.
   2. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
   3. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
   4. Strainer Screen: 40 [60]-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
   5. CWP Rating: 125 psig.

B. Stainless-Steel Bellow, Flexible Connectors:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Amber/Booth
      b. Mason Industries
c. Metraflex

3. End Connections: Threaded or flanged to match equipment connected.
5. CWP Rating: 150 psig.
6. Maximum Operating Temperature: 250 deg F.

PART 3 - EXECUTION

3.01 PIPING APPLICATIONS

A. Hot-water heating piping, aboveground, shall be any of the following:
   1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
   2. Schedule 40 steel pipe; Class 125, cast-iron fittings; cast-iron flanges and flange fittings; and threaded joints.

B. Makeup-water piping installed aboveground shall be the following:
   1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

C. Condensate-Drain Piping: Type M, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

D. Air-Vent Piping:
   1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.
   2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.

E. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.

3.02 VALVE APPLICATIONS

A. Install shutoff-duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.

B. Install [throttling-duty] [calibrated-orifice, balancing] valves at each branch connection to return main.

C. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.

D. Install check valves at each pump discharge and elsewhere as required to control flow direction.

E. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; and pipe drain to nearest floor drain or as indicated on Drawings.
Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01, for installation requirements.

F. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.03 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such 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. Select system components with pressure rating equal to or greater than system operating pressure.

K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

P. Install valves according to Division 23 Section "General-Duty Valves for HVAC Piping."
Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

S. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

T. Install expansion loops, expansion joints, anchors, and pipe alignment guides as specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping."

U. Identify piping as specified in Division 23 Section "Identification for HVAC Piping and Equipment."

### 3.04 HANGERS AND SUPPORTS

A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Comply with the following requirements for maximum spacing of supports.

B. Install the following pipe attachments:
   1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
   2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
   3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
   4. Spring hangers to support vertical runs.
   5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
   6. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.

C. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
   1. NPS 3/4: Maximum span, 7 feet; minimum rod size, 1/4 inch.
   2. NPS 1: Maximum span, 7 feet; minimum rod size, 1/4 inch.
   3. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
   4. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
   5. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 3/8 inch.
   6. NPS 3: Maximum span, 12 feet; minimum rod size, 3/8 inch.
   7. NPS 4: Maximum span, 14 feet; minimum rod size, 1/2 inch.
   8. NPS 6: Maximum span, 17 feet; minimum rod size, 1/2 inch.
   9. NPS 8: Maximum span, 19 feet; minimum rod size, 5/8 inch.
  10. NPS 10: Maximum span, 20 feet; minimum rod size, 3/4 inch.
  11. NPS 12: Maximum span, 23 feet; minimum rod size, 7/8 inch.
  12. NPS 14: Maximum span, 25 feet; minimum rod size, 1 inch.
  13. NPS 16: Maximum span, 27 feet; minimum rod size, 1 inch.
  14. NPS 18: Maximum span, 28 feet; minimum rod size, 1-1/4 inches.
  15. NPS 20: Maximum span, 30 feet; minimum rod size, 1-1/4 inches.
D. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
   1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
   2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
   3. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
   4. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
   5. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
   6. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.

E. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.05 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. 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.

F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.06 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.

C. Install tangential air separator in pump suction. Install blowdown piping with gate or full-port ball valve; extend full size to nearest floor drain.

D. Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system Project requirements.
3.07 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install ports for pressure gages and thermometers at coil inlet and outlet connections according to Division 23 Section "Meters and Gages for HVAC Piping."

3.08 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:
   1. Leave joints, including welds, uninsulated and exposed for examination during test.
   2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
   3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
   4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
   5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:
   1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
   2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
   3. Isolate expansion tanks and determine that hydronic system is full of water.
   4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
   5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
   6. Prepare written report of testing.

C. Perform the following before operating the system:
   1. Open manual valves fully.
   2. Inspect pumps for proper rotation.
   3. Set makeup pressure-reducing valves for required system pressure.
   4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
   5. Set temperature controls so all coils are calling for full flow.
   6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

END OF SECTION
SECTION 23 21 23

HYDRONIC PUMPS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following:
   2. Separately coupled, base-mounted, end-suction centrifugal pumps.

1.03 DEFINITIONS

A. Buna-N: Nitrile rubber.

B. EPT: Ethylene propylene terpolymer.

1.04 SUBMITTALS

A. Product Data: Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.

B. Shop Drawings: Show pump layout and connections. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.

C. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.05 QUALITY ASSURANCE

A. Source Limitations: Obtain hydronic pumps through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. UL Compliance: Comply with UL 778 for motor-operated water pumps.
1.06 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

B. Store pumps in dry location.

C. Retain protective covers for flanges and protective coatings during storage.

D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

E. Comply with pump manufacturer's written rigging instructions.

1.07 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 CLOSE-COUPLLED, IN-LINE CENTRIFUGAL PUMPS

A. Manufacturers:
   1. Armstrong Pumps Inc.
   2. Bell & Gossett; Div. of ITT Industries.
   3. Taco, Inc.

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically. Rate pump for 125-psig minimum working pressure and a continuous water temperature of 225 deg F.

C. Pump Construction:
   1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, and threaded companion-flange connections.
   2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
   3. Pump Shaft: Steel, with copper-alloy shaft sleeve.
   4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.
   5. Pump Bearings: Oil lubricated; bronze-journal type.
D. Motor: Single speed, with grease-lubricated ball bearings, unless otherwise indicated; and rigidly mounted to pump casing. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

E. Capacities and Characteristics: Refer to drawings.

2.03 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS

A. Manufacturers:
1. Armstrong Pumps Inc.
2. Aurora Pump; Division of Pentair Pump Group.
3. Bell & Gossett; Div. of ITT Industries.
4. PACO Pumps.
5. Taco, Inc.

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal. Rate pump for 125-psig minimum working pressure and a continuous water temperature of 225 deg F.

C. Pump Construction:
1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and flanged connections.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
3. Pump Shaft: Steel, with copper-alloy shaft sleeve.
4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket.
5. Pump Bearings: Grease-lubricated ball bearings contained in cast-iron housing with grease fittings.

D. Shaft Coupling: Molded rubber insert and interlocking spider capable of absorbing vibration..

E. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.

F. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.

G. Motor: Single speed, with grease-lubricated ball bearings, unless otherwise indicated; secured to mounting frame, with adjustable alignment. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

H. Capacities and Characteristics: Refer to drawings.
2.04 PUMP SPECIALTY FITTINGS

A. Suction Diffuser: Angle pattern, 175-psig pressure rating, cast-iron body and end cap, pump-inlet fitting; with bronze startup and bronze or stainless-steel permanent strainers; bronze or stainless-steel straightening vanes; drain plug; and factory-fabricated support.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of work.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 CONCRETE BASES

A. Install concrete bases of dimensions indicated for pumps and controllers. Refer to Division 23 Section "Common Work Results for HVAC."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.

2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

4. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Cast-in-place concrete materials and placement requirements are specified in Division 03.

3.03 PUMP INSTALLATION

A. Comply with HI 1.4.

B. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.

C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

D. Set base-mounted pumps on concrete foundation. Disconnect coupling before setting. Do not reconnect couplings until alignment procedure is complete.

1. Support pump baseplate on rectangular metal blocks and shims, or on metal wedges with small taper, at points near foundation bolts to provide a gap of 3/4 to 1-1/2 inches between pump base and foundation for grouting.
2. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and suction and discharge flanges of pump to verify that they are level and plumb.

E. Automatic Condensate Pump Units: Install units for collecting condensate and extend to open drain.

3.04 ALIGNMENT

A. Align pump and motor shafts and piping connections after setting on foundation, grout has been set and foundation bolts have been tightened, and piping connections have been made.

B. Comply with pump and coupling manufacturers' written instructions.

C. Adjust pump and motor shafts for angular and offset alignment by methods specified in HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation."

D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.05 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

E. Install check valve and throttling valve on discharge side of pumps.

F. Install suction diffuser and shutoff valve on suction side of pumps.

G. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.

H. Install pressure gages on pump suction and discharge, at integral pressure-gage tapping, or install single gage with multiple input selector valve.

I. Install electrical connections for power, controls, and devices.

J. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

K. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
END OF SECTION
SECTION 23 31 13
METAL DUCTS

PART 1 - GENERAL

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

1.02 SUMMARY
   A. This Section includes metal ducts for supply, return, outside, and exhaust air-distribution
      systems in pressure classes from minus 2- to plus 10-inch wg. Metal ducts include the
      following:
      1. Rectangular ducts and fittings.
      2. Single-wall, round spiral-seam ducts and formed fittings.
      3. Duct liner.
   B. Related Sections include the following:
      1. Division 23 Section "Air Duct Accessories" for dampers, sound-control devices,
         duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.03 SYSTEM DESCRIPTION
   A. Duct system design, as indicated, has been used to select size and type of air-moving
      and -distribution equipment and other air system components. Changes to layout or
      configuration of duct system must be specifically approved in writing by Architect.
      Accompany requests for layout modifications with calculations showing that proposed
      layout will provide original design results without increasing system total pressure.

1.04 SUBMITTALS
   A. Shop Drawings: CAD-generated and drawn to [\textit{1/4 inch equals 1 foot}] [\textit{1/8 inch equals 1 foot}] <\textit{Insert scale}> scale. Show fabrication and installation details for metal
      ducts.
      1. Fabrication, assembly, and installation, including plans, elevations, sections,
         components, and attachments to other work.
      2. Duct layout indicating sizes and pressure classes.
      3. Elevations of top and bottom of ducts.
      4. Dimensions of main duct runs from building grid lines.
      5. Fittings.
      6. Reinforcement and spacing.
      7. Seam and joint construction.
      8. Penetrations through fire-rated and other partitions.
      9. Equipment installation based on equipment being used on Project.
      10. Duct accessories, including access doors and panels.
11. Hangers and supports, including methods for duct and building attachment, vibration isolation, and seismic restraints.
12. <Insert additional items.>

B. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
1. Ceiling suspension assembly members.
2. Other systems installed in same space as ducts.
3. Ceiling- and wall-mounting access doors and panels required to provide access to dampers and other operating devices.
4. Ceiling-mounting items, including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

C. Field quality-control test reports.

1.05 QUALITY ASSURANCE

A. NFPA Compliance:
1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 SHEET METAL MATERIALS

A. 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: Lock-forming quality; complying with ASTM A 653/A 653M and having G90 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.

C. Aluminum Sheets: ASTM B 209, alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

D. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts.

E. 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 DUCT LINER

A. Fibrous-Glass Liner: Comply with NFPA 90A or NFPA 90B and with NAIMA AH124.

1. Manufacturers:

2. Materials: ASTM C 1071; surfaces exposed to airstream shall be coated to prevent erosion of glass fibers.
   a. Thickness: [1 inch] [1-1/2 inches].
   b. Thermal Conductivity (k-Value): 0.26 at 75 deg F mean temperature.
   c. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
   d. Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
   e. Mechanical Fasteners: Galvanized steel suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in duct.
      1) Tensile Strength: Indefinitely sustain a 50-lb- tensile, dead-load test perpendicular to duct wall.
      2) Fastener Pin Length: As required for thickness of insulation and without projecting more than 1/8 inch into airstream.
      3) Adhesive for Attaching Mechanical Fasteners: Comply with fire-hazard classification of duct liner system.

2.04 SEALANT MATERIALS

A. Joint and Seam Sealants, General: The term "sealant" is not limited to materials of adhesive or mastic nature but includes tapes and combinations of open-weave fabric strips and mastics.

B. Water-Based Joint and Seam Sealant: Flexible, adhesive sealant, resistant to UV light when cured, UL 723 listed, and complying with NFPA requirements for Class 1 ducts.

C. Solvent-Based Joint and Seam Sealant: One-part, nonsag, solvent-release-curing, polymerized butyl sealant formulated with a minimum of 75 percent solids.

D. Flanged Joint Mastic: One-part, acid-curing, silicone, elastomeric joint sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.

E. Flange Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.

2.05 HANGERS AND SUPPORTS

A. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.

2. Exception: Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

B. Hanger Materials: Galvanized sheet steel or threaded steel rod.
1. Hangers Installed in Corrosive Atmospheres: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

2. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for steel sheet width and thickness and for steel rod diameters.

3. Galvanized-steel straps attached to aluminum ducts shall have contact surfaces painted with zinc-chromate primer.

C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

D. Trapeze and Riser Supports: Steel shapes complying with ASTM A 36/A 36M.
   3. Supports for Aluminum Ducts: Aluminum support materials unless materials are electrolytically separated from ducts.

2.06 RECTANGULAR DUCT FABRICATION

A. Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" and complying with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.
   1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.
   2. Deflection: Duct systems shall not exceed deflection limits according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

B. Transverse Joints: Prefabricated slide-on joints and components constructed using manufacturer's guidelines for material thickness, reinforcement size and spacing, and joint reinforcement.
   1. Manufacturers:
      a. Ductmate Industries, Inc.

C. Formed-On Flanges: Construct according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," Figure 1-4, using corner, bolt, cleat, and gasket details.
   1. Manufacturers:
      a. Ductmate Industries, Inc.
   2. Duct Size: Maximum 30 inches wide and up to 2-inch wg pressure class.
   3. Longitudinal Seams: Pittsburgh lock sealed with noncuring polymer sealant.

D. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches and larger and 0.0359 inch thick or less, with more than 10 sq. ft. of nonbraced panel area unless ducts are lined.
2.07 APPLICATION OF LINER IN RECTANGULAR DUCTS

A. 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.

B. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.

C. Butt transverse joints without gaps and coat joint with adhesive.

D. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.

E. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and standard liner product dimensions make longitudinal joints necessary.

F. 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.

G. 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:
   1. Fan discharges.
   2. Intervals of lined duct preceding unlined duct.
   3. Upstream edges of transverse joints in ducts where air velocities are greater than 2500 fpm (12.7 m/s) or where indicated.

H. 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.

2.08 ROUND DUCT AND FITTING FABRICATION

A. Round, [Longitudinal] [Spiral Lock] [Longitudinal- and Spiral Lock]-Seam Ducts: Fabricate supply ducts of galvanized steel according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

B. Duct Joints:
   1. Ducts up to 20 Inches in Diameter: Interior, center-beaded slip coupling, sealed before and after fastening, attached with sheet metal screws.
   2. Ducts 21 to 72 Inches in Diameter: Three-piece, gasketed, flanged joint consisting of two internal flanges with sealant and one external closure band with gasket.
   3. Ducts Larger Than 72 Inches in Diameter: Companion angle flanged joints per SMACNA "HVAC Duct Construction Standards--Metal and Flexible," Figure 3-2.
   4. Round Ducts: Prefabricated connection system consisting of double-lipped, EPDM rubber gasket. Manufacture ducts according to connection system manufacturer's tolerances.
      a. Manufacturers:
         1) Ductmate Industries, Inc.
C. 90-Degree Tees and Laterals and Conical Tees: Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," with metal thicknesses specified for longitudinal-seam straight ducts.

D. Diverging-Flow Fittings: Fabricate with reduced entrance to branch taps and with no excess material projecting from fitting onto branch tap entrance.

E. Fabricate elbows using die-formed, gored, pleated, or mitered construction. [Bend radius of die-formed, gored, and pleated elbows shall be 1-1/2 times duct diameter.] Unless elbow construction type is indicated, fabricate elbows as follows:
   1. Mitered-Elbow Radius and Number of Pieces: Welded construction complying with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.
   2. 90-Degree, 2-Piece, Mitered Elbows: Use only for supply systems or for material-handling Class A or B exhaust systems and only where space restrictions do not permit using radius elbows. Fabricate with single-thickness turning vanes.
   3. Round Elbows 8 Inches and Less in Diameter: Fabricate die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
   4. Round Elbows 9 through 14 Inches in Diameter: Fabricate gored or pleated elbows for 30, 45, 60, and 90 degrees unless space restrictions require mitered elbows. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
   5. Round Elbows Larger Than 14 Inches in Diameter and All Flat-Oval Elbows: Fabricate gored elbows unless space restrictions require mitered elbows.
   6. Die-Formed Elbows for Sizes through 8 Inches in Diameter and All Pressures 0.040 inch thick with 2-piece welded construction.
   7. Round Gored-Elbow Metal Thickness: Same as non-elbow fittings specified above.
   8. Flat-Oval Elbow Metal Thickness: Same as longitudinal-seam flat-oval duct specified above.
   9. Pleated Elbows for Sizes through 14 Inches in Diameter and Pressures through 10-Inch wg: 0.022 inch.

PART 3 - EXECUTION

3.01 DUCT APPLICATIONS

   A. Static-Pressure Classes: Refer to drawings.

   B. All ducts shall be galvanized steel except as follows:

      1. Aluminum ductwork in shower rooms.

3.02 DUCT INSTALLATION

   A. Construct and install ducts according to SMACNA's "HVAC Duct Construction Standards-Metal and Flexible," unless otherwise indicated.
B. Install round ducts in lengths not less than 12 feet unless interrupted by fittings.

C. Install ducts with fewest possible joints.

D. Install fabricated fittings for changes in directions, size, and shape and for connections.

E. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12 inches, with a minimum of 3 screws in each coupling.

F. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.

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. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.

J. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work.

K. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.

L. Electrical Equipment Spaces: Route ducts to avoid passing through transformer vaults and electrical equipment spaces and enclosures.

M. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2 inches.

N. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire dampers, sleeves, and firestopping sealant. Fire and smoke dampers are specified in Division 23 Section "Air Duct Accessories." Firestopping materials and installation methods are specified in Division 07 Section "Penetration Firestopping."

O. Protect duct interiors from the elements and foreign materials until building is enclosed. [Follow SMACNA's "Duct Cleanliness for New Construction."]

P. Paint interiors of metal ducts, that do not have duct liner, for 24 inches upstream of registers and grilles. Apply one coat of flat, black, latex finish coat over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 09 painting Sections.

3.03 SEAM AND JOINT SEALING

A. Seal duct seams and joints according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for duct pressure class indicated.
   1. For pressure classes lower than 2-inch wg, seal transverse joints.
B. Seal ducts before external insulation is applied.

3.04 HANGING AND SUPPORTING

A. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.

B. Support vertical ducts at maximum intervals of 16 feet and at each floor.

C. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.

D. Install concrete inserts before placing concrete.

E. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
   1. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

3.05 CONNECTIONS

A. Make connections to equipment with flexible connectors according to Division 23 Section "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.06 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections according to SMACNA's "HVAC Air Duct Leakage Test Manual" and prepare test reports:
   1. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
   2. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.
   3. Maximum Allowable Leakage: Comply with requirements for Leakage Class 3 for round and flat-oval ducts, Leakage Class 12 for rectangular ducts in pressure classes lower than and equal to 2-inch wg (both positive and negative pressures), and Leakage Class 6 for pressure classes from 2- to 10-inch wg.
   4. Remake leaking joints and retest until leakage is equal to or less than maximum allowable.

END OF SECTION
SECTION 23 33 00
AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following:
   1. Volume dampers.
   2. Motorized control dampers.
   3. Fire dampers.
   4. Smoke dampers.
   5. Combination fire and smoke dampers.
   6. Turning vanes.
   7. Duct-mounting access doors.
   8. Flexible connectors.
  10. Duct accessory hardware.

B. Related Sections include the following:
   1. Division 23 Section "Instrumentation and Control for HVAC" for electric and damper actuators.
   2. Division 28 Section "Fire Detection and Alarm" for duct-mounting fire and smoke detectors.

1.03 SUBMITTALS

A. Product Data: For the following:
   1. Volume dampers.
   2. Motorized control dampers.
   3. Fire dampers.
   4. Smoke dampers.
   5. Combination fire and smoke dampers.
   6. Turning vanes.
   7. Duct-mounting access doors.
   8. Flexible connectors.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Special fittings.
   3. Motorized-control damper installations.
4. Fire-damper, smoke-damper, and combination fire- and smoke-damper installations, including sleeves and duct-mounting access doors.

C. Coordination Drawings: Reflected ceiling plans, drawn to scale and coordinating penetrations and ceiling-mounting items. Show ceiling-mounting access panels and access doors required for access to duct accessories.

1.04 QUALITY ASSURANCE


PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 SHEET METAL MATERIALS

A. Comply with SMACNA’s "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated.

B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G90 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.

C. Aluminum Sheets: ASTM B 209, alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

D. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

2.03 VOLUME DAMPERS

A. Manufacturers:
   1. Air Balance, Inc.
   2. American Warming and Ventilating.
   4. Ruskin Company.

B. General Description: Factory fabricated, with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a
fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.

1. Pressure Classes of 3-Inch wg or Higher: End bearings or other seals for ducts with axles full length of damper blades and bearings at both ends of operating shaft.

C. Low-Leakage Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, low-leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications.

1. Steel Frames: [Hat] [U] [Angle]-shaped, galvanized sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
2. Roll-Formed Steel Blades: 0.064-inch thick, galvanized sheet steel.
4. Bearings: Oil-impregnated bronze thrust or ball.
7. Tie Bars and Brackets: Galvanized steel.

D. Jackshaft: 1-inch diameter, galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.

1. Length and Number of Mountings: Appropriate to connect linkage of each damper in multiple-damper assembly.

E. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inch thick zinc-plated steel, and a 3/4-inch hexagon locking nut. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.

2.04 MOTORIZED CONTROL DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. American Warming and Ventilating.
4. Ruskin Company.

B. General Description: AMCA-rated, minimum of 0.1084-inch thick, galvanized-steel frames with holes for duct mounting; minimum of 0.0635-inch thick, galvanized-steel damper blades with maximum blade width of 8 inches. Dampers shall be opposed blade for volume control and parallel blade for isolation/shut-off service.

1. Secure blades to 1/2-inch diameter, zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
2. Operating Temperature Range: From minus 40 to plus 200 deg F.
3. Provide parallel- or opposed-blade design with inflatable seal blade edging, or replaceable rubber seals, rated for leakage at less than 10 cfm per sq. ft. of damper area, at differential pressure of 4-inch wg when damper is being held by torque of 50 in. x lbf; when tested according to AMCA 500D.
2.05 FIRE DAMPERS

A. Manufacturers:
   1. Greenheck
   2. Nailor Industries Inc.
   3. Prefco Products, Inc.
   4. Ruskin Company

B. Fire dampers shall be labeled according to UL 555.

C. Fire Rating: 1-1/2 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: 0.052 or 0.138 inch thick as indicated and of length to suit application.
   2. Exceptions: Omit sleeve where damper frame width permits direct attachment of perimeter mounting angles on each side of wall or floor, and thickness of damper frame complies with sleeve requirements.

F. Mounting Orientation: Vertical or horizontal as indicated.

G. Blades: Roll-formed, interlocking, 0.034-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.

I. Fusible Links: Replaceable, 165 deg F rated.

2.06 COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers:
   1. Air Balance, Inc.
   2. Greenheck
   3. Nailor Industries Inc.
   4. Ruskin Company

B. General Description: Labeled according to UL 555S. Combination fire and smoke dampers shall be labeled according to UL 555 for 1-1/2-hour rating.

C. Fusible Links: Replaceable, 165 deg F rated.

D. Frame and Blades: 0.064-inch-thick, galvanized sheet steel.

E. Mounting Sleeve: Factory-installed, 0.052-inch-thick, galvanized sheet steel; length to suit wall or floor application.

F. Damper Motors: Modulating and two-position action.
   1. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
   2. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
3. **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.

4. **Outdoor Motors and Motors in Outside-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.

5. **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.

6. **Electrical Connection:** 115 V, single phase, 60 Hz.

### 2.07 TURNING VANES

A. **Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible"** for vanes and vane runners. Vane runners shall automatically align vanes.

B. **Turning Vanes:** Single wall with intermediate support rails if the length of the vanes exceeds 36". Edges of the turning vanes shall be parallel with the sides of the lebow. Rails shall be 2" wide for elbows up to 12", and 4" wide for elbows over 12" in the dimension perpendicular to the vanes.

### 2.08 DUCT-MOUNTING ACCESS DOORS

A. **General Description:** Fabricate doors airtight and suitable for duct pressure class.

B. **Door:** Double wall, duct mounting, and rectangular; fabricated of galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class. Include vision panel where indicated. Include 1-by-1-inch butt or piano hinge and cam latches.

1. **Manufacturers:**
   a. American Warming and Ventilating.
   b. Ductmate Industries, Inc.
   c. Flexmaster U.S.A., Inc.
   d. Greenheck.
   f. Ventfabrics, Inc.

2. **Frame:** Galvanized sheet steel, with bend-over tabs and foam gaskets.

3. **Provide number of hinges and locks as follows:**
   a. **Less Than 12 Inches Square:** Secure with two sash locks.
   b. **Up to 18 Inches Square:** Two hinges and two sash locks.
   c. **Up to 24 by 48 Inches:** Three hinges and two compression latches with outside and inside handles.
   d. **Sizes 24 by 48 Inches and Larger:** One additional hinge.

C. **Door:** Double wall, duct mounting, and round; fabricated of galvanized sheet metal with insulation fill and 1-inch thickness. Include cam latches.

1. **Manufacturers:**
   a. Ductmate Industries, Inc.
   b. Flexmaster U.S.A., Inc.

2. **Frame:** Galvanized sheet steel, with spin-in notched frame.
D. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.
E. Insulation: 1-inch thick, fibrous-glass or polystyrene-foam board.

2.09 FLEXIBLE CONNECTORS

A. Manufacturers:
   1. Ductmate Industries, Inc.
   2. Duro Dyne Corp.
   3. Ventfabs, Inc.

B. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.

   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.

2.10 FLEXIBLE DUCTS

A. Manufacturers:
   1. Flexmaster U.S.A., Inc.
   2. Hart & Cooley, Inc.

B. Insulated-Duct Connectors: UL 181, Class 1, multiple layers of aluminum laminate 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 20 to plus 210 deg F.

C. Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action, in sizes 3 through 18 inches to suit duct size.

2.11 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 APPLICATION AND 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. Provide 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 motorized control dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.

D. Install volume dampers in ducts with liner; avoid damage to and erosion of duct liner.

E. Provide balancing dampers at points on supply, return, and exhaust systems where branches lead from larger ducts as required for air balancing. Install at a minimum of two duct widths from branch takeoff.

F. Provide test holes at fan inlets and outlets and elsewhere as indicated.

G. Install fire and smoke dampers, with fusible links, according to manufacturer’s UL-approved written instructions.

H. Install duct access doors to allow for inspecting, adjusting, and maintaining accessories and terminal units as follows:
   1. On both sides of duct coils.
   2. Downstream from volume dampers, turning vanes, and equipment.
   3. Adjacent to fire or smoke dampers, providing access to reset or reinstall fusible links.
   4. To interior of ducts for cleaning; before and after each change in direction, at maximum 50-foot spacing.
   5. On sides of ducts where adequate clearance is available.

I. Install the following sizes for duct-mounting, rectangular access doors:
   1. One-Hand or Inspection Access: 8 by 5 inches.
   2. Two-Hand Access: 12 by 6 inches.

J. Install the following sizes for duct-mounting, round access doors:
   1. One-Hand or Inspection Access: 8 inches in diameter.
   3. Head and Hand Access: 12 inches in diameter.

K. Label access doors according to Division 23 Section “Identification for HVAC Piping and Equipment.”
L. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators.

M. For fans developing static pressures of 5-inch wg and higher, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

N. Install duct test holes where indicated and required for testing and balancing purposes.

3.02 ADJUSTING

A. Adjust duct accessories for proper settings.

B. Adjust fire and smoke dampers for proper action.

C. Final positioning of manual-volume dampers is specified in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

END OF SECTION
SECTION 23 34 23
HVAC POWER VENTILATORS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following:
   1. Centrifugal roof ventilators.

1.03 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on actual Project site elevations.

B. Operating Limits: Classify according to AMCA 99.

1.04 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
   1. Certified fan performance curves with system operating conditions indicated.
   2. Certified fan sound-power ratings.
   3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
   4. Material thickness and finishes, including color charts.
   5. Dampers, including housings, linkages, and operators.
   6. Roof curbs.
   7. Fan speed controllers.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

C. Coordination Drawings: Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   1. Roof framing and support members relative to duct penetrations.
   2. Ceiling suspension assembly members.
   3. Size and location of initial access modules for acoustical tile.
   4. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
D. Field quality-control test reports.
E. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.05 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.
C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.
D. UL Standard: Power ventilators shall comply with UL 705.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.
B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.
C. Lift and support units with manufacturer's designated lifting or supporting points.

1.07 COORDINATION

A. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

1.08 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Belts: Oneset(s) for each belt-driven unit.

PART 2 - PRODUCTS

2.01 CENTRIFUGAL ROOF VENTILATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   2. Carnes Company HVAC.
4. Loren Cook Company.
5. Penn Ventilation.

B. Description: Belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.

C. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.
   1. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.

D. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

E. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:
   1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
   4. Fan and motor isolated from exhaust airstream.

F. Accessories:
   1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
   2. Bird Screens: Removable, 1/2-inch mesh, aluminum wire.
   3. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.

G. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch-thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.
   1. Configuration: [Self-flashing without a cant strip, with mounting flange] [Built-in cant and mounting flange] [Built-in raised cant and mounting flange].
   2. Overall Height: 12 inches.

H. Capacities and Characteristics: Refer to drawings.

2.02 MOTORS

A. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.03 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."
PART 3 - EXECUTION

3.01 INSTALLATION

A. Install power ventilators level and plumb.

B. Secure roof-mounting fans to roof curbs with cadmium-plated hardware. Refer to Division 07 Section "Roof Accessories" for installation of roof curbs.

C. Install units with clearances for service and maintenance.

D. Label units according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."

3.02 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Air Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.03 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
10. Shut unit down and reconnect automatic temperature-control operators.
11. Remove and replace malfunctioning units and retest as specified above.
B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.04 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Refer to Division 23 Section “Testing, Adjusting, and Balancing for HVAC” for testing, adjusting, and balancing procedures.

D. Replace fan and motor pulleys as required to achieve design airflow.

E. Lubricate bearings.

END OF SECTION
SECTION 23 36 00
AIR TERMINAL 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. This Section includes the following:
   1. Shutoff single-duct air terminal units.

1.03 SUBMITTALS

A. Product Data: For each type of product indicated, include rated capacities, furnished specialties, sound-power ratings, and accessories.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Include a schedule showing unique model designation, room location, model number, size, and accessories furnished.
   2. Wiring Diagrams: Power, signal, and control wiring.

C. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   1. 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.

D. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section “Operation and Maintenance Data” include the following:
   1. Instructions for resetting minimum and maximum air volumes.
   2. Instructions for adjusting software set points.

1.04 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
B. NFPA Compliance: Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

1.05 COORDINATION

A. Coordinate layout and installation of air terminal units and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 SHUTOFF SINGLE-DUCT AIR TERMINAL UNITS

A. Manufacturers:
   1. Anemostat; a Mestek Company.
   2. Carnes.
   5. METALAIRE, Inc.; Metal Industries Inc.
   7. Titus.
   8. Trane Co. (The); Worldwide Applied Systems Group.

B. Configuration: Volume-damper assembly inside unit casing with control components located inside a protective metal shroud.

C. Casing: 0.034-inch steel.
   2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
   3. Air Outlet: S-slip and drive connections.
   4. Access: Removable panels for access to dampers and other parts requiring service, adjustment, or maintenance; with airtight gasket.

D. Regulator Assembly: Extruded-aluminum or galvanized-steel components; key damper blades onto shaft with nylon-fitted pivot points located inside unit casing.
   1. Automatic Flow-Control Assembly: Combined spring rates shall be matched for each volume-regulator size with machined dashpot for stable operation.
   2. Factory-calibrated and field-adjustable assembly with shaft extension for connection to externally mounted control actuator.

E. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
1. Maximum Damper Leakage: ARI 880 rated, 2 percent of nominal airflow at 3-inch wg inlet static pressure.
2. Damper Position: Normally [open] [closed].

F. DDC Controls: Single-package unitary controller and actuator specified in Division 23 Section "Instrumentation and Control for HVAC."

2.03 SOURCE QUALITY CONTROL

A. Identification: Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.

B. Verification of Performance: Rate air terminal units according to ARI 880.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

3.02 CONNECTIONS

A. Connect ducts to air terminal units according to Division 23 Section "Metal Ducts."

3.03 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace malfunctioning units and retest as specified above.

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. This Section includes ceiling- and wall-mounted diffusers, registers, and grilles.

B. Related Sections include the following:
   1. Division 23 Section "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.03 SUBMITTALS

A. Product Data: For each 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, model number, size, and accessories furnished.

B. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   1. 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.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Anemostat
   2. Carnes
   3. Krueger
   4. Metal-Aire
DIFFUSERS, REGISTERS, AND GRILLES

2.02 CEILING AIR DIFFUSERS

A. General: Except as otherwise indicated, provide manufacturer's standard ceiling air diffusers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.

B. Performance: Provide ceiling air diffusers that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.

C. Ceiling Compatibility: Provide diffusers with border styles that are compatible with adjacent ceiling systems, and that are specifically manufactured to fit into ceiling module with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling systems which will contain each type of ceiling air diffuser.

D. Types: Provide ceiling diffusers of type, capacity, and with accessories and finishes as listed on air device schedule. Provide aluminum diffusers installed in moist areas.

2.03 REGISTERS AND GRILLES

A. General: Except as otherwise indicated, provide manufacturer's standard registers and grilles where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.

B. Performance: Provide registers and grilles that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.

C. Wall Compatibility: Provide registers and grilles with border styles that are compatible with adjacent wall systems, and that are specifically manufactured to fit into wall construction with accurate fit and adequate support. Refer to general construction drawings and specifications for types of wall construction which will contain each type of wall register and grille.

D. Types: Provide registers and grilles of type, capacity, and with accessories and finishes as listed on air device schedule. Provide aluminum registers and grilles installed in moist areas.

2.04 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."
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 practicable. 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.

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 41 00
PARTICULATE AIR FILTRATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes factory-fabricated air-filter devices and media used to remove particulate matter from air for HVAC applications.

1.03 SUBMITTALS

A. Product Data: Include dimensions; operating characteristics; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.

B. Shop Drawings: Include plans, elevations, sections, and details to illustrate component assemblies and attachments.
   1. Show filter rack assembly, dimensions, materials, and methods of assembly of components.
   2. Include setting drawings, templates, and requirements for installing anchor bolts and anchorages.

C. Operation and Maintenance Data: For each type of filter and rack to include in emergency, operation, and maintenance manuals.

1.04 QUALITY ASSURANCE

A. Comply with ARI 850.

B. Comply with ASHRAE 52.1 and ASHRAE 52.2 for method of testing and rating air-filter units.

C. Comply with NFPA 70 for installing electrical components.

D. Comply with NFPA 90A and NFPA 90B.
1.05 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Provide one complete set of filters for each filter bank.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Air Filters:
      a. AAF International.
      b. Farr Co.
   2. Filter Gages:
      a. Dwyer Instruments, Inc.

2.02 DISPOSABLE PANEL FILTERS

A. Description: Factory-fabricated, viscous-coated, 2” thick flat-panel-type, disposable air filters with holding frames.

B. Media: Interlaced glass fibers sprayed with nonflammable adhesive.

C. Frame: Cardboard frame with perforated metal retainer.

D. Holding Frames: 20 gage minimum galvanized steel frame with expanded metal grid on outlet side and steel rod grid on inlet side, hinged with pull and retaining handles.

E. Rating: 500 FPM face velocity, 0.15” w.g. initial resistance, 0.5” w.g. final resistance. MERV 8.

2.03 EXTENDED-SURFACE, DISPOSABLE PANEL FILTERS

A. Description: Factory-fabricated, dry, extended-surface filters with holding frames.

B. Media: Fibrous material formed into deep-V-shaped pleats and held by self-supporting wire grid.

C. Rating: 500 FPM face velocity, 0.5” w.g. initial resistance, 1.0” w.g. final resistance. MERV 13.

2.04 FILTER GAGES

A. Description: Diaphragm type with dial and pointer in metal case, vent valves, black figures on white background, and front recalibration adjustment.
   1. Diameter: 4-1/2 inches.
2. Range: 0- to 2.0-inch wg.

B. Accessories: Static-pressure tips with integral compression fittings, ¼” aluminum tubing, gage connections, 2-way or 3-way vent valves, and mounting bracket.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install filter frames according to manufacturer’s written instructions.

B. Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.

C. Install filters in position to prevent passage of unfiltered air.

D. Install filter gage for each filter bank.

E. Install filter gage static-pressure tips upstream and downstream from filters to measure pressure drop through filter. Mount filter gages on outside of filter housing or filter plenum in an accessible position. Adjust and level inclined gages.

F. Coordinate filter installations with duct and air-handling unit installations.

3.02 CLEANING

A. After completing system installation and testing, adjusting, and balancing air-handling and air-distribution systems, clean filter housings and install new filter media.

END OF SECTION
SECTION 23 52 33
WATER-TUBE BOILERS

PART 1 - GENERAL

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

1.02 SUMMARY
A. This Section includes packaged, factory-fabricated and -assembled, gas-fired, finned
   water-tube boilers, trim, and accessories for generating hot water.
   1. Factory assembled.
   2. Forced-draft gas burner.

1.03 SUBMITTALS
A. Product Data: Include performance data, operating characteristics, furnished specialties,
   and accessories.
B. Shop Drawings: For boilers, boiler trim, and accessories. Include plans, elevations,
   sections, details, and attachments to other work.
C. Source quality-control test reports.
D. Field quality-control test reports.
E. Operation and Maintenance Data: For boilers, components, and accessories to include
   in emergency, operation, and maintenance manuals.
F. Warranty: Special warranty specified in this Section.

1.04 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in
   NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction,
   and marked for intended use.
B. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and
   Pressure Vessel Code.
C. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to
   “Gas and Oil Fired Boilers - Minimum Efficiency Requirements.”
D. I=B=R Compliance: Boilers shall be tested and rated according to HI's “Rating Procedure for Heating Boilers” and “Testing Standard for Commercial Boilers,” with I=B=R emblem on a nameplate affixed to boiler.

E. UL Compliance: Test boilers for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

1.05 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.06 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace drums, tubes, headers, cabinets, atmospheric gas burners, and pressure vessels of boilers that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Drums, Tubes, Headers, Cabinets, and Atmospheric Gas Burner: [Five] <Insert number> years from date of Substantial Completion, pro rata.

2. Warranty Period for Pressure Vessel: [20] <Insert number> years from date of Substantial Completion, for thermal shock.

PART 2 - PRODUCTS

2.01 FINNED WATER-TUBE BOILERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Lochinvar Corporation (Copper-Fin II).
2. Patterson-Kelley (Thermific).

B. Description: Factory-fabricated, -assembled, and -tested boiler with tubes sealed into headers pressure tight, and set on a steel base; including insulated jacket, flue-gas vent, combustion-air intake connections, water supply and return connections, and controls.

C. Heat Exchanger:

1. Finned coppertubing with stainless-steel baffles.
2. Bronzeheaders.
3. [Single] [Two]-pass, [horizontal] [vertical] [coil] configuration.
4. Tubes shall be sealed in header [with silicone O-ring gaskets] [by welding] [by mechanically rolling tubes in header].

D. Combustion Chamber Internal Insulation: Interlocking panels of refractory insulation, high-temperature cements, mineral fiber, and ceramic refractory tile for service temperatures to 2000 deg F.

E. Casing:

1. Jacket: Sheet metal, with snap-in or interlocking closures.
2. Control Compartment Enclosure: NEMA 250, Type 1A.
3. Finish: Baked enamel over primer.
4. Insulation: Minimum 1-inch-thick, mineral-fiber insulation surrounding the heat exchanger.
5. Combustion-Air Connection: Inlet duct collar and sheet metal closure over burner compartment.
6. Mounting base to secure boiler.

F. Burner:
   a. Sealed Combustion: Factory-mounted centrifugal fan to draw outside air into boiler and discharge into burner compartment.
   b. Direct Vent: Factory-mounted centrifugal fan to draw flue gas out of boiler and discharge into boiler vent.
2. Vertical Burner:
   a. High-temperature stainless steel to fire in a 360-degree pattern.
   b. Burner shall have a viewing port for observation of burner operation and a factory-mounted centrifugal fan to supply outside air to boiler burner.
   c. Fan shall be controlled to prepurge and postpurge the combustion chamber before firing.
3. Gas Train: Control devices and full-modulation control sequence shall comply with requirements in [AGA] [ASME CSD-1] [FMG] [IRI] [UL]. In addition to these requirements, include shutoff cock, pressure regulator, and control valve.
4. Pilot: Intermittent-electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff with electronic supervision of burner flame.
5. Flue-Gas Recirculation Fans: Centrifugal fans on burner assembly to recirculate flue gas to decrease oxides of nitrogen emissions to less than 30ppm.
   a. Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

G. Trim:
1. Aquastat Controllers: Operating, firing rate, and high limit.
2. Safety Relief Valve: ASME rated.
3. Pressure and Temperature Gage: Minimum 3-1/2-inch-diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges so normal operating range is about 50 percent of full range.

H. Controls:
1. Refer to Division 23 Section "Instrumentation and Control for HVAC."
2. Boiler operating controls shall include the following devices and features:
   a. Control transformer.
   b. Motorized Vent Damper: Interlocked with burner to open before burner starts. If damper fails to open, stop burner operation.
   c. Set-Point Adjust: Set points shall be adjustable.
3. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.
   a. High Cutoff: [Manual] [Automatic] reset stops burner if operating conditions rise above maximum boiler design temperature.
   c. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.
4. Building Management System Interface: Factory install hardware and software to enable building management system to monitor, control, and display boiler status and alarms.
   a. Monitoring: On/off status, [common trouble alarm] [low water level alarm] <Insert monitoring>.
   b. Control: On/off operation, [hot water supply temperature set-point adjustment] <Insert control>.
   c. A communication interface with building management system shall enable building management system operator to remotely control and monitor the boiler from an operator workstation. Control features available, and monitoring points displayed, locally at boiler control panel shall be available through building management system.

2.02 ELECTRICAL POWER

A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.

B. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.
   2. Wiring shall be numbered and color-coded to match wiring diagram.
   3. Install factory wiring outside of an enclosure in a [metal] raceway.
   4. Field power interface shall be to [wire lugs] [fused disconnect switch] [nonfused disconnect switch] [circuit breaker].
   5. Provide branch power circuit to each motor and to controls [with disconnect switch or circuit breaker].
   6. Provide each motor with overcurrent protection.

2.03 VENTING KITS

A. Vent Damper: Motorized, UL listed for use on atmospheric burner boiler equipped with draft hood; motor to open and close damper; stainless-steel vent coupling and damper blade; keyed wiring harness connector plug; and dual-position switches to permit burner operation.

B. Kit: Complete system, [ASTM A 959, Type 29-4C] stainless steel, pipe, vent terminal, thimble, indoor plate, vent adapter, condensate trap, and sealant.

C. Combustion-Air Intake: Stainless steel, pipe, vent terminal with screen, inlet air coupling, and sealant.

2.04 SOURCE QUALITY CONTROL

A. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.

B. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.
PART 3 - EXECUTION

3.01 EXAMINATION

A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.
   1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

B. Examine mechanical spaces for suitable conditions where boilers will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 BOILER INSTALLATION

A. Install boilers level on concrete base. Concrete base is specified in Division 23 Section "Common Work Results for HVAC," and concrete materials and installation requirements are specified in Division 03.

B. Install gas-fired boilers according to NFPA 54.

C. Install electrical devices furnished with boiler but not specified to be factory mounted.

D. Install control wiring to field-mounted electrical devices.

3.03 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to boiler to allow service and maintenance.

C. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas train connection. Provide a reducer if required.

D. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.

E. Install piping from safety relief valves to nearest floor drain.

F. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.

G. Boiler Flue Venting:
   1. Install venting kit and combustion-air intake.
   2. Connect full size to boiler connections.[Comply with requirements in Division 23 Section "Breechings, Chimneys, and Stacks."]

H. Connect breeching to full size of boiler outlet. Comply with requirements in Division 23 Section "Breechings, Chimneys, and Stacks" for venting materials.
I. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

J. Connect wiring according to Division 26 Section "Low-Voltage, Electrical Power Conductors and Cables."

3.04 FIELD QUALITY CONTROL

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

B. Tests and Inspections:
   1. Perform installation and startup checks according to manufacturer's written instructions.
   2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
   3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
      a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level, and water temperature.
      b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Remove and replace malfunctioning units and retest as specified above.

D. Performance Tests:
   1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
   2. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment in order to comply.
   3. Perform field performance tests to determine the capacity and efficiency of the boilers.
      a. For dual-fuel boilers, perform tests for each fuel.
      b. Test for full capacity.
      c. Test for boiler efficiency at [low fire 20, 40, 60, 80, 100, 80, 60, 40 and 20] <Insert range> percent of full capacity. Determine efficiency at each test point.
   4. Repeat tests until results comply with requirements indicated.
   5. Provide analysis equipment required to determine performance.
   6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.

3.05 DEMONSTRATION

A. [Engage a factory-authorized service representative to train] [Train] Owner's maintenance personnel to adjust, operate, and maintain boilers. [Video training sessions.] Refer to Division 01 Section "Demonstration and Training."

WATER-TUBE BOILERS
23 52 33 - 6
PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes fan-coil units and accessories.

1.03 DEFINITIONS

A. BAS: Building automation system.

1.04 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

C. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   1. Ceiling suspension components.
   2. Structural members to which fan-coil units will be attached.
   3. Method of attaching hangers to building structure.
   4. Size and location of initial access modules for acoustical tile.
   5. Items penetrating finished ceiling, including the following:
      a. Lighting fixtures.
      b. Air outlets and inlets.
      c. Speakers.
      d. Sprinklers.
      e. Access panels.

D. Samples for Initial Selection: For units with factory-applied color finishes.

E. Field quality-control test reports.
F. Operation and Maintenance Data: For fan-coil units to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.

G. Warranty: Special warranty specified in this Section.

1.05 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.06 COORDINATION

A. Coordinate layout and installation of fan-coil units and suspension system components with other construction that penetrates or is supported by ceilings, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

1.07 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of condensing units that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Compressor failure.
      b. Condenser coil leak.
   2. Warranty Period: [Four] [Five] [10] \(<\text{Insert number}\) years from date of Substantial Completion.
   3. Warranty Period (Compressor Only): [Five] [10] \(<\text{Insert number}\) years from date of Substantial Completion.
   4. Warranty Period (Condenser Coil Only): [Five] \(<\text{Insert number}\) years from date of Substantial Completion.

1.08 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fan-Coil-Unit Filters: Furnish one spare filter for each filter installed.
   2. Fan Belts: Furnish one spare fan belt for each unit installed.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 DUCTED FAN-COIL UNITS

   A. Manufacturers:
      1. International Environmental Corporation.
      3. Trane.

   B. Description: Factory-packaged and -tested units rated according to ARI 440, ASHRAE 33, and UL 1995.

   C. Coil Section Insulation: \( \frac{1}{2} \text{-inch} \) [1-inch] thick \{coated\} [foil-faced] glass fiber complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.
      1. Fire-Hazard Classification: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.

   D. Chassis: Galvanized steel where exposed to moisture, with baked-enamel finish and removable access panels.

   E. Cabinets: Steel with baked-enamel finish in manufacturer's standard paint color.
      1. Supply-Air Plenum: Sheet metal plenum finished and insulated to match the chassis.
      2. Return-Air Plenum: Sheet metal plenum finished to match the chassis.

   F. Filters: Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
      1. Pleated Cotton-Polyester Media: 90 percent arrestance and 7 MERV.

   G. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain.

   H. Belt-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the cabinet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.
      1. Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

   I. Control devices and operational sequence are specified in Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls."

   J. Electrical Connection: Factory wire motors and controls for a single electrical connection.

   K. Capacities and Characteristics: Refer to drawings.
PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas to receive fan-coil units for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping and electrical connections to verify actual locations before fan-coil-unit installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install fan-coil units level and plumb.

B. Install fan-coil units to comply with NFPA 90A.

C. Suspend fan-coil units from structure with elastomeric hangers. Vibration isolators are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

D. Verify locations of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation.

E. Install new filters in each fan-coil unit within two weeks after Substantial Completion.

3.03 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
   1. Install piping adjacent to machine to allow service and maintenance.

B. Connect supply and return ducts to fan-coil units with flexible duct connectors specified in Division 23 Section "Air Duct Accessories." Comply with safety requirements in UL 1995 for duct connections.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.04 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
B. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION
SECTION 23 82 33

CONVECTORS

PART 1 - GENERAL

1.01 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.

1.02 SUMMARY

A. This Section includes the following:
   1. Hydronic convectors.

1.03 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each type of product indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Plans, elevations, sections, and details.
   2. Details of custom-fabricated enclosures indicating dimensions.
   3. Location and size of each field connection.
   4. Location and arrangement of piping valves and specialties.
   5. Enclosure joints, corner pieces, access doors, and other accessories.

C. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   1. Structural members, including wall construction, to which convection units will be attached.
   2. Method of attaching convection units to building structure.
   3. Penetrations of fire-rated wall and floor assemblies.

D. Color Samples for Initial Selection: For units with factory-applied color finishes.

E. Color Samples for Verification: For each type of exposed finish required.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For convection heating units to include in emergency, operation, and maintenance manuals.
1.04 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

PART 2 - PRODUCTS

2.01 HOT-WATER CONVECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Airtherm
   2. Dunham-Bush
   3. Rittling
   4. Rosemex.
   5. Sterling.
   6. Trane.
   7. Vulcan

B. Convecto Elements: Seamless copper tubing mechanically expanded into evenly spaced aluminum fins and rolled into cast-brass headers with inlet/outlet and air vent; steel side plates and supports. Factory-pressure-test element at minimum 100 psig.

C. Front and Top Panel: Minimum 16 gage steel with exposed corners rounded; removable front panels with tamper-resistant fasteners braced and reinforced for stiffness.

D. Wall-Mounting Back and End Panels: Minimum 18 gage steel.

E. Support Brackets: Locate at maximum 36-inch spacing to support front panel and element.

F. Insulation: 1/2-inch-thick, fibrous glass on inside of the back of the enclosure.

G. Finish: Baked-enamel finish in manufacturer’s custom color as selected by Architect.

H. Damper: Knob-operated internal damper.

I. Enclosure Style: Sloped top.
   1. Front Inlet Grille: Punched louver; painted to match enclosure.
   2. Front Inlet Grille: Extruded-aluminum linear bar grille; pencil-proof bar spacing.
      b. Anodized finish, color as selected by Architect from manufacturer’s [standard] [custom] colors.
      c. Painted to match enclosure.
   3. [Top] [Front] Outlet Grille: Punched louver; painted to match enclosure.
   4. [Top] [Front] Outlet Grille: Extruded-aluminum linear bar grille; pencil-proof bar spacing.
      b. Anodized finish, color as selected by Architect from manufacturer’s [standard] [custom] colors.
      c. Painted to match enclosure.
PART 3 - EXECUTION

3.01 EXAMINATION
A. Examine areas to receive convection heating units for compliance with requirements for installation tolerances and other conditions affecting performance.
B. Examine roughing-in for hydronic-piping connections to verify actual locations before convection heating unit installation.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 CONVECTOR INSTALLATION
A. Install units level and plumb.
B. Install air-seal gasketing between wall and recessing flanges or front cover of fully recessed unit.

3.03 CONNECTIONS
A. Piping installation requirements are specified in Division 23 Section "Hydronic Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
B. Connect hot-water units and components to piping according to Division 23 Section "Hydronic Piping."
   1. Install shutoff valves on inlet and outlet, and balancing valve on outlet.
C. Install control valves as required by Division 23 Section "Instrumentation and Control for HVAC."
D. Install piping adjacent to convection heating units to allow service and maintenance.

3.04 FIELD QUALITY CONTROL
A. Perform the following field tests and inspections and prepare test reports:
   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.
B. Remove and replace convection heating units that do not pass tests and inspections and retest as specified above.

END OF SECTION
SECTION 23 82 39
UNIT HEATERS

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. Cabinet unit heaters with centrifugal fans and hot-water coils.
   2. Propeller unit heaters with [hot-water] [steam] [electric-resistance heating] coils.
   3. Wall and ceiling heaters with propeller fans and electric-resistance heating coils.

1.03 DEFINITIONS
A. BAS: Building automation system.
B. CWP: Cold working pressure.
C. PTFE: Polytetrafluoroethylene plastic.
D. TFE: Tetrafluoroethylene plastic.

1.04 SUBMITTALS
A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each product indicated.
B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Plans, elevations, sections, and details.
   2. Location and size of each field connection.
   3. Details of anchorages and attachments to structure and to supported equipment.
   4. Equipment schedules to include rated capacities, operating characteristics, furnished specialties, and accessories.
   5. Location and arrangement of piping valves and specialties.
   6. Location and arrangement of integral controls.
C. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   1. Suspended ceiling components.
2. Structural members to which unit heaters will be attached.
3. Method of attaching hangers to building structure.
4. Size and location of initial access modules for acoustical tile.
5. Items penetrating finished ceiling, including the following:
   a. Lighting fixtures.
   b. Air outlets and inlets.
   c. Speakers.
   d. Sprinklers.
   e. Access panels.
   f. [Insert item.]
6. Perimeter moldings for exposed or partially exposed cabinets.

D. Samples for Initial Selection: Finish colors for units with factory-applied color finishes.

E. Operation and Maintenance Data: For cabinet unit heaters to include in emergency, operation, and maintenance manuals.

1.05 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.06 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Cabinet Unit Heater Filters: Furnish one spare filter(s) for each filter installed.

PART 2 - PRODUCTS

2.01 CABINET UNIT HEATERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide products by one of the following:
   1. Airtherm; a Mestek Company.
   4. Rosemex Products.
   5. Trane.

C. Description: A factory-assembled and -tested unit complying with ARI 440.

D. Coil Section Insulation: ASTM C 1071; surfaces exposed to airstream shall be erosion-resistant coating to prevent erosion of glass fibers.
   1. Thickness: 1/2 inch.

UNIT HEATERS
23 82 39 - 2
2. Thermal Conductivity (k-Value): 0.26 Btu x in./h x sq. ft. at 75 deg F mean temperature.
3. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
4. Adhesive: Comply with ASTM C 916 and with NFPA 90A or NFPA 90B.

E. Cabinet: Steel with baked-enamel finish with manufacturer's standard paint, in color selected by Architect.
   1. Vertical Unit, Exposed Front Panels: Minimum 0.0528-inch-thick, sheet steel, removable panels with channel-formed edges secured with tamperproof cam fasteners.
   2. Recessing Flanges: Steel, finished to match cabinet.
   3. Control Access Door: Key operated.
   4. Extended Piping Compartment: 8-inch-wide piping end pocket.

F. Filters: Minimum arrestance according to ASHRAE 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
   1. Washable Foam: 70 percent arrestance and 3 MERV.

G. Hot-Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain.

H. Fan and Motor Board: Removable.
   1. Fan: Forward curved, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.
   2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
   3. Wiring Terminations: Connect motor to chassis wiring with plug connection.

I. Basic Unit Controls:
   1. Control voltage transformer.
   2. Unit-mounted thermostat with the following features.
      b. Fan on-auto switch.
      d. Adjustable deadband.
      e. Concealed set point.
      f. Concealed indication.
      g. Deg F indication.
   3. Unit-mounted temperature sensor.

J. Electrical Connection: Factory wire motors and controls for a single field connection.

K. Capacities and Characteristics: Refer to drawings.

2.02 PROPELLER UNIT HEATERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Airtherm; a Mestek Company.
UNIT HEATERS

3. Rosemex Products.
4. Trane.

B. Description: An assembly including casing, coil, fan, and motor in horizontal discharge configuration with adjustable discharge louvers.

C. Cabinet: Removable panels for maintenance access to controls.

D. Cabinet Finish: Manufacturer's standard baked enamel applied to factory-assembled and -tested propeller unit heater before shipping.

E. Discharge Louver: Adjustable fin diffuser for horizontal units and conical diffuser for vertical units.

F. General Coil Requirements: Test and rate hot-water propeller unit heater coils according to ASHRAE 33.

G. Hot-Water Coil: Copper tube, minimum 0.025-inch wall thickness, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 325 deg F, with manual air vent. Test for leaks to 350 psig underwater.

H. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.

I. Fan Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

J. Control Devices:
   1. Unit-mounted, fan-speed switch.
   2. Unit-mounted thermostat.

K. Capacities and Characteristics: Refer to drawings.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas to receive unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping and electrical connections to verify actual locations before unit heater installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install cabinet unit heaters to comply with NFPA 90A.

B. Install propeller unit heaters level and plumb.
C. Suspend propeller unit heaters from structure with all-thread hanger rods and [elastomeric hangers] [spring hangers] [spring hangers with vertical-limit stop]. Hanger rods and attachments to structure are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Vibration hangers are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

D. Install new filters in each cabinet unit heater within two weeks of Substantial Completion.

3.03 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Connect piping to cabinet unit heater's factory, hot-water piping package. Install the piping package if shipped loose.

D. Comply with safety requirements in UL 1995.

E. Unless otherwise indicated, install union and ball valve on supply-water connection and union and calibrated balancing valve on return-water connection of unit heater. Hydronic specialties are specified in Division 23 Section "Hydronic Piping."

F. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

G. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.04 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace malfunctioning units and retest as specified above.

3.05 ADJUSTING

A. Adjust initial temperature set points.

B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [two] -[Insert number] visits to Project during other-than-normal occupancy hours for this purpose.

END OF SECTION
SECTION 26 05 00
BASIC ELECTRICAL REQUIREMENTS

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. Description: Work shall consist of furnishing all labor, equipment, supplies, and materials, unless otherwise specified, necessary for the installation of complete electrical systems as required by the specifications and as shown on the drawings, subject to the terms and conditions of the contract. The Work shall also include the completion of those details of electrical work not mentioned or shown which are necessary for the successful operation of all electrical systems.

B. Certain labor, materials, and equipment may be furnished under other Sections of these specifications, by Utility Companies or by the Owner. When this is the case, the extent, source and description of these items will be as indicated on the drawings or as described in the specifications.

1.03 RELATED SECTIONS

A. Basic Electrical Requirements specifically applicable to Division 26 Sections, in addition to Division 1 - General Requirements.

B. Refer to LEED Section 01352 for all LEED requirements.

1.04 REFERENCE STANDARDS

A. Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents. A listing of applicable reference standards is contained in Division 1.

B. Latest editions of the following:

3. NECA - Standard of Installation.
4. The University of Colorado at Boulder Electrical Standards.
5. Other references as listed elsewhere in these specifications.
1.05 DEFINITIONS

A. "Furnish" or "Provide": To supply, install and connect up complete and ready for safe and regular operation of particular work unless specifically otherwise noted.

B. "Install": To erect, mount and connect complete with related accessories.

C. "Supply": To purchase, procure, acquire and deliver complete with related accessories.

D. "Work": Labor, materials, equipment, apparatus, controls, accessories, and other items required for proper and complete installation.

E. "Wiring": Raceway, fittings, wire, boxes and related items.

F. "Concealed": Embedded in masonry, concrete or other construction, installed in furred spaces, within double partitions or hung ceilings, in trenches, in crawl spaces, or in enclosures.

G. "Exposed": Not installed underground or "concealed" as defined above.

H. "Indicated," "Shown" or "Noted": As indicated, shown or noted on drawings or specifications.

I. "Similar" or "Equal": Equal in materials, weight, size, design, construction, capacity, performance, and efficiency of specified product.

J. "Reviewed," "Satisfactory," "Accepted," or "Directed": As reviewed, satisfactory, accepted, or directed by or to Engineer.

K. "Related Work" includes, but is not necessarily limited to, mentioned work associated with, or affected by, the work specified.

L. Refer to Article 100 of the currently adopted National Electrical Code for other definitions as applicable to this project.

1.06 WORK SEQUENCE

A. Construct Work in sequence under provisions of Division 1 where applicable.

1.07 DRAWINGS AND SPECIFICATIONS

A. The drawings indicate the general arrangement of circuits and outlets, locations of switches, panelboards and other work. Information shown on the drawings is schematic, however, recircuiting will not be permitted without specific acceptance. Drawings and specifications are complementary each to the other. What is called for by one shall be as binding as if called for by both. Data presented on these drawings is as accurate as planning can determine, but accuracy is not guaranteed and field verification of all dimensions, locations, levels, etc., to suit field conditions is directed. Review all Architectural, Structural and Mechanical Drawings and Specifications; adjust all work to conform to all conditions shown therein. The Architectural drawings shall take precedence over all other drawings.
B. Prior to submitting a bid, visit the site of the job and ascertain all conditions affecting the proposed installation and adjust all work accordingly. Make provisions for these costs.

C. Discrepancies between different plans, between plans and specifications, between specifications, or regulations and codes governing this installation shall be brought to the attention of the Engineer in writing before the date of bid opening. In the event such discrepancies exist, and the Engineer is not so notified, the adjudication of responsibility shall be solely at the discretion of the Engineer.

1.08 COORDINATION

A. Prior to fabrication or installation of any electrical work, participate in detailed coordination planning meetings with all other building utilities system trades, under the direction of the General Contractor, so as to completely establish routings, elevations, space requirements, and coordination of access, layout, and suspension requirements in relationship to the building structure and the work of all other trades.

1.09 SUBMITTALS (Refer to Division 1)

A. Submit shop drawings and product data in accordance with provisions of Division 1.

B. Prior to submission, shop drawings, material lists and catalog cuts or manufacturer's printed data shall be thoroughly checked for compliance with contract requirements, compatibility with equipment being furnished by the Contractor or Owner, accuracy of dimensions, coordination with work of other trades, and conformance with sound and safe practice as to erection of installation. Each submittal shall bear Contractor's signed statement evidencing such checking.

C. Clearly mark each shop drawing as follows for purposes of identification:

1. Shop Drawing
2. Equipment Identification Used on Contract Drawings
3. Date
4. Name of Project
5. Branch of Work
6. Engineer's Name
7. Contractor's Name

D. Clearly mark printed material, catalog cuts, pamphlets or specification sheets, and shop drawings with the same designation shown on the contract document schedules. Identify specific item proposed, showing catalog number, recess openings, dimensions, capacities, electrical characteristics, etc. Submittals, which are incomplete, will be returned to the Contractor without review.

E. Contractor agrees that submittals processed by the Engineer are not change orders; that the purpose of submittals is to demonstrate to the Engineer that the Contractor understands the design concept; and that the Contractor demonstrates this understanding by indicating which equipment and material he intends to furnish and install and by detailing the fabrication and installation methods he intends to use.

F. Contractor shall be responsible for dimensions (which he shall confirm and correlate at the job site), fabrication processes and techniques of construction, and coordination of his work with that of other trades. The Contractor shall check and verify all
measurements and review shop drawings before submitting them. If any deviations from the specified requirements for any item of material or equipment exist, such deviation shall be expressly stated in writing and incorporated with the submittal.

G. Maintain one copy of shop drawings at the project field office until completion of the project, and make this copy available, upon request, to representatives of the Engineer and Owner.

H. No equipment or materials shall be installed or stored at the jobsite until submittals for such equipment or materials have been given review action permitting their use.

I. Shop drawings and manufacturer's published data shall be submitted for:

1. All switchboards, panelboards
2. Transformers
3. Lighting fixtures (catalog cuts)
4. Fire alarm system
5. Automatic transfer switch
6. Security system
7. Motor control centers
8. Packaged Generator Set

1.10 RECORD DOCUMENTS

A. Maintain a contract set of electrical drawings at the site. Neatly mark all changes, discoveries and deviations from the original drawings. Use a color which contrasts with the prints. This shall be a separate set of drawings, not used for construction purposes, and shall be kept up to date as the job progresses and shall be made available for inspection by the Engineer at all times. Upon completion of the contract, this set of record drawings shall be delivered to the Engineer. Record documents to be provided by the Contractor shall clearly and accurately show the following:

1. Major raceway systems, size and location, for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; and fuse and circuit breaker size and arrangements.
2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.

1.11 REGULATORY REQUIREMENTS

A. Conform to those editions of the following as currently adopted by the local code enforcement authority:

1. ANSI/NFPA 70.
4. Comply with requirements of the utility and telephone companies furnishing service to this installation.
5. Other requirements as listed elsewhere in these specifications.
B. Obtain electrical permits, plan review, and inspections from authority having jurisdiction in accordance with Division 1.

C. The drawings and specifications take precedence when they are more stringent than codes, statutes, or ordinances in effect. Applicable codes, ordinances, standards and statutes take precedence when they are more stringent than, or conflict with the drawings and specifications.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Materials and Equipment: Acceptable to the authority having jurisdiction as suitable for the use intended, except where more stringent requirements are indicated by the Contract Documents.

B. Compatibility with Available Space: Equipment layouts shown are based on use of equipment as specified. If the Contractor chooses equipment available from any other manufacturer listed as an acceptable manufacturer, or offers equipment under the provision for substitutions, the Contractor shall be solely responsible for first ascertaining that the offered equipment can be installed in the space available with ample clearances for maintenance. Include coordination drawings, as specified herein, when required.

C. All equipment and materials installed shall be new, unless otherwise specified.

D. Defective or damaged materials shall be replaced or repaired, prior to final acceptance, in a manner acceptable to the Engineer or Owner and at no additional cost to the Owner.

E. All electrical materials shall be acceptable for installation only if labeled or listed by a nationally recognized testing laboratory and if accepted by local authorities.

F. All major equipment components shall have the manufacturer's name, address, model number, and serial number permanently attached in a conspicuous location.

2.02 STORAGE AND PROTECTION

A. Store products in accordance with manufacturer's instructions, with seals and labels intact and legible. Store sensitive products in weather-tight enclosures; maintain within temperature and humidity ranges required by manufacturer's instructions.

B. For exterior storage of fabricated products, place on sloped supports above ground. Cover products subject to deterioration with impervious sheet covering; provide ventilation to avoid condensation.

C. Arrange storage to provide access for inspection. Periodically inspect to assure products are undamaged, and are maintained under required conditions.

2.03 PRODUCT OPTIONS

A. Products Specified by Reference Standards or by Description Only: Any product meeting those standards.
B. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit a request for substitution for any manufacturer not specifically named.

C. Products Specified by Naming One or More Manufacturers without a Provision for Substitutions: Products of named manufacturers meeting specifications; no options, no substitutions allowed.

2.04 PRODUCTS LIST

A. Within 30 days after date of Owner-Contract or Agreement, submit complete list of major products required for submittal under these specifications, with name of manufacturer, trade name, and model number of each product.

2.05 SUBSTITUTIONS

A. Refer to Division 1.

2.06 GUARANTEE

A. The entire electrical system installed under this Contract shall be left in proper working order. Replace, at no additional cost to the Owner, any work, materials, or equipment which evidences defects in design, construction, or workmanship within one year, or as specifically noted elsewhere in these specifications, from date of final acceptance.

PART 3 - EXECUTION

3.01 WORKMANSHIP

A. Install work using procedures defined in NECA Standard of Installation.

B. Workmanship shall conform to highest industry standards for each trade involved in erection of the work.

C. Contractor's personnel and subcontractors selected to perform the work shall be well versed and skilled in the trades involved.

D. Any changes or deviations from the drawings and specifications must be accepted in writing by the Engineer. All errors in installation shall be corrected at the expense of the Contractor. All specialties shall be installed as detailed on the drawings. Where details or specific installation requirements are not provided, manufacturer's recommendations shall be followed.

E. Upon completion of work, all equipment and materials shall be installed complete, thoroughly checked, correctly adjusted, and left ready for intended use or operation. All work shall be thoroughly cleaned and all residue shall be removed from surfaces. Exterior surfaces of all material and equipment shall be delivered in a perfect, unblemished condition.
F. Contractor shall provide a complete installation, including all required labor, material, cartage, insurance, permits, and taxes.

3.02 CHASES, OPENINGS, CUTTING AND PATCHING

A. Carefully lay out all work in advance so as to eliminate where possible, cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings and roofs. Any damage to the building, structure, piping, ducts, equipment or any defaced finish shall be repaired by skilled mechanics of the trades involved at no additional cost to the Owner and to the satisfaction of the Architect/Engineer. Any necessary cutting, channeling, drilling or welding as required for the proper support, concealment, installation or anchoring of raceways, outlets, or other electrical equipment shall be performed in a careful manner, and as approved by the Engineer.

B. All openings made in fire-rated walls, floors, or ceilings shall be patched and made tight in a manner to conform to the fire rating for the surface penetrated.

C. All penetrations required through completed concrete construction shall be core drilled at minimum size required. Precautions shall be taken when drilling to prevent damage to structural concrete. The Contractor shall obtain permission from the Engineer before proceeding with drilling.

3.03 ELECTRICAL INSTALLATIONS

A. Coordinate electrical systems, equipment, and materials installation with other building components. If equipment of a different size is furnished by the Contractor, the Contractor shall furnish and install the proper motor starter, fuses, circuit breaker, disconnect switch, wire and conduit required for the equipment furnished, at no additional cost to the Owner and shall be approved by the Owner.

3.04 PROGRESS OF WORK

A. Order the progress of electrical work to conform to the progress of the work of the other trades. Complete the entire installation as soon as the condition of the building will permit. Any cost resulting from defective or ill-timed work performed under this Section shall be borne by this Contractor.

3.05 TRENCHING AND BACKFILLING

A. Perform all trenching and backfilling required by work performed under this Section in accordance with the excavating and grading specifications and as herein specified.

B. Excavate trenches to the depth required for the utilities involved. The trench bottom shall be graded true and free from stones or soft spots, bottom of trenches must be compacted.

C. After installation of electrical work, backfill, tamp, and compact to insure against the possibility of differential settling, in conformity with Division 2 Specifications. Verify location of existing or new utilities and, if damaged by this Contractor, replace or repair.
3.06 ELECTRICAL COMPLETION

A. Indoctrination of Operating and Maintenance Personnel: Furnish the services of a qualified representative of the supplier of each item or system itemized below who shall instruct specific personnel, as designated by the Owner, in the operation and maintenance of that item or system.

1. Instruction shall be given when the particular system is complete, and shall be of the number of hours indicated and at the time requested by the Owner. A representative of the Contractor shall be present for all demonstrations.

<table>
<thead>
<tr>
<th>System</th>
<th>Hours Of Instruction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire Alarm System</td>
<td>8 (2 4-hour sessions)</td>
</tr>
<tr>
<td>Electrical Distribution Equipment</td>
<td>8 (2 4-hour sessions)</td>
</tr>
<tr>
<td>(under 600 volts)</td>
<td></td>
</tr>
</tbody>
</table>

B. Operating and Maintenance Manuals and Parts Lists: Deliver three (3) complete operating & maintenance manuals and parts lists to the Owner at the time of the above required indoctrination. Fully explain the contents of the manuals as part of required indoctrination and instruct the Owner's personnel in the correct procedure in obtaining service, both during and after the guarantee period.

1. The operating and maintenance manuals and parts lists shall give complete information as to whom the Owner shall contact for service and parts. Include address and phone number. Furnish evidence that an authorized service organization regularly carries a complete stock of repair parts for these items (or systems), and that the organization is available for service. Service shall be furnished within 24 hours after requested.

C. Operating and Acceptance Tests: Provide all labor, instruments, and equipment for the performance of tests as specified below and elsewhere in these specifications. Submit three copies of a typewritten test report to the Engineer for his approval.

1. For a seven-day period after building has been placed into normal service, record the full load current in each phase or line at the main service entrance and submit to the Engineer.

2. Perform a careful inspection of the main switchboard bus structure and cable connections to verify that all connections are torqued to manufacturer's recommendations.

D. Clean-Up: Remove all materials, scrap, etc., relative to the electrical installation, and leave the premises and all equipment, lamps, fixtures, etc. in a clean, orderly condition. Any costs to the Owner for clean-up of the site will be charged against the Contractor.

E. Acceptance Demonstration: Upon completion of the work, at a time to be designated by the Engineer, the Contractor shall demonstrate for the Owner the operation of the entire installation, including all systems provided under this contract.

F. Final acceptance by the Owner will not occur until all operating instructions are received and Owner's personnel have been thoroughly indoctrinated in the maintenance and operation of all equipment.

END OF SECTION
SECTION 26 05 19
BUILDING WIRE AND CABLE

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. Building Wire and Cable.
   B. Wiring Connections and Terminations

1.03 RELATED SECTIONS
   A. Section 260532 - Conduit
   B. Section 260534 – Electrical Boxes and Fittings.
   C. Section 260529 - Supporting Devices and Seals
   D. Section 260553- Electrical Identification

1.04 REFERENCE STANDARDS
   A. Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents. A listing of applicable reference standards is contained in Division 1.
   B. NEMA WC 70 – Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
   C. NEMA WC 70 – Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

1.05 SUBMITTALS
   A. Submit shop drawings and product data under the provisions of Section 260500.

1.06 PROJECT CONDITIONS
   A. Verify that field measurements are as shown on Drawings.
   B. Conductor sizes are based on copper.
C. Wire and cable routing shown on Drawings is appropriate unless dimensioned. Route wire and cable as required to meet project conditions.

D. Where wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required.

1.07 COORDINATION

A. Coordinate Work under provisions of Section 260500.

B. Determine required separation between wiring and other work.

C. Determine routing to avoid interference with other work.

PART 2 - PRODUCTS

2.01 BUILDING WIRE

A. Thermoplastic-Insulated Building Wire: NEMA WC 70.

B. Rubber-Insulated Building Wire: NEMA WC 70.

C. Feeders and Branch Circuits: Copper, stranded conductor, 600 volt, insulation, THHN/THWN, or XHHW.

D. Control Circuits: Copper, stranded conductor 600 volt insulation, THHN/THWN, or XHHW.

2.02 REMOTE CONTROL AND SIGNAL CABLE

A. Control Cable for Class 1 Remote Control and Signal Circuits: Copper conductor, 600 volt insulation, rated 60 degree C, individual conductors twisted together, shielded, and covered with a PVC jacket.

B. Control Cable for Class 2 or Class 3 Remote Control and Signal Circuits: Copper conductor, 300 volt insulation, rated 60 degrees C, individual conductors twisted together, shielded, and covered with a PVC jacket; UL listed.

C. Plenum Cable for Class 2 or Class 3 Remote Control and Signal Circuits: Copper conductor, 300 volt insulation, rated 60 degrees C, individual conductors twisted together, shielded, and covered with a non-metallic jacket; UL listed for use in air handling ducts, hollow spaces used as ducts, and plenums.

D. Install all remote control and signal cables in cable tray, raceways, or supported every 4'-0" on bridal rings.
PART 3 - EXECUTION

3.01 GENERAL WIRING METHODS

A. Use no wire smaller than No. 12 AWG for power and lighting circuits, and no smaller than No. 16 AWG for control wiring.

B. Use No. 10 AWG conductor for 20 ampere, 120-volt branch circuit home runs longer than 75 feet, and for 20 ampere, 277-volt branch circuit home runs longer than 200 feet.

C. Place an equal number of conductors for each phase of a circuit in same raceway or cable.

D. Splice only in accessible junction or outlet boxes.

E. Neatly train and lace wiring inside boxes, equipment, and panelboards. Make temporary connections to panelboard devices with sufficient slack conductor to facilitate reconnections required for balancing loads between phases.

F. Damaged conductors during installation shall be replaced.

G. Install products in accordance with manufacturer's instructions.

3.02 WIRING INSTALLATION IN RACEWAYS

A. Pull all conductors into a raceway at the same time. Use UL listed wire-pulling lubricant for pulling No. 4 AWG and larger wires.

B. Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.

C. Completely and thoroughly swab raceway system before installing conductors.

D. Length of conductors at receptacles, junction boxes and switches: At least 6" of free conductor shall be left at each outlet, junction box and switch for splices or connection of fixtures or devices.

3.03 WIRING CONNECTION AND TERMINATIONS

A. Splice only in accessible junction boxes.

B. For No. 8 AWG and smaller, use insulated spring wire connectors with plastic caps.

C. Use split bolt connectors for copper wire splices and taps, No. 6 AWG and larger. Tape un-insulated conductors and connectors with electrical tape to 150 percent of the insulation value of conductor.

D. Thoroughly clean wires before installing lugs and connectors.

E. Make splices, taps and terminations to carry full ampacity of conductors without perceptible temperature rise.
F. Terminate up to #10 AWG spare conductors with wire nuts. Use electrical tape for spare conductor #8 AWG and larger.

G. Terminate aluminum conductors with tin-plated, aluminum-bodied compression connectors only. Fill with anti-oxidant compound before installing conductor.

H. Use suitable reducing connectors or mechanical connector adaptors for connecting aluminum conductors to copper conductors.

I. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.

J. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.

3.04 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under provisions of Division 1.

B. Inspect wire and cable for physical damage and proper connection.

C. Torque test conductor connections and terminations to manufacturer's recommended values.

D. Perform continuity test on all power and equipment branch circuit conductors. Verify proper phasing connections.

3.05 WIRE AND CABLE INSTALLATION SCHEDULE

A. Concealed Interior Locations: Building wire in raceways or cable as approved herein.

   1. If specified, cables may be used for lighting fixture connections and in interior partitions for branch circuits.

B. Exposed Interior Locations: Building wire in raceways.

C. Above Accessible Ceilings: Building wire in raceways or cable as approved herein.

D. Wet or Damp Interior Locations: Building wire in raceway.

E. Exterior Locations: Building wire in raceways.

F. Underground Locations: Building wire in raceways.

3.06 WIRE AND CABLE COLOR CODING

A. Wires No. 6 AWG and smaller shall be factory color-coded. Wire No. 4 AWG and larger shall be color-coded with color tape 6-inch length of exposed ends, and at every accessible junction box on the branch circuit or feeder.
120/208 Volts
A = Black
B = Red
C = Blue
Neutral = White
Ground = Green

B. Maintain the color-coding throughout the system from panel to the last device on the branch circuit.

3.07 FIELD QUALITY CONTROL

A. Prior to energizing, all feeders from transformers, switchboards, and building service cables, are to be tested with a 500-volt insulation megohm meter to determine insulation resistance levels to assure requirements are fulfilled. All field test data is to be recorded and submitted. Test is to include meggering for one minute between conductors and between each conductor and ground. Cables are to be meggered after installation with cables disconnected at both ends. The values must be not less than as follows:

<table>
<thead>
<tr>
<th>Conductor Size</th>
<th>Resistance Megohms 1000 ft.</th>
</tr>
</thead>
<tbody>
<tr>
<td>#16 AWG to #8 AWG</td>
<td>200</td>
</tr>
<tr>
<td>#6 AWG to #2/0 AWG</td>
<td>100</td>
</tr>
<tr>
<td>#3/0 AWG to 500 KCMIL</td>
<td>50</td>
</tr>
</tbody>
</table>

END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Gutter and pipe freeze protection heat trace cable.
   2. Controls for heat trace.

B. Related Sections:
   1. Section 260532 – Conduit
   2. Section 262416 – Panelboards

1.02 REFERENCES

A. National Electrical Code (NEC/NFPA 70) (Current Edition)
B. National Fire Protection Association (NFPA)
C. National Electrical Manufacturers Association (NEMA)
D. American National Standards Institute (ANSI)
E. Institute of Electrical and Electronic Engineers (IEEE)
F. All applicable local codes and UCB standards

PART 2 - PRODUCTS

2.01 HEAT TRACE CABLE FOR PIPE FREEZE PROTECTION

A. Heating cables shall be self-regulating, such that they vary their output in response to temperature variations along the length of a traced pipe. Heating cable to be used for a given application shall be based on the design and operating environment requirements. The following self-regulating heating cables are approved:

   1. Self-regulating heating cable design shall be capable of maintaining process temperatures up to 150° F (65° C) and continuous exposure to temperatures of 185° F (85° C) while de-energized.
   2. Cable must be capable of being cut to a desired length to suit the installation conditions and must form a continuous heating circuit.
3. The heating cable shall consist of two parallel 16 AWG (minimum) nickel-plated copper bus wires embedded in a semi-conductive polymer core that forms a continuous matrix heating element. A polyethylene dielectric insulating jacket is extruded over the heating element core.

4. A metallic braid of tinned copper shall cover the basic cable. The braid shall provide a nominal coverage of 80%.

5. The cable shall be further covered with a polyolefin over jacket.

6. Long-term stability shall be established by the service life performance test per IEEE Std. 515.1.

7. Cable shall be BYLIN, Chromalux, Thermacon or UCBEE approved equal.

2.02 CONTROLS FOR PIPE FREEZE PROTECTION

A. Provide controller that can sense outside air temperature. When temperature drops to 34° F., heat trace shall be energized and de-energize the heat trace when the temperature rises above 36° F. The setting must be capable of field adjustment.

2.03 DESIGN PIPE FREEZE PROTECTION

A. The equipment materials and installation shall be suited for the electrical classification of the area involved.

B. A minimum safety factor of 10% shall be used to determine heat loss.

C. Heat loss calculations shall consider that the thermal insulation may be oversized to allow space for the heating cable(s).

D. Heater cable lengths for piping shall include cable on all in-line components including, but not limited to, flanges, pumps, valves, pipe supports/hangers, vents/drains and instruments.

2.04 INSTALLATION

A. Refer to manufacturer’s installation instructions and design guide for proper installation and layout methods. Deviations from these instructions could result in performance characteristics different than intended.

B. All installations and terminations must conform to the NEC and any other applicable national or local code requirements.

C. All heat tracing circuits shall be equipped with ground-fault equipment protection in accordance with applicable codes and standards.

D. Heating cable shall be attached to pipes on maximum one-foot intervals.

E. Heating cable shall be installed such that all in-line devices and equipment may be easily removed and reinstalled without cutting the heating cable.

F. Heating cable shall be installed on the lower quadrant of horizontal pipe whenever possible to avoid mechanical damage. Cable shall be located on the outside radius of all 45° and 90° pipe elbows.
2.05 TESTING

A. Heating cable shall be tested with a megohmmeter (megger) between the heating cable bus wires and the heating cable metallic braid. While a 2,500 Vdc megger test is recommended, the minimum acceptable level for testing is 500 Vdc. This test should be performed a minimum of three times:

1. Prior to installation while the cable is still on reel(s).
2. After installation of heating cable and completion of circuit fabrication kits (including any splice kits) but prior to installation of thermal insulation.
3. After installation of thermal insulation but prior to connecting cable to power.

B. The minimum acceptable level for the megger readings is 20 megohms, regardless of the circuit length.

C. Results of the megger readings shall be recorded and submitted to the UCBEE.

2.06 HEAT TRACE CABLE FOR GUTTER DE-ICING/SNOW MELTING

A. The heating cable shall be UL and CSA listed specifically as electric gutter de-icing and snow-melting equipment.

B. The heating cable shall be of parallel resistance construction capable of being cut to length and terminated in the field.

C. The heating cable shall consist of two parallel nickel-plated copper bus wires embedded in a radiation cross-linked, self-regulating, conductive, polymer core specifically designed for snow and ice melting. The heating cable shall include a polyolefin dielectric jacket rated 300 VAC at 105° C, a tinned-copper braid (14 AWG equivalent wire size), and a UV stabilized polyolefin overjacket.

D. Cable shall be Bylin, Chromalux, Thermacon or UCBEE approved equal.

2.07 CONTROLS FOR GUTTER DE-ICING/SNOW MELTING HEAT TRACE

A. Gutter de-icing/snow melting shall have dual controls.

1. Controls shall consist of both temperature and moisture. Temperature must be 34° F or lower and moisture must be present in gutter for heat trace to operate. If moisture is not present and temperature is below 34° F. heat trace is not to operate. Both conditions must be met in order for heat trace to operate.

B. Controller shall be Environmental Technology, Inc., Model APS-4 snow switch or approved equal by UCBEE sized for the application, i.e., number of zones controlled.
PART 3 - EXECUTION

3.01 INSTALLATION

A. Gutter/Downspout Heating System shall be installed in accordance with the manufacturer’s Design and Installation Manual. Any deviations shall be reviewed and approved by the manufacturer/UCBEE.

B. Coordinate with the RIM System and SRH / WFP heating cable installers, the gutter and downspout installers, and the control panel wiring and section conduit and junction box wiring installers.

C. The electrical contractor shall test the heating cables and submit results to UCBEE for review and approval.

END OF SECTION
SECTION 26 05 26
GROUNDING AND BONDING

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. Power System Grounding
B. Communication System Grounding
C. Electrical Equipment and Raceway Grounding and Bonding

1.03 REFERENCE STANDARDS

A. Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents.
B. NFPA Compliance: NFPA 70 "National Electrical Code (NEC)."
C. UL Compliance: Applicable requirements of UL Standards Nos. 467 "Electrical Grounding and Bonding Equipment," and 869, "Electrical Service Equipment," pertaining to grounding and bonding of systems, circuits and equipment. In addition, require compliance with UL Std 486A, "Wire Connectors". Grounding and bonding products which are to be UL-listed and labeled for their intended usage.
D. IEEE Compliance: Applicable requirements and recommended installation practices of IEEE Standards 141 and 142 pertaining to grounding and bonding of systems, circuits and equipment.

1.04 SYSTEM DESCRIPTION

A. Ground the electrical service system neutral at service entrance equipment to metallic cold water service, building steel and to supplementary grounding electrodes, as indicated on drawings.
B. Ground each separately-derived system neutral to nearest metallic cold water pipe 2-inch diameter or larger, building steel and where present to the referenced ground bar as shown on drawings.
C. Provide communications system grounding conductor at point of service entrance and connect to nearest referenced ground bar as shown on drawings.
D. Bond together system neutrals, service equipment enclosures, exposed non-current carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, receptacle ground connectors, and plumbing systems.

1.05 SUBMITTALS

A. Submit shop drawings under provisions of Section 260500.

B. Indicate layout of ground ring, location of system grounding electrode connections, and routing of grounding electrode conductors.

C. Submit all field test reports.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Ground Rods: Copper or copper-clad steel, 3/4-inch diameter, minimum length 10 feet.

B. Mechanical Grounding Connectors: For all grounding connections above grade.
   1. Manufacturer: Burndy Electrical
   2. Material: Copper.
   3. Compression Type: Irreversible.
   4. UL listed under Standard UL467.

C. Wire:
   1. Material: Copper.
   2. Size: As indicated on the drawings. When size is not indicated, size per Article 250 of NEC requirements.

D. Grounding Connection Accessories:
   1. Electrical insulating tape, heat-shrinkable insulating tubing, welding materials, bonding straps, as recommended by accessories manufacturers for type service required.

E. Field Welding: Exothermic welded connections are required where grounding conductors connect to underground grounding conductors and to underground grounding electrodes, and for bonding to steel. All underground connection shall be exothermic welded.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Provide a separate, insulated equipment grounding conductor in feeder and branch circuits. Terminate each ground conductor to the bushing and ground lug.
B. Connect grounding electrode conductors to metal water pipe using a suitable ground clamp. Make connections to flanged piping at street side of flange.

C. Supplementary Grounding Electrode: Use grounding mats, or driven ground rods, where indicated. Install ground rods in suitable recessed well; fill with gravel after connection is made.

D. Use minimum No. 6 AWG copper conductor for communications service grounding conductor. Leave 10-feet slack conductor at terminal board or cabinet.

E. Provide isolated grounds for all microprocessor and data processing equipment, where indicated on drawings.

F. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, connections are to be tightened to comply with tightening torque values specified in UL 486A to assure permanent and effective grounding.

G. Provide code-sized ground cable bonding jumpers, installed with ground clamps, across all conduit expansion couplings and fittings.

H. Route grounding connections, conductors to ground, and grounding conductors to protective devices in the shortest and straightest paths possible to minimize transient voltage rises.

I. Provide a corrosion-resistant finish to field connections, buried metallic bonding products, and where factory applied protective coatings have been destroyed, where subject to corrosive action.

J. All continuous runs of cable tray and all isolated sections of cable tray shall be grounded at intervals not to exceed 20 feet.

K. Provide an equipment grounding conductor in all non-metallic conduits.

L. Provide an equipment grounding conductor in all flexible metallic conduits.

M. Grounding conductor in feeders and branch circuits extend ground conductor to switches, receptacle, equipment enclosures, equipment, and panels etc. and ground as required.

3.02 FIELD QUALITY CONTROL

A. Upon completion of installation of electrical grounding and bonding systems, the ground resistance shall be tested with an earth ground resistance tester in accordance with IEEE 81, "Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System". Where tests show resistance-to-ground is over values in Table 1 below, Contractor shall take appropriate action to reduce resistance to the values in Table 1, by driving additional ground rods; and then retest to demonstrate compliance. All results shall be recorded and submitted.
Table 1

<table>
<thead>
<tr>
<th>Earth Ground Resistance to Equipment</th>
<th>Equipment (Ohms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pad Mount Transformer</td>
<td>5</td>
</tr>
<tr>
<td>Secondary Neutrals and Other Ground</td>
<td>10</td>
</tr>
</tbody>
</table>

END OF SECTION
SECTION 26 05 29
SUPPORTING DEVICES AND SEALS

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. Conduit and equipment supports.
B. Fastening hardware.
C. Wall and floor seals.

1.03 RELATED DOCUMENTS

A. Drawings, general and special conditions, Division 1 - General Requirements and other applicable technical specifications apply to work of this Section.

1.04 RELATED SECTIONS

A. Division 3 - Cast-in-Place Concrete. Concrete equipment pads.
B. Coordinate size, shape and location of concrete pads with Division 3.
C. Refer to Section 260500 for coordination requirements.

1.05 REFERENCE STANDARDS

A. A. Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents. A listing of applicable reference standards is contained in Division 1.

1.06 QUALITY ASSURANCE

A. Support systems shall be adequate for weight of equipment and conduit, including wiring, which they carry.
PART 2 - PRODUCTS

2.01 MATERIAL

A. Support Channel: Galvanized or painted steel for non-corrosive environment.

B. Hardware: Corrosion-resistant.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Fasten hanger rods, conduit clamps, and outlet and junction boxes to building structure using precast insert system, expansion anchors, preset inserts, or beam clamps. Do not use spring steel clips and clamps; however, caddy fasteners are accepted.

B. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls; expansion anchors or preset inserts in solid masonry walls; self-drilling anchors or expansion anchor on concrete surfaces; sheet metal screws in sheet metal studs; and wood screws in wood construction.

C. Do not fasten supports to piping, ductwork, mechanical equipment, or conduit.

D. Do not drill structural steel members.

E. Fabricate supports from structural steel or steel channel, rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under all nuts.

F. Install all free-standing electrical equipment on a 4-inch concrete housekeeping pad.

G. Install surface-mounted cabinets and panelboards with minimum of four anchors.

H. Bridge studs top and bottom with channels to support flush-mounted cabinets and panelboards in stud walls.

I. Where conduit penetrates fire-rated walls, concrete and/or masonry walls and floors, it shall be sleeved. Seal opening around conduit with UL listed foamed silicone elastomer compound.

J. Where conduit penetrates waterproofed floors or exterior walls subject to entry of moisture, provide pipe sleeves two sizes larger than conduit, suitably flashed or sealed where appropriate. Seal annular space around conduit with UL listed foamed silicone elastomer compound.

K. Route conduit through roof openings for piping and ductwork where possible; otherwise, route through roof jack with pitch pocket.

L. No suspended conduit or box supports shall be less than 1/4-inch diameter steel rod. Rod used as pedestal support is not acceptable. The contractor shall not use tie wire or wire of any type to support conduits, junction boxes or pull boxes.
M. No more than five (5) 1/2-inch conduits, three (3) 3/4-inch conduits or two (2) 1-inch conduits shall be supported on a single 1/4-inch diameter steel rod.

N. All conduits shall be supported by approved hangers. Supports installed and used by other trades such as duct hangers, pipe hangers, ceiling hangers, etc. shall not be used for conduit support. No conduit shall be hung from air handling duct of any type. Electrical conduit systems “shall stand alone”.

O. All light fixtures shall be independently supported at opposite corners from structural steel or from trapeze supported from structural steel by electrical contractor.

P. Wall-mounted fixtures shall be supported from building structure with approved backing support to prevent any damage to the wall.

Q. Concrete anchors shall not be used to suspend heavy electrical loads such as electrical switch panels or four-inch and larger conduits. Anchors shall be designed to support conduits and cable tray when full fitted to maximum capacity with cables.

3.02 EQUIPMENT BASES

A. Provide equipment pad bases of concrete type, construction, and finish as herein specified. Bases shall be of dimensions indicated or, where not specifically indicated or specified, dimensions shall be 4 inches height with width and length providing 4 inches of projection of base beyond outline dimension of supported equipment.

1. Concrete shall be Class 3000, prepared in conformity with ACI 301, ASTM C 33, and ASTM C 94, as applicable. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping, using equipment and procedures for consolidation of concrete in accordance with ACI 309. Perform consolidation so that concrete is thoroughly worked around reinforcement and other embedded items and into corners. Perform curing of concrete by moist curing, by moisture-retaining cover curing, or by combinations thereof, as directed or approved.

2. Provide oiled wood forms for concrete placement, adequately braced to ensure straight and vertical sides for bases. Finished bases shall provide a 3/4-inch chamfer at all exposed edges. Except where vibration attenuating base mountings are specified, provide No. 4 dowels (conforming to ASTM A 615, Grade 60), grouted into place, for anchorage of bases to substrate for all applications for which imposed strains or dynamic forces produced by equipment operation introduce the possibility of displacement of bases. Spacing of dowels shall be not less than 24 inches o.c., with a minimum of 4 dowels for each base.

3. Bases where indicated shall be reinforced by installation of 6 x 6 No. 8 AWG welded wire fabric conforming to ASTM A 185. Apply measures, during concrete placement, to ensure that fabric remains vertically centered in bases.

4. Bring slab surfaces to correct level with straightedge and strikeoff. Do not disturb slab surfaces prior to beginning finishing operations. Float finish surfaces and provide steel trowel final finish.
B. For all equipment to be installed on concrete bases or other concrete construction, provide templates, anchor bolts, and accessories as required. When installing equipment, set equipment into final position, shim equipment bases, skids or rails for level positioning, and install non-shrink grout for uniform support, and securely bolt into final position.

END OF SECTION
SECTION 26 05 32
CONDUIT

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 SECTION INCLUDES
   A. Metal Conduit
   B. Flexible Metal Conduit
   C. Liquidtight Flexible Metal Conduit
   D. Electrical Metallic Tubing
   E. Nonmetallic Conduit
   F. Fittings and Conduit Bodies

1.03 RELATED SECTIONS
   A. Division 1 - Cutting and Patching.
   B. Division 2 - Trenching: Excavation and backfill for conduit and utilities on site.
   C. Division 3 - Cast-In-Place Concrete: Protective envelope for underground conduit installations.
   D. Division 7 - Sheet Metal Flashing and Trim
   E. Section 260526 - Grounding and Bonding
   F. Section 260529 - Supporting Devices and Seals
   G. Section 260534 - Electrical Boxes and Fittings
   H. Section 260553 - Electrical Identification

1.04 REFERENCES
   A. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.
   B. ANSI C80.3 - Electrical Metallic Tubing, Zinc Coated.
C. ANSI/NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.


E. NECA - "Standard of Installation".

F. NEMA RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.

G. NEMA TC 2 - Electrical Plastic Conduit (EPC-40 and EPC-80).

H. NEMA TC 3 – PVC Fittings for Use with Rigid PVC Conduit and Tubing.

1.05 DESIGN REQUIREMENTS

A. Conduit Size: ANSI/NFPA 70.

1.06 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 260500.

B. Accurately record actual routing of conduits larger than two (2) inches or larger, regardless of location (i.e., above ceiling, below slab, etc.). Dimension from building columns.

C. Accurately record actual routing of all conduits installed in and under the slab. Dimension from the building columns.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products under provisions of Section 260500 and Division 1.

B. Accept conduit on site. Inspect for damage.

C. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

D. Protect PVC conduit from sunlight.

1.08 PROJECT CONDITIONS

A. Verify that field measurements are as shown on Drawings.

B. Verify routing and termination locations of conduit prior to rough-in.

C. Conduit routing is shown on Drawings in approximate locations unless dimensioned. Route as required to complete wiring system and to coordinate with the work of other trades.
PART 2 - PRODUCTS

2.01 CONDUIT REQUIREMENTS

A. Minimum Size, unless otherwise specified:
   1. Homeruns:
      a. 3/4-Inch above accessible ceilings.
      b. 3/4-Inch above unaccessible ceilings and in concrete slab.
      c. 1-Inch below grade and below slab on grade.

B. Branch Circuits after the first junction point: 3/4-Inch C unless otherwise specified.

C. Underground Installations:
   1. More than 5-Feet from Foundation Wall: Use PVC Schedule 40 nonmetallic conduit, except as otherwise noted.
   2. Within 5-Feet from Foundation Wall: Use rigid steel plastic coated conduit.
   3. In or Under Slab on Grade: Use PVC Schedule 40 nonmetallic conduit.

D. Outdoor Locations, Above Grade: Use rigid steel conduit.

E. In Slab Above Grade:
   1. Use PVC Schedule 40 nonmetallic conduit, unless otherwise specified.
   2. Maximum Size Conduit in Slab: 3/4-Inch or as permitted by the Structural Engineer, based on field conditions.

F. Wet and Damp Locations: Use rigid steel conduit if subject to physical damage. Thickwall nonmetallic conduit in areas not subject to physical damage and acceptable to the local authority.

G. Dry Locations:
   2. Exposed: Use rigid steel conduit if subject to damage below 8-feet, otherwise use electrical metallic tubing.

2.02 METAL CONDUIT

A. Rigid Steel Conduit: ANSI C80.1.

B. Intermediate Metal Conduit (IMC): Rigid steel.

C. Fittings and Conduit Bodies: ANSI/NEMA FB 1; material to match conduit.

2.03 PVC COATED METAL CONDUIT

A. Description: NEMA RN 1; rigid steel conduit with external PVC coating, 20 mil thick.
B. Fittings and Conduit Bodies: ANSI/NEMA FB 1; steel fittings with external PVC coating to match conduit.

2.04 FLEXIBLE METAL CONDUIT
A. Description: Interlocked steel construction.

2.05 LIQUIDTIGHT FLEXIBLE METAL CONDUIT
A. Description: Interlocked steel construction with PVC jacket.

2.06 ELECTRICAL METALLIC TUBING (EMT)
A. Description: ANSI C80.3; galvanized tubing.
B. Fittings and Conduit Bodies: ANSI/NEMA FB 1; steel, compression or set screw type.

2.07 NONMETALLIC CONDUIT
A. Description: NEMA TC 2; Schedule 40 PVC.
B. Fittings and Conduit Bodies: NEMA TC 3.

PART 3 - EXECUTION

3.01 INSTALLATION
A. Install conduit in accordance with NECA "Standard of Installation".
B. Install nonmetallic conduit in accordance with manufacturer's instructions.
C. Arrange supports to prevent misalignment during wiring installation.
D. Support conduit using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.
E. Group related conduits; support using conduit rack. Construct rack using steel channel, provide space on each for 25 percent additional conduits.
F. Fasten conduit supports to building structure and surfaces under provisions of Section 260529.
G. Do not support conduit with wire or perforated pipe straps. Remove wire used for temporary supports
H. Do not attach conduit to ceiling support wires.

I. Arrange conduit to maintain headroom and present neat appearance.

J. Route exposed conduit parallel and perpendicular to walls.

K. Route conduit installed above accessible ceilings parallel and perpendicular to building elements and walls.

L. Route conduit in and under slab from point-to-point. Dimension from building columns.

M. Do not cross conduits in slab except with written approval from the Structural Engineer.

N. Routing conduits parallel in the slab is prohibited except with written approval from the Structural Engineer.

O. Maintain adequate clearance between conduit and piping.

P. Maintain 12-inch clearance between conduit and surfaces with temperatures exceeding 104 degrees F.

Q. Cut conduit square using saw or pipe cutter; de-burr cut ends.

R. Bring conduit to shoulder of fittings; fasten securely.

S. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for twenty (20) minutes, minimum.

T. Use conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.

U. Install no more than equivalent of four 90-degree bends between boxes. Use conduit bodies to make sharp changes in direction, as around beams. Use hydraulic one-shot bender to fabricate or factory elbows for bends in metal conduit larger than 2-inch size.

V. Avoid moisture traps; provide junction box with drain fitting at low points in conduit system.

W. Provide suitable fittings to accommodate expansion and deflection where conduit crosses, control and expansion joints.

X. Provide suitable pull string in each empty conduit except sleeves and nipples.

Y. Use suitable caps to protect installed conduit against entrance of dirt and moisture.

Z. Ground and bond conduit under provisions of Section 260526.

AA. Identify conduit under provisions of Section 260553.

BB. Transition from underground nonmetallic conduit to above grade metal conduit or electrical metallic tubing shall be made in or below the slab. The transition between nonmetallic conduit and above grade conduit shall be made with a rigid steel, plastic coated elbow.
3.02 INTERFACE WITH OTHER PRODUCTS

A. Install conduit to preserve fire resistance rating of partitions and other elements, using approved materials and methods.

B. Route conduit through roof openings for piping and ductwork or through suitable roof jack with pitch pocket. Coordinate location with roofing installation specified.

END OF SECTION
SECTION 26 05 33
SURFACE RACEWAYS

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.

PART 2 - PRODUCTS

2.01 SURFACE METAL RACEWAY

A. Manufacturers:
   1. Panduit Corp.
   2. Square-D Company
   3. Hubbell, Inc.
   4. Wiremold Company
   5. Substitutions: Under provisions of Section 260500.

2.02 SURFACE METAL RACEWAY

A. Description: Sheet metal channel with fitted cover, suitable for use as surface metal raceway.

B. Size: As shown on Drawings.

C. Finish: Gray enamel.

D. Fittings, Boxes, and Extension Rings: Furnish manufacturer's standard accessories.

2.03 MULTIOUTLET ASSEMBLY

A. Manufacturers:
   1. Wiremold Company
   2. Hubbell, Inc.

B. Multi-Outlet Assembly: Sheet metal channel with fitted cover, with pre-wired receptacles, suitable for use as multi-outlet assembly.

C. Size: As indicated on Drawings.

D. Receptacles: Provide covers and accessories to accept receptacles specified in Section 262726.

E. Receptacle Spacing: As indicated.
F. Receptacle Color: As specified in Section 262726.

G. Channel Finish: Gray enamel.

H. Fittings: Furnish manufacturer's standard couplings, elbows, and connectors.

2.04 WIREWAY

A. Manufacturers:
   1. Cooper B-Line
   2. Wiremold Company
   3. Square-D
   4. Hoffman
   5. Substitutions: Under provisions of Section 260500.

B. General purpose type wireway.

C. Knockouts: Manufacturer's standard.

D. Size: As indicated on Drawings.

E. Description: Cover: Screw cover.

F. Connector: Flanged.

G. Fittings: Lay-in type with drip shield.

H. Finish: Rust inhibiting primer coating with gray enamel finish.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Use flat-head screws, clips, and straps to fasten raceway channel to surfaces. Mount plumb and level.

C. Use suitable insulating bushings and inserts at connections to outlets and corner fittings.

D. Wireway Supports: Provide steel channel as specified in Section 260529.

E. Close ends of wireway and unused conduit openings.

F. Ground and bond raceway and wireway under provisions of Section 260526.

END OF SECTION
SECTION 26 05 34
ELECTRICAL BOXES AND FITTINGS

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. Wall and Ceiling Outlet Boxes
B. Floor Boxes
C. Pull and Junction Boxes

1.03 RELATED DOCUMENTS

A. Drawings, general and special conditions, Division 1 - General Requirements and other applicable technical specifications apply to work of this Section.

1.04 RELATED SECTIONS

A. Division 7 - Firestopping.
B. Division 8 - Access Doors: Wall and ceiling access doors.
C. Section 262726 - Wiring Devices: Service fittings and fire-rated poke-through fittings for floor boxes.
D. Section 260535 - Cabinets and Enclosures.
E. Section 260580 – Equipment Wiring Systems.

1.05 REFERENCE STANDARDS

A. Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents. A listing of applicable reference standards is contained in Division 1.

B. ANSI/NEMA FB 1 - Fittings and Supports for Conduit and Cable Assemblies.
C. ANSI/NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports.
E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.06 PROJECT CONDITIONS

A. Verify field measurements are as shown on Drawings.
B. Verify locations of floor boxes and outlets prior to rough-in.
C. Electrical boxes are shown on Drawings in approximate locations unless dimensioned. Install at location required for box to serve intended purpose. Include installation within 10-feet of location shown. Refer to Architectural Drawings.

PART 2 - PRODUCTS

2.01 OUTLET BOXES

A. Sheet Metal Outlet Boxes: ANSI/NEMA OS 1; galvanized steel, with 2-inch male fixture studs where required.
B. Cast Boxes: NEMA FB 1, Type FD, cast ferroalloy. Provide gasketed cover by box manufacturer. Provide threaded hubs.

2.02 FLOOR BOXES

A. Floor Boxes: ANSI/NEMA OS 1 or NEMA FB 1, fully adjustable.

2.03 PULL AND JUNCTION BOXES

A. Sheet Metal Boxes: NEMA OS 1; galvanized steel.
B. Sheet Metal Boxes Larger than 12-Inches in Any Dimension: Hinged enclosure in accordance with Section 260535.
C. Surface-Mounted Cast Metal Box: NEMA 250, Type 6; flat-flanged, surface-mounted junction box.
   1. Material: Galvanized cast iron.
   2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install electrical boxes as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.
B. Install electrical boxes to maintain headroom and to present neat mechanical appearance.

C. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.

D. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.

E. Install boxes to preserve fire resistance rating of partitions and other elements, using materials and methods under the provisions of Division 7.

F. Align adjacent wall-mounted outlet boxes for switches, thermostats, and similar devices with each other.

G. Use flush mounting outlet boxes in finished areas.

H. Do not install flush mounting boxes back-to-back in walls; provide minimum 6-inch separation. Provide minimum 12-inch separation between back-to-back boxes in acoustic-rated walls.

I. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.

J. Use stamped steel bridges to fasten flush mounting outlet box between studs.

K. Install flush mounting box without damaging wall insulation or reducing its effectiveness.

L. Use adjustable steel channel fasteners for hung ceiling outlet box.

M. Do not fasten boxes to ceiling support wires.

N. Support boxes independently of conduit, except cast box that is connected to two (2) rigid metal conduits both supported within 12 inches of box.

O. Use gang box where more than one (1) device is mounted together. Do not use sectional box.

P. Use gang box with plaster ring for single device outlets.

Q. Use cast outlet box in exterior locations exposed to the weather and wet locations.

R. Use cast floor boxes for installations in slab on grade; formed steel boxes are acceptable for other installations.

S. Set floor boxes level.

T. Large Pull Boxes: Boxes larger than 100 cubic inches in volume or 12-inches in any dimension.
   1. Interior Dry Locations: Use hinged enclosure under provisions of Section 260535.
   2. Other Locations: Use surface-mounted cast iron box.

U. Minimum junction and pull box size 4-11/16" x 4-11/16" x 2-1/4".
V. Minimum outlet box size 4” x 4” x 2”.
W. Minimum telephone outlet box size 4-11/16” x 4-11/16” x 2-1/4”.
X. Minimum junction box size for fire alarm pull stations, control module, monitor module, 4” x 4” x 2-3/4”. Provide plaster ring at all pull station locations.
Y. Box extensions are prohibited.

3.02 INTERFACE WITH OTHER PRODUCTS
A. Coordinate installation of outlet box for products furnished under other sections.
B. Coordinate locations and sizes of required access doors with Division 8.
C. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.
D. Coordinate mounting heights and locations of outlets mounted above counters, benches and backsplashes.
E. Position outlet boxes to locate luminaires as shown on reflected ceiling plan.

3.03 ADJUSTING
A. Adjust floor box flush with finish flooring material.
B. Adjust flush-mounting outlets to make front flush with finished wall material.
C. Install knockout closure in unused box openings.

END OF SECTION
SECTION 26 05 35

CABINETS AND ENCLOSURES

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 SECTION INCLUDES

A. Hinged cover enclosures.
B. Cabinets.
C. Terminal blocks.
D. Accessories.

1.03 RELATED SECTIONS

A. Section 260529 - Supporting Devices and Seals.

1.04 REFERENCES

A. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
B. NEMA ICS 4 - Terminal Blocks for Industrial Control Equipment and Systems.

1.05 SUBMITTALS

A. Submit under provisions of Section 260500.
B. Product Data: Provide manufacturer's standard data for enclosures and cabinets.
C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of products.

1.06 EXTRA MATERIALS

A. Provide two of each cabinet key.
PART 2 - PRODUCTS

2.01 HINGED COVER ENCLOSURES
A. Construction: NEMA 250, Type 1 steel enclosure.
B. Covers: Continuous hinge, held closed by flush latch operable by key.
C. Provide interior plywood panel for mounting terminal blocks and electrical components; finish with matte white enamel.
D. Enclosure Finish: Manufacturer’s standard enamel.

2.02 CABINETS
A. Boxes: Galvanized steel with removable endwalls.
B. Box Size: As indicated.
D. Fronts: Steel, surface type with concealed hinge, and flush lock keyed to match branch circuit panelboard. Finish with gray baked enamel.
E. Knockouts: As required.
F. Provide metal barriers to separate compartments containing control wiring operating at less than 50 volts from power wiring.
G. Provide accessory feet for free-standing equipment.

2.03 TERMINAL BLOCKS
B. Power Terminals: Unit construction type with closed back and tubular pressure screw connectors, rated 600 volts.
C. Signal and Control Terminals: Modular construction type, suitable for channel mounting, with tubular pressure screw connectors, rated 300 volts.
D. Provide ground bus terminal block, with each connector bonded to enclosure.

2.04 FABRICATION
A. Shop assemble enclosures and cabinets housing terminal blocks or electrical components in accordance with ANSI/NEMA ICS 6.
B. Provide conduit hubs on enclosures.
C. Provide protective pocket inside front cover with schematic diagram, connection diagram, and layout drawing of control wiring and components within enclosure.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that surfaces are ready to receive Work.

3.02 INSTALLATION

A. Install Products in accordance with manufacturer's instructions.

B. Install enclosures and boxes plumb. Anchor securely to wall and structural supports at each corner.

C. Install cabinet fronts plumb.

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. Buried and Duct Bank Warnings.
B. Electrical Power, Control and Communication Conductors and Conduit.
C. Operational Instructions and Warnings.
D. Danger Signs.
E. Equipment/System Identification Signs.

1.03 RELATED SECTIONS
A. Division 9 - Painting.

1.04 REFERENCE STANDARDS
A. Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents. A listing of applicable reference standards is contained in Division 1.

1.05 QUALITY ASSURANCE
A. ANSI Compliance: Applicable requirements of ANSI A13.1, "Piping and Piping Systems".
B. FS Compliance: Applicable requirements of FS L-P-387 "Plastic Sheet, Laminated, Thermosetting (for designation plates)".
C. UL Compliance: Applicable requirements of UL Standard 969, "Marking and Labeling Systems," pertaining to electrical identification systems.
D. NEMA Compliance: Applicable requirements of NEMA Standard Nos. WC-1 and WC-2 pertaining to identification of power and control conductors.
E. Comply with "OSHA" sign standards for danger, caution, warning, etc.
1.06 SUBMITTALS

A. Submit product data under provisions of Division 1.

B. Include schedule for all specified applications of electrical identification.

PART 2 - PRODUCTS

2.01 ELECTRICAL IDENTIFICATION MATERIALS

A. General: The manufacturer's standard products of categories and types required are to be used for each application.

B. Color-Coded Emergency Power Conduit Markers:
   1. Manufacturer's standard self-adhesive vinyl tape not less than 3 mils thick. Tape 1-1/8-inch wide by 4-1/2-inch long marker for 2-inch and smaller conduit. Tape 2-1/4-inch wide by 9-inch long marker for 2-1/2-inch and larger conduit. Black lettering is to indicate highest voltage of cable(s) in conduit.
   2. Colors: Red tape.

C. Underground Type Plastic Line Marker:
   1. Manufacturer's standard permanent, bright-colored, continuous-printed plastic tape, intended for direct-burial service; not less than 6-inches wide x 4 mils thick. Printing is required on tape, which most accurately indicates type of service.
   2. Color: Yellow.

D. Cable/Conductor Identification Bands:
   1. For cables smaller than No. 2/0 manufacturer's standard vinyl-cloth self-adhesive cable/conductor markers of wrap-around type, either pre-numbered plastic coated type, or write-on type with clear plastic self-adhesive cover flap are to be used and numbered to show circuit identification.
   2. For cables No. 2/0 AWG and larger, heat shrink sleeving is to be used for phase color coding.

E. Plasticized Tags:
   1. Manufacturer's standard preprinted or partially preprinted accident-prevention and operational tags, on plasticized card stock with matte finish suitable for writing, approximately 3-1/4-inch x 5-5/8-inch, with brass grommets and wire fasteners, and with appropriate preprinted wording including large-size primary wording, e.g., DANGER, CAUTION, DO NOT OPERATE.

F. Baked Enamel Danger Signs:
   1. Manufacturer's standard "DANGER" signs of baked enamel finish on 20-gauge steel; of standard Red, Black and White graphics; 14-inch x 10-inch size except where 10-inch x 7-inch is the largest size which can be applied where needed;
with recognized standard explanation wording, e.g., XXXX VOLTS, KEEP AWAY, BURIED CABLE, DO NOT TOUCH SWITCH, etc.

G. Engraved Plastic-Laminate Signs:

1. Engraved stock melamine plastic laminate, complying with FS L-P-387, in sizes and thicknesses indicated, engraved with engraver's standard letter style of sizes and wording indicated, White face and Black core (Black letters on a White background) except as otherwise required (emergency power and fire alarm shall be Red with White letters), punched for mechanical fastening with a minimum of two (2) screws.

2. Thickness: 1/16-Inch, for units up to 20 square inches or 8-inch length; 1/8-inch for larger units.

3. Fasteners: A minimum of two (2) self-tapping stainless steel screws.

4. Minimum letter height shall be as follows:

   a. 1/2-Inch:
      1) Panelboard name.
      2) Switchboard name.
      3) Transformer name.
      4) Transformer switch name.
      5) System control panel name.

   b. 1/4-Inch:
      1) Voltage rating.
      2) Ampere rating.
      3) Source circuit ("Fed from Normal or Generator").
      4) Individual circuit breaker number and load name.
      5) Individual switch circuit number and load name.
      6) Individual motor starter circuit number and load name.
      7) Individual indicating light function.
      8) Individual pushbutton function.
      9) Individual selector switch functions.

H. Lettering and Graphics:

1. Names, abbreviations and other designations used in electric identification work are to be coordinated with corresponding designation shown, specified or scheduled. Numbers, lettering and wording as required or as recommended by manufacturer or as required for proper identification and operation/maintenance of electrical systems and equipment.

I. Adhesive Marking Tape for Device Cover Plates:

1. Avery-type or equal with 3/16-inch minimum height letters. Labels shall have black letters on clear labels for normal and red letters on clear labels for emergency. Embossed Dymo-Tape labels are not acceptable.
PART 3 - EXECUTION

3.01 APPLICATION AND INSTALLATION

A. General Installation Requirements:
   1. Regulations: Governing regulations and requests of governing authorities are to be complied with for identification of electrical work.

B. Underground Conduit and Ductbank Identification:
   1. During back-filling/top-soiling of each exterior underground conduit and ductbank, a continuous underground-type plastic line marker, located directly over conduit or ductbank at 12-inches below finished grade or 4-inches below paving, shall be provided.

C. Cable/Conductor Identification:
   1. The application of cable/conductor identification, with circuit number, on each cable/conductor in each box/enclosure/cabinet where wires of more than one circuit or communication/signal system are present is required. The identification is to match the marking system used in panelboards, shop drawings, contract documents, and similar previously established identification for project’s electrical work.

D. Junction Box and Pull Box Identification:
   1. On the Cover of each junction box and pull box: The circuit number(s) of the enclosed conductors are to be legibly written with a Black permanent ink broad tip marking pen and the system identified for FA (Fire Alarm) EM (Emergency) PA (Public Address), S (Security) TC (Temperature Control).
   2. Covers for Emergency System junction boxes and pull boxes shall be painted Yellow.
   3. Covers for the Fire Alarm System junction boxes and pull boxes shall be painted Red.
   4. Covers for the Telephone System junction boxes and pull boxes shall be painted Green.
   5. Covers for the Television System junction boxes and pull boxes shall be painted Violet.
   6. Covers for the Computer/Data System junction boxes and pull boxes shall be painted Blue.
   7. Covers for the 277/480V System junction boxes and pull boxes shall be painted Orange.

E. Conduits
   1. Install identification label on concealed inaccessible conduits within three feet of becoming inaccessible.

F. Operational Identification and Warnings:
1. Wherever required to ensure safe and efficient operation and maintenance of electrical systems, and electrically connected mechanical systems and general systems and equipment, including prevention of misuse of electrical facilities by unauthorized personnel, self-adhesive plastic signs or similar equivalent identification, instruction or warnings on switches, outlets and other controls, devices and covers of electrical enclosures shall be provided. Where detailed instructions or explanations are needed, provide plasticized tags with clearly written messages adequate for intended purposes.

G. Caution Signs:

1. The following caution sign is to be provided for all circuit breakers and switchboards where turning off a circuit will automatically start an emergency operation:

   "CAUTION TURNING OFF THIS CIRCUIT WILL AUTOMATICALLY START EMERGENCY OPERATION."

2. The following caution sign is to be provided for all automatic transfer switches, switches, circuit breakers, equipment, and emergency panels that are energized by the emergency power system:

   "CAUTION AUTOMATICALLY ENERGIZED BY EMERGENCY POWER SUPPLY SYSTEM."

H. Equipment/System Identification:

1. An engraved plastic-laminated sign is to be provided on each major unit of electrical equipment in the building; including central or master unit of each electrical system including communication/control/signal/alarm systems, unless unit is specified with its own self-explanatory identification or signal system. Except as otherwise indicated, provide single line of text, letter height as specified, black lettering on white field. Provide text matching terminology and numbering of the contract documents and shop drawings. The sign shall include unit designation, source circuit number, circuit voltage, and other data specifically indicated. Also, the sign shall indicate normal source circuit number ("Fed from . .") and emergency source circuit number when the equipment is a transfer switch or fed directly from a transfer switch. Include signs for each unit of the following categories of electrical work:

   a. Switchboards, panelboards (include main bus ampacity on sign), electrical cabinets and enclosures.
   b. Access panel/doors to electrical facilities.
   c. Disconnect switch.
   d. Push buttons, selector switches, indicating lights. (Circuit number and voltage not required on sign).
   e. Power transfer equipment: Contactors and transfer switches.
   f. Power generating units.
   g. Telephone cabinets and switching equipment. (Circuit number and voltage not required on sign.)
   h. Fire Alarm Control Panel.

2. The installation of signs are required at locations indicated or, where not otherwise indicated, at location for best convenience of viewing without
interference with operation and maintenance of equipment. The sign shall be secured to the substrate with fasteners, except use adhesive where fasteners should not or cannot penetrate substrate.

I. For panelboards, provide framed, typed circuit schedules (label all spares and spaces in pencil) with explicit description and identification of items controlled by each individual breaker.

J. Provide tape labels for identification of individual receptacles and switches. Locate tape on back of plate and indicate associated source panelboard and circuit number.

END OF SECTION
SECTION 26 05 80
EQUIPMENT WIRING SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS
   A. Drawings, general and special conditions, Division 1 - General Requirements and other applicable technical specifications apply to work of this Section.

1.02 SUMMARY
   A. Electrical connections to equipment specified under other Sections or furnished by Owner.

1.03 RELATED SECTIONS
   A. Division 1 - Owner-furnished equipment.
   B. Division 14 - Elevators.
   C. Divisions 22 & 23 - Electrical Requirements for Mechanical Equipment.
   D. Division 21 - Fire Protection.
   E. Division 22 - Plumbing Pumps.
   F. Division 22 - Water Heaters.
   G. Division 23 - HVAC pumps.
   H. Division 23- Air Handling Units.
   I. Section 260532 - Conduit.
   J. Section 260519 – Building Wire and Cable.
   K. Section 260534 - Electrical Boxes and Fittings.

1.04 REFERENCE STANDARDS
   A. Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents. A listing of applicable reference standards is contained in Divisions1.
   B. NEMA WD 1 - General-Purpose Wiring Devices.
   C. NEMA WD 5 - Specific-Purpose Wiring Devices.
PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS - CORDS AND CAPS
A. Hubbell
B. General Electric
C. Pass & Seymour
D. Arrow, Hart & Hegeman

2.02 CORDS AND CAPS
A. Straight-Blade Attachment Plug: NEMA WD 1.
B. Locking-Blade Attachment Plug: NEMA WD 5.
C. Attachment Plug Configuration: Match receptacle configuration at outlet provided for equipment.
D. Cord Construction: Oil-resistant thermoset insulated Type SO multi-conductor flexible cord with identified equipment grounding conductor, suitable for hard usage in damp locations.
E. Cord Size: Suitable for connected load of equipment and rating of branch circuit overcurrent protection.

PART 3 - EXECUTION

3.01 INSPECTION
A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.02 PREPARATION
A. Review equipment submittals prior to installation and electrical rough-in. Verify location, size, and type of connections. Coordinate details of equipment connections with supplier and installer.

3.03 INSTALLATION
A. Use wire and cable with insulation suitable for temperatures encountered in heat-producing equipment.
B. Make conduit connections to equipment using flexible conduit. Use liquid-tight flexible conduit in damp or wet locations.
C. Install pre-finished cord set where connection with attachment plug is indicated or specified, or use attachment plug with suitable strain-relief clamps.

D. Provide suitable strain-relief clamps for cord connections to outlet boxes and equipment connection boxes.

E. Make wiring connections in control panel or in wiring compartment of pre-wired equipment in accordance with manufacturer's instructions. Provide interconnecting wiring where indicated.

F. Install disconnect switches, controllers, control stations, and control devices such as limit switches and temperature switches as indicated. Connect with conduit and wiring as indicated.

3.04 EQUIPMENT CONNECTION SCHEDULE

A. Furnish, set in place, and wire, except as may be otherwise indicated, all heating, ventilating, air conditioning, plumbing, fire protection, and other motors and controls in accordance with the following schedule. Carefully coordinate with work performed under the Mechanical and other Divisions of these specifications.

B. Symbols:

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD</td>
<td>Section in which driven equipment is specified.</td>
</tr>
<tr>
<td>E</td>
<td>Electrical Contractor</td>
</tr>
<tr>
<td>M</td>
<td>Mechanical Contractor</td>
</tr>
<tr>
<td>C</td>
<td>Controls Contractor</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item</th>
<th>Furnished By</th>
<th>Set in Place By</th>
<th>Control Wiring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Equipment Motors, Controls and Integral Disconnect Switches

1. Automatically controlled, with or without HOA switches except as otherwise specified (including integral disconnect if specified).  
   SD  E  C/M

2. Automatically controlled with or without HOA switches & which are furnished as part of factory-wired equipment (including integral disconnect if specified).  
   SD  SD  C/M

3. Manually controlled (including integral disconnect if specified).  
   SD  E  E

4. Manually controlled and which are furnished as part of factory-wired equipment (including integral disconnect if specified).  
   SD  SD  C/M

5. Special duty types (part winding, etc.) (including integral disconnect if specified).  
   SD  E  C/M

Variable frequency drives  
   SD  E  C/M

Line voltage thermostats  
   M  E
<table>
<thead>
<tr>
<th>Item</th>
<th>Furnished By</th>
<th>Set in Place By</th>
<th>Control Wiring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time clocks, remote bulb thermostats, motor valves, float controls, etc., which are an integral part of or directly attached to ducts, pipes, etc.</td>
<td>M</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>Environmental control panels</td>
<td>C/M</td>
<td>C/M</td>
<td>C/M</td>
</tr>
<tr>
<td>Motor valves, dampers, solenoid valves</td>
<td>SD</td>
<td>M</td>
<td>C/M</td>
</tr>
<tr>
<td>Alarm bells</td>
<td>SD</td>
<td>SD</td>
<td>E</td>
</tr>
<tr>
<td>Control circuit power supply</td>
<td>E</td>
<td>E</td>
<td></td>
</tr>
<tr>
<td>Low voltage controls, thermostats, valves, actuators, damper motors, EP and PE switches, etc.</td>
<td>C/M</td>
<td>C/M</td>
<td>C/M</td>
</tr>
<tr>
<td>Fire protection controls</td>
<td>M</td>
<td>M</td>
<td>E</td>
</tr>
<tr>
<td>Duct-mounted fire and smoke detectors, relays for fan shutdown</td>
<td>E</td>
<td>M</td>
<td>C/M</td>
</tr>
<tr>
<td>Boiler and water heater controls, boiler burner control panels, internally wired</td>
<td>M</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>Stand alone disconnect switches, thermal overload switches, manual operating switches</td>
<td>E</td>
<td>E</td>
<td></td>
</tr>
</tbody>
</table>

C. Notes to the Schedule:

1. Not all equipment indicated in the schedule is used in this project. Apply as required.
2. Complete wiring diagrams for installation purposes shall be furnished under the Mechanical or other Divisions, as applicable.
3. All line and low voltage wiring shall be installed utilizing materials and methods as specified in the Electrical Division of the specifications.
4. Provide NEMA-rated motors and equipment suitable for operation on the voltage systems as designated below with tolerances for the allowable voltage variations above and below the nominal:

| Rated Motor Voltage |
|---------------------|-------------------|-------------------|
| Service Voltage     | ½-HP and Smaller  | ¾-HP and Larger   |
| And Phase           | 1-Phase           | 3-Phase           |
| 120/208V, 3ph       | 115V              | 200V              |
| 277/480V, 3ph       |                   | 460V              |

END OF SECTION
SECTION 26 09 44

NETWORK LIGHTING CONTROLS

PART 1 - GENERAL

1.01 OVERVIEW

A. Provide a complete low voltage lighting control system for the building as shown on the plans and specified herein.

B. Lighting control system shall utilize networking technology based upon "LonWorks" and be LonMark certified to Level 3.1. System shall be able to operate as a stand-alone entity with the option of using a web server device so that programming and viewing of status can be accomplished by any PC connected to the same LAN or via the internet.

C. All relay panel interiors shall be pre-assembled complete with the necessary relays, transformers and devices. Relay panels that are wall mounted shall have interiors separate from enclosure so as to permit easy mounting, conduit installation and wire pull to enclosures. Enclosures mounted in the ceiling space are not required to have separate interiors.

1.02 MANUFACTURERS

A. All components are to be supplied by same manufacturer. Manufacturer to be a supplier of this type of equipment for over ten (10) years.

B. Low voltage control system shall be manufactured by Douglas Lighting Controls.

1.03 PRIOR APPROVAL SUBMISSIONS

A. Manufacturers wishing to submit quotations on the lighting control system must pre-qualify. Pre-qualification information must be submitted to the electrical consulting engineer not later than ten (10) working days prior to the final closing of tenders for this project.

B. The manufacturer must be prepared to demonstrate the equipment being proposed before the closing of tender.

C. Submit a one-line diagram of the proposed system configuration for review.

1.04 INSTRUCTION MANUALS

A. Supply manuals on system components to permit ease of installation, system operation and maintenance including, but not limited to the following:

1. Lighting control system step-by-step operating instructions.
2. Relay panel schedules indicating circuits connected, inputs assigned, area controlled, panel location and panel equipment details.
PART 2 - MATERIALS

2.01 RELAYS

A. 2-Wire HID Relay suited for all types of lighting loads: WR-6161

1. Lighting control relays mounted in relay panels shall be WR-6161 full load relays suitable for all types of lamp loads up to 20 Amperes. Load contacts shall be able to sustain 1500 amp fault currents for up to 20 milliseconds.
2. The relay shall be contained in a molded case containing both low and high voltage terminals and shall have a built-in operating lever marked ON/OFF for manual switching at the relay panel.
3. Switching the relay shall be accomplished with ONE signal wire and a common return. The signal wire shall be able to signal ON and OFF and shall also carry status current that indicates if the relay is ON or OFF.
4. UL Listing 20A : 120 & 277 VAC; CSA 20A : 120, 277 & 347 VAC

B. 2-Wire HID Relay, 2 pole, suitable for 480V applications: WR-6172

1. 2-Pole lighting control relays mounted in relay panels shall be WR-6172 full load relays suitable for all types of lamp loads up to 20 Amperes. Load contacts shall be able to sustain 1500 amp fault currents for up to 20 milliseconds.
2. Switching the relay shall be accomplished with ONE signal wire and a common return. The signal wire shall be able to signal ON and OFF and shall also carry status current that indicates if the relay is ON or OFF.
3. The relay shall be contained in a molded case containing both low and high voltage terminals and shall have a built-in operating lever marked ON/OFF for manual switching at the relay panel.
4. UL Listing 20A : 120, 277 & 480 VAC; CSA 20A : 120, 277 & 347 VAC

2.02 PRE-ASSEMBLED RELAY PANELS: PWEX SERIES

A. Where indicated on the drawings, provide a factory pre-assembled relay panel. The panel's enclosure shall be for surface or flush installation, with a screw-on cover or a hinged door assembly as required.

B. The panel shall consist of a pre-assembled interior insert; UL/CSA approved Douglas Cat No: CxxM or WxxM series with capacities for 12, 24, 36, 48 or 72 relays as required. Panel enclosure must be UL/CSA Approved.

C. Panel interior shall have the following pre-assembled and pre-wired:

1. Suitable divider separating class 1 and class 2 compartments.
2. Control transformer, UL/CSA approved for class 2 circuits, Douglas Cat. No. WR-4075-xxx where xxx = primary voltage.
3. Low voltage relays as required by switched circuits shown on plans or schedules.
4. Control devices as required.

2.03 RELAY CONTROLS INSTALLED IN RELAY PANELS

A. Programmable Relay Scanners: WRS-2224
1. When groups of relays are to be switched by master switches or time controls and it still must be possible to switch individual relays by local switches, provide programmable relay scanner WRS-2224.

2. Each scanner shall be solid state and have 24 relay outputs. An output shall be capable of switching the connected relay ON and OFF and sensing if the connected relay is ON or OFF.

3. Each programmable relay scanner shall have 5 switch inputs to accommodate group switches. Each switch input can be set with the keypad built into the scanner to switch some or all of the 24 relay outputs of the scanner. Each switch input must indicate an ON state if any of the relays in the group is ON. If all relays are OFF, then indicate an OFF state to the group switch.

4. The scanner shall be able to provide an optional flick warn option for each of the 5 groups. After the flick warn, the occupant has 5 minutes to prevent the local lights from switching OFF by activating the local switch.

5. The scanner shall provide an optional time-out option. When activated, this option will allow any relay in the system when switched on, to be timed for a 2-hour interval before being switched off. Flick warn may also be added to this option.

6. The programming of the scanner shall be user friendly with instructions printed on the scanner label.

7. The relay scanner shall accept a plug-in module, WNX-2624 Network Node. The network node shall use LonWorks technology and shall be LonMark certified (V3.1). This node shall be capable of connecting to an FTT-10A data line to communicate with other scanners in different relay panels or with other vendors using LonWorks technology.

2.04 RELAY PANEL NETWORK & LONWORKS TECHNOLOGY

A. Overview of Network Nodes

1. Relay panels that are networked together with Douglas Scanners and Network nodes shall be able to operate as a stand-alone system or shall be able to be integrated as a part of a LonWorks Building Automation System that includes other functions of the building such as HVAC and Security.

2. The network shall use LonWorks Inter-Operable technology and the network nodes attached to the relay scanners shall be LonMark certified to the Level 3.1 standard for lighting.

B. Stand-Alone System

1. The stand-alone system shall not require the services of an integrator or other software specialist to program the system. No PC or extra device shall be required for setting which relays are controlled by a group switch input. It shall be possible to view and edit which relays are controlled by a switch input with indicators and buttons built into the relay control devices. The stand-alone system shall provide the following features:

   a. Each input can control any group of relays located throughout the system.
b. A single group of relays can be operated by more than one input.
c. When connected to an input, a pilot light switch shall indicate the state of the relay group. If any relay in the group is ON, the switch shall indicate ON. If all relays of the group are OFF, the switch shall indicate OFF.
d. Group inputs shall be able to accept signals from other devices such as time clocks, photocells or contact closures from other systems to provide automation of the lighting controls.
e. Each relay group shall be able to support the flick-warn option. After the flick warn, the occupant has 5 minutes to prevent the local lights from switching OFF by activating the local switch.
f. Each relay group shall be able to support the time-out option, which allows the occupant to activate by local switch a relay that will time-out after 2 hours. It shall be possible to enable and disable the feature with a time clock so that it is only active when needed (after hours).

C. Network Manager

1. Provide as required on the drawings a WNP-2150 Network Manager complete with web server capability. The system shall have the following features:
   a. Program and control up to 60 Network Nodes.
   b. Allow photo sensors to be connected on the data line and to assign multiple set points to different groups of relays.
   c. Provide Astronomic time clock capability
   d. Display relay panels individually and allow relays to be assigned to groups by simple point and click.
   e. Schedules allow for 1024 events and 16 unique holiday schedules.
   f. Groups can be configured to have user settable flick warn, time out and cleaning variables.
   g. Flick warn and time out durations are user settable on an individual relay basis.
   h. Allow switches to control groups spanning all panels in the system.
   i. Web interface must use standard HTML pages that allow any PC with a Web Browser access to the system.
   j. Security access available with 4 levels.
   k. Diagnostic tools for queries of status of network devices, relays and log reports.
   l. Full backup and restore capabilities.

2.05 SATELLITE PANELS

A. WSP-2718

1. Where indicated on the drawings, provide a WSP-2718 Satellite Panel complete with 8 latching relays capable of switching 20 amp lighting loads and rated for 120/277/347VAC. Each panel is to be connected on to the data line network and configured using the WNP-2150 Network Manager and shall contain the following hardware features:
   a. 10 switch inputs
   b. 2 - 24VDC inputs for occupancy sensors requiring DC voltage.
   c. 1 DC power supply rated for 250ma for supplying power to occupancy sensors.
   d. 2 digital inputs for accepting signals from WPS-5533 or WPS-5527 photo sensors capable of sensing 0 – 6,000 foot candles.
2. Switch inputs are to be capable of switching individual relays, local groups of relays within the panel or global groups of relays system wide. Each switch input can be configured for connection to standard Douglas switches, momentary 24VAC switches or maintained contact 24VAC switches. Each input can also be configured to be ON or OFF only. The inputs may also be configured to have interlocking logic so that if the photo sensor has switched a relay off it is possible to set an input so a local wall switch cannot override the photo sensor relay on unless there is insufficient light.

3. In rooms with photo sensor control, it shall be possible to set relays to switch at different light levels so that as the amount of daylight changes, different amounts of artificial light can be switched on or off. It shall be possible to set a sequence of switching 3 lamp fixtures with a relay each for the single lamp and outer lamps as follows: As daylight increases, the single lamp relay is switched off first. The next step requires the outer lamp relay OFF and the single lamp relay ON simultaneously. As daylight passes the maximum threshold, the single lamp relay is switched off. This sequence is reversed as daylight declines.

4. The Satellite Panels shall accept either 24VDC or 24VAC occupancy sensors. The inputs may be configured for OFF only or ON/OFF switching scenarios. It shall be possible to link the photo sensor control with occupancy sensing so that when light levels are high enough, the occupancy sensor will not switch the photo sensor controlled relays ON.

2.06 WALL SWITCHES & ACCESSORIES

A. Switches:
   1. Remote control switches and switch hardware to mount to standard wall boxes. Standard switches mount up to 3 switches per gang.
   2. Rocker switches shall be WR-8001.
   3. Switches that require an indicator shall be WR-8501 push button switch. Switch shall have integral LED's that indicate both ON and OFF states (red=ON, green=OFF). The switch shall have a plastic cap to permit holding a paper identification label.
   4. Switches that require keyed operation shall be WRK-8201 Key switch complete with integral LED to indicate state.
   5. Wiring of switches to be #18 AWG, solid conductor. Check with manufacturer regarding other gauges before installing.

B. Switch Plates:
   1. Select switch plates to suit number of switches as shown on the plans. Up to 3 switches can be installed in a 1 gang box. Use WN-3020 filler plugs where appropriate.
   2. Switch plates are to be made of stainless steel shall be WN-76xx series cover plates.

2.07 OCCUPANCY DETECTION

A. Indoor, Ceiling Mount Occupancy Detector: WRM-5104
1. Where required, provide a PIR occupancy sensor Model WRM-5104. The occupancy sensor shall control up to 4 Douglas relays directly. It shall also be possible to connect Douglas wall switches in parallel to each relay for occupant override if required.

2. Occupancy sensor to include the following features:
   a. Adjustable time out (30 sec to 30 min) and sensitivity
   b. Tilt & swivel lens direction adjustment
   c. Coverage of 1600 sq. ft., Indoor ceiling mount, ceiling heights 8’ to 16’max
   d. Function select - on/off switching or off-only switching.

2.08 PHOTOCELL & DAYLIGHT CONTROLS

A. Outdoor and Skylight Photocell: WPC-5577 & WPS-5527 Remote Sensor

1. Provide where required a photometric sensor (WPS-5527), capable of sensing from 1-6,000 foot candles. The sensor is to be connected via 2-conductor, #18 AWG wire to the WPC-5577 control unit located in the panel. Existing light levels shall be continuously displayed by LED’s. Set point adjustments shall be easy to set with UP and DOWN control buttons. Instructions shall be printed on the label of the control unit.

2. The control unit shall have two sets of outputs. Both output sets shall be capable of being overridden by a remote switch or via a button built into the photocell control unit. Each output can be governed with a time clock (via an enable/disable input).

B. Indoor Task Area Daylight Sensor: WPC-5621

1. Provide where required an indoor daylight sensor WPC-5621 for applications that harvest daylight by ON/OFF control of lighting circuits. The sensor shall switch relays ON when natural light is insufficient and OFF when it is sufficient. The sensor shall be ceiling mounted and shall measure light reflected upward from the surface below. The sensor shall be easy to adjust with a range setting and a set-point slider located under the front faceplate.

2. The daylight sensor shall have an adjustable dead-band setting so that cycling effects can be eliminated.

3. The daylight sensor shall also include an enable/disable feature so that the sensor will only operate when desired and will be disabled during off hours.

C. Indoor Task Area Daylight Sensor for Dimmable Ballasts: WPC-5700

1. Provide where required an indoor daylight sensor WPC-5700 for applications that harvest daylight by regulating the electronic dimmable fluorescent ballasts. The sensor shall regulate the ballast so that when natural light is bright the lamp is dim and when natural light is dim the lamp is bright. The sensor shall be ceiling mounted and measures light reflected upward from the surface below. The sensor shall have a range setting and a set-point slider located under the front faceplate.

2. The sensor shall be compatible with Phillips/Advance Mark VII, Motorola Helios or any other ballast that uses the same 0-10V dimming control method. The sensor shall connect with 2 wires connected in parallel to a maximum of 50 ballasts. No other connections to the sensor are required for the dimming function.
PART 3 - INSTALLATION

3.01 RELAY PANELS AND CONDUIT
   A. Ensure that conduit for line voltage wires enters panel in line voltage areas and conduit for low voltage control wires enters panel on low voltage areas. Check manufacturer’s drawings for location of line and low voltage areas.

3.02 LOW VOLTAGE WIRING
   A. For low voltage wiring, provide wire type as recommended by the manufacturer.
   B. Adhere to manufacturer's recommendations as to maximum wire length and maximum quantity of relays per switch.
   C. Data line shall be #16 twisted pair Belden #8471 or equal.

3.03 LINE VOLTAGE WIRING
   A. Use wire gauges from #12AWG to #14AWG as appropriately sized for the branch circuit.

3.04 SYSTEMS INTEGRATED WITH BUILDING AUTOMATION SYSTEM USING LONWORKS
   A. If a LonWorks system is being installed and being integrated with another LonWorks system the system integrator shall be responsible for setting up and programming the system.

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. This Section includes service and distribution switchboards rated 600 V and less.

1.03 DEFINITIONS
   A. EMI: Electromagnetic interference.
   B. GFCI: Ground-fault circuit interrupter.
   C. RFI: Radio-frequency interference.
   D. RMS: Root mean square.
   E. SPDT: Single pole, double throw.

1.04 SUBMITTALS
   A. Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
   B. Shop Drawings: For each switchboard and related equipment.
      1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
         a. Enclosure types and details for types other than NEMA 250, Type 1.
         b. Bus configuration, current, and voltage ratings.
         c. Short-circuit current rating of switchboards and overcurrent protective devices.
         d. Descriptive documentation of optional barriers specified for electrical insulation and isolation.
         e. Utility company's metering provisions with indication of approval by utility company.
         f. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
2. Wiring Diagrams: Power, signal, and control wiring.

C. Field quality-control test reports including the following:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

D. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Routine maintenance requirements for switchboards and all installed components.
   2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
   3. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.05 QUALITY ASSURANCE

A. Source Limitations: Obtain switchboards through one source from a single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with NEMA PB 2, "Deadfront Distribution Switchboards."

E. Comply with NFPA 70.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver in sections or lengths that can be moved past obstructions in delivery path.

B. Store indoors in clean dry space with uniform temperature to prevent condensation. Protect from exposure to dirt, fumes, water, corrosive substances, and physical damage.

C. If stored in areas subjected to weather, cover switchboards to provide protection from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside switchboards; install electric heating (250 W per section) to prevent condensation.

D. Handle switchboards according to NEMA PB 2.1 and NECA 400.
1.07 PROJECT CONDITIONS

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

B. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:


C. Service Conditions: NEMA PB 2, usual service conditions, as follows:

1. Altitude not exceeding 6600 feet (2000 m).

1.08 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 MANUFACTURED UNITS

A. Manufacturers:

1. Eaton Corporation
4. Square D

B. Front-Connected, Front-Accessible Switchboard: Fixed, individually mounted main device, panel-mounted branches, and sections rear aligned.

C. Nominal System Voltage: 208Y/120 V.

D. Main-Bus Continuous: As indicated on drawings.

E. Enclosure: Steel, NEMA 250, Type 1.
F. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

G. Barriers: Between adjacent switchboard sections.

H. Utility Metering Compartment: Fabricated compartment and section complying with utility company's requirements. If separate vertical section is required for utility metering, match and align with basic switchboard.

I. Buses and Connections: Three phase, four wire, unless otherwise indicated.
   3. Ground Bus: 1/4-by-2-inch- (6-by-50-mm-) minimum-size, hard-drawn copper of 98 percent conductivity, equipped with pressure connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
   4. Contact Surfaces of Buses: Silver plated.
   5. Main Phase Buses, Neutral Buses, and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
   6. Neutral Buses: 100 percent of the ampacity of phase buses, unless otherwise indicated, equipped with pressure connectors for outgoing circuit neutral cables. Bus extensions for busway feeder neutral bus are braced.

J. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

2.03 OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker: NEMA AB 3, with interrupting capacity to meet available fault currents.
   3. Electronic trip-unit circuit breakers shall have RMS sensing, field-replaceable rating plug, and the following field-adjustable settings:
      a. Instantaneous trip.
      b. Long- and short-time pickup levels.
      c. Long- and short-time time adjustments.
      d. Ground-fault pickup level, time delay, and I²t response.

B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.
1. Lugs: Compression style, suitable for number, size, trip ratings, and conductor material.
2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
4. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
5. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
6. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.

C. Enclosed, Insulated-Case Circuit Breaker: Fully rated, encased-power circuit breaker with interrupting capacity rating to meet available fault current.

1. Fixed circuit-breaker mounting.
2. Two-step, stored-energy closing.
3. Microprocessor-based trip units with interchangeable rating plug, LED trip indicators, and the following field-adjustable settings:
   a. Instantaneous trip.
   b. Long- and short-time pickup levels.
   c. Long- and short-time time adjustments with \( I^2t \) response.
   d. Ground-fault pickup level, time delay, and \( I^2t \) response.

2.04 INSTRUMENTATION

A. Instrument Transformers: NEMA EI 21.1, IEEE C57.13, and the following:

1. Potential Transformers: Secondary voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.
2. Current Transformers: Ratios shall be as indicated with accuracy class and burden suitable for connected relays, meters, and instruments.
3. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kV.
4. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondaries to ground overcurrent relays to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker ground-fault protection.

B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:

1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
   a. Phase Currents, Each Phase: Plus or minus 1 percent.
   b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
   c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
   d. Megawatts: Plus or minus 2 percent.
   e. Megavars: Plus or minus 2 percent.
   f. Power Factor: Plus or minus 2 percent.
   g. Frequency: Plus or minus 0.5 percent.
h. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from 5 to 60 minutes.

i. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent. Accumulated values unaffected by power outages up to 72 hours.

2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

2.05 CONTROL POWER

A. Control Circuits: 120 V, supplied through secondary disconnecting devices from control-power transformer.

B. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

C. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

PART 3 - EXECUTION

3.01 PROTECTION

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

3.02 EXAMINATION

A. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.03 INSTALLATION

A. Install switchboards and accessories according to NEMA PB 2.1 and NECA 40.

B. Install and anchor switchboards level on concrete bases, 4-inch (100-mm) nominal thickness. Concrete base is specified in Division 26 Section "Hangers and Supports for Electrical Systems," and concrete materials and installation requirements are specified in Division 03.

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.

2. For switchboards, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to switchboards.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

D. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

E. Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.
   1. Set field-adjustable switches and circuit-breaker trip ranges.

3.04 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

B. Switchboard Nameplates: Label each switchboard compartment with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.05 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:
   1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

B. Perform the following field tests and inspections and prepare test reports:
   1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Sections 7.1, 7.5, 7.6, 7.9, 7.10, 7.11, and 7.14 as appropriate. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.06 CLEANING

A. On completion of installation, inspect interior and exterior of switchboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

3.07 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices,
instrumentation, and accessories. Refer to Division 01 Section "Demonstration and Training."

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. This Section includes the following:

1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.

1.03 DEFINITIONS

A. EMI: Electromagnetic interference.
B. GFCI: Ground-fault circuit interrupter.
C. RFI: Radio-frequency interference.
D. RMS: Root mean square.
E. SPDT: Single pole, double throw.

1.04 SUBMITTALS

A. Product Data: For each type of panelboard, overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a. Enclosure types and details for types other than NEMA 250, Type 1.
b. Bus configuration, current, and voltage ratings.
c. Short-circuit current rating of panelboards and overcurrent protective devices.
d. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

2. Wiring Diagrams: Power, signal, and control wiring.
C. Field quality-control test reports including the following:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

D. Panelboard Schedules: For installation in panelboards.

E. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section “Operation and Maintenance Data,” include the following:
   1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
   2. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.05 QUALITY ASSURANCE

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of panelboards and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with NEMA PB 1.

E. Comply with NFPA 70.

1.06 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
   1. Altitude not exceeding 6600 feet (2000 m).

1.07 COORDINATION

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

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.08 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Keys: Six spares for each type of panelboard cabinet lock.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Panelboards, Overcurrent Protective Devices, Controllers, Contactors, and Accessories:
   a. Eaton Corporation
   c. Siemens Energy & Automation, Inc.
   d. Square D

2.02 MANUFACTURED UNITS

A. Enclosures: Flush- and surface-mounted cabinets. NEMA PB 1, Type 1.

1. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.

2. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Provide flush or surface cabinet front as required with concealed trim clamps, hinged trim door-in-door construction with interior door containing a flush lock all keyed alike. Finish in manufacturer's standard gram enamel. Door- in- door hinged trim enclosure shall contain two quarter turn latches. (See detail at the end of this section.) University shall install the lock on the door-in-door exterior door.

3. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.

4. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.

5. Finish: Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat.

B. Phase and Ground Buses:

2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.
3. Isolated Equipment Ground Bus: Adequate for branch-circuit equipment ground conductors; insulated from box.
4. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads, for panels serving heavy computer loads.
5. Split Bus: Vertical buses divided into individual vertical sections.

C. Conductor Connectors: Suitable for use with conductor material.

1. Main and Neutral Lugs: Compression type.
2. Ground Lugs and Bus Configured Terminators: Compression type.
3. Feed-Through Lugs: Compression type suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
4. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

D. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.

2.03 PANELBOARD SHORT-CIRCUIT RATING

A. Fully rated to interrupt symmetrical short-circuit current available at terminals. Series rating is not allowed.

2.04 DISTRIBUTION PANELBOARDS

A. Doors: Secured with vault-type latch with tumbler lock; keyed alike. Omit for fused-switch panelboards.

B. Main Overcurrent Protective Devices: Circuit breaker.

C. Branch Overcurrent Protective Devices:

1. For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
2. For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.05 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

B. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.
2.06 OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker: UL 489, with interrupting capacity to meet available fault currents.


3. Electronic trip-unit circuit breakers shall have RMS sensing; field-replaceable rating plug; and with the following field-adjustable settings:
   a. Instantaneous trip.
   b. Long- and short-time pickup levels.
   c. Long- and short-time time adjustments.
   d. Ground-fault pickup level, time delay, and I²t response.


B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.

1. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.

2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.

3. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Mount top of trim 78 inches above finished floor, unless otherwise indicated.

C. Mount plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.

D. Install overcurrent protective devices and controllers.

1. Set field-adjustable switches and circuit-breaker trip ranges.

E. Install filler plates in unused spaces.

F. Stub four 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.

G. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
3.02 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.03 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Building Wire and Cable."

3.04 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:
   1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

B. Perform the following field tests and inspections and prepare test reports:
   1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.05 CLEANING

A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION
SECTION 26 27 26
WIRING DEVICES

PART 1 - GENERAL

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

1.02 SUMMARY
A. This Section includes the following:
   1. Receptacles, receptacles with integral GFCI, and associated device plates.
   2. Twist-locking receptacles.
   3. Isolated-ground receptacles.
   4. Snap switches and wall-box dimmers.
   5. Floor service outlets, poke-through assemblies, service poles, and multi-outlet assemblies.
B. Related Sections include the following:
   1. Division 27 Section "Communications Horizontal Cabling" for workstation outlets.

1.03 DEFINITIONS
A. EMI: Electromagnetic interference.
B. GFCI: Ground-fault circuit interrupter.
C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

1.04 SUBMITTALS
A. Product Data: For each type of product indicated.
B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
C. Samples: One for each type of device and wall plate specified, in each color specified.
D. Field quality-control test reports.
E. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.
1.05 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

1.06 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1. Cord and Plug Sets: Match equipment requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.02 STRAIGHT BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Cooper; 5351 (single), 5352 (duplex).
   b. Hubbell; HBL5351 (single), CR5352 (duplex).
   c. Leviton; 5891 (single), 5352 (duplex).
   d. Pass & Seymour; 5381 (single), 5352 (duplex).

B. Isolated-Ground, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Hubbell; CR 5253IG.
   b. Leviton; 5362-IG.
   c. Pass & Seymour; IG6300.
2. Description: Straight blade; equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.03 GFCI RECEPTACLES

A. General Description: Straight blade, non-feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Cooper; GF20.
   b. Pass & Seymour; 2084.
   c. Hubbell; GF5362

2.04 TWIST-LOCKING RECEPTACLES

A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 and UL 498. Configuration as indicated on drawings or as required by equipment.

2.05 PENDANT CORD-CONNECTOR DEVICES

A. Description: Matching, locking-type plug and receptacle body connector; NEMA WD 6, heavy-duty grade. Configuration as indicated on drawings or as required by equipment.


2. External Cable Grip: Woven wire-mesh type made of high-strength galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.06 CORD AND PLUG SETS

A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.

1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.


2.07 SNAP SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches, 120/277 V, 20 A:
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).
   b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
   c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
   d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).

C. Pilot Light Switches, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Cooper; 2221PL for 120 V and 277 V.
   b. Hubbell; HPL1221PL for 120 V and 277 V.
   c. Leviton; 1221-PLR for 120 V, 1221-7PLR for 277 V.
   d. Pass & Seymour; PS20AC1-PLR for 120 V.

2. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."

D. Key-Operated Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Cooper; 2221L.
   b. Hubbell; HBL1221L.
   c. Leviton; 1221-2L.
   d. Pass & Seymour; PS20AC1-L.

2. Description: Single pole, with factory-supplied key in lieu of switch handle.

E. Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors.

1. Products: Subject to compliance with requirements, provide one of the following:
   b. Hubbell; HBL1557.
   c. Leviton; 1257.
   d. Pass & Seymour; 1251.

F. Key-Operated, Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Cooper; 1995L.
   b. Hubbell; HBL1557L.
   c. Leviton; 1257L.
   d. Pass & Seymour; 1251L.
2.08 WALL-BOX DIMMERS

A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.

B. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472.

C. Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.
   1. 600 W; dimmers shall require no derating when ganged with other devices.

D. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.

2.09 WALL PLATES

A. Single and combination types to match corresponding wiring devices.
   1. Plate-Securing Screws: Metal with head color to match plate finish.
   4. Material for Damp Locations: Thermoplastic with spring-loaded lift cover, and listed and labeled for use in "wet locations."

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant thermoplastic with lockable cover.

2.10 FLOOR SERVICE FITTINGS

A. Type: Modular, flush-type, dual-service units suitable for wiring method used.

B. Compartments: Barrier separates power from voice and data communication cabling.

C. Service Plate: Round, solid brass with satin finish.

D. Power Receptacle: NEMA WD 6 configuration 5-20R, gray finish, unless otherwise indicated.

2.11 POKE-THROUGH ASSEMBLIES

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

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Hubbell Incorporated; Wiring Device-Kellems.
   2. Pass & Seymour/Legrand; Wiring Devices & Accessories.
3. Square D/ Schneider Electric.
4. Thomas & Betts Corporation.
5. Wiremold Company (The).

C. Description: Factory-fabricated and wired assembly of below-floor junction box with multichanneled, through-floor raceway/firestop unit and detachable matching floor service outlet assembly.

1. Service Outlet Assembly: Flush type with two simplex receptacles and space for two RJ-45 jacks.
2. Size: Selected to fit nominal 3-inch (75-mm) cored holes in floor and matched to floor thickness.
3. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
4. Closure Plug: Arranged to close unused 3-inch (75-mm) cored openings and reestablish fire rating of floor.
5. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors and a minimum of four, 4-pair, Category 5e voice and data communication cables.

2.12 MULTIOUTLET ASSEMBLIES

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

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Hubbell Incorporated; Wiring Device-Kellems.
2. Wiremold Company (The).

C. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.

D. Raceway Material: Metal, with manufacturer's standard finish.

E. Wire: No. 12 AWG.

2.13 SERVICE POLES

A. Description: Factory-assembled and wired units to extend power and voice and data communication from distribution wiring concealed in ceiling to devices or outlets in pole near floor.

1. Poles: Nominal 2.5-inch- (65-mm-) square cross section, with height adequate to extend from floor to at least 6 inches (150 mm) above ceiling, and with separate channels for power wiring and voice and data communication cabling.
2. Mounting: Ceiling trim flange with concealed bracing arranged for positive connection to ceiling supports; with pole foot and carpet pad attachment.
3. Finishes: Manufacturer's standard painted finish and trim combination.
4. Wiring: Sized for minimum of five No. 12 AWG power and ground conductors and a minimum of four, 4-pair, Category 3 or 5 voice and data communication cables.

5. Power Receptacles: Two duplex, 20-A, heavy-duty, NEMA WD 6 configuration 5-20R units.


2.14 FINISHES

A. Color: Wiring device catalog numbers in Section Text do not designate device color.

1. Wiring Devices Connected to Normal Power System: Ivory, unless otherwise indicated or required by NFPA 70 or device listing.

2. Isolated-Ground Receptacles: As specified above, with orange triangle on face.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Coordination with Other Trades:

1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.

2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.

3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.

4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.

2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.

3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.

4. Existing Conductors:
   a. Cut back and pigtail, or replace all damaged conductors.
   b. Straighten conductors that remain and remove corrosion and foreign matter.
   c. Pigtailing existing conductors is permitted provided the outlet box is large enough.

D. Device Installation:
1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.
10. Install wall switches 42 inches above floor, OFF position down.
11. Install convenience receptacles 18 inches above floor, 2 inches above counters or backsplash, grounding pole on bottom.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multi-gang wall plates.

I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.02 IDENTIFICATION

A. Comply with Division 26 Section "Identification for Electrical Systems."

1. Receptacles and Switches: Identify panelboard and circuit number from which served.
3.03 FIELD QUALITY CONTROL

A. Tests for Convenience Receptacles:

1. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
2. Using the test plug, verify that the device and its outlet box are securely mounted.

END OF SECTION
SECTION 26 28 13

FUSES

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 SECTION INCLUDES
   A. Fuses.
   B. Spare fuse cabinet.

1.03 REFERENCES
   B. NEMA FU 1 - Low Voltage Cartridge Fuses.

1.04 SUBMITTALS
   A. Submit under provisions of Section 260500.
   B. Product Data: Provide data sheets showing electrical characteristics including time-current curves.

1.05 PROJECT RECORD DOCUMENTS
   A. Submit under provisions of Section 260500.
   B. Record actual fuse sizes.

1.06 QUALIFICATIONS
   A. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum three years experience.

1.07 REGULATORY REQUIREMENTS
   A. Conform to requirements of NFPA 70.
   B. Furnish products listed and classified by UL and referenced standards as suitable for purpose specified and indicated.
1.08 MAINTENANCE MATERIALS
   A. Provide two fuse pullers.

1.09 EXTRA MATERIALS
   A. Provide three of each size and type fuse installed.

PART 2 - PRODUCTS

2.01 MANUFACTURERS
   A. Manufacturers:
      1. Bussman
      2. Littelfuse
      3. Ferraz-Shawmut

2.02 FUSE REQUIREMENTS
   A. Dimensions and Performance: NEMA FU 1, Class as specified or indicated.
   B. Voltage: Provide fuses with voltage rating suitable for circuit phase-to-phase voltage.
   C. Power Load Feeder Switches Larger than 600 amperes: Class L (time delay).
   D. Power Load Feeder Switches: Class RK1.
   E. Motor Load Feeder Switches: Class RK5.
   F. Other Feeder Switches Larger than 600 amperes: Class L time delay.
   G. Other Feeder Switches: Class RK1 (time delay).
   H. Power Branch Circuits: Class RK1 (time delay).
   I. Motor Branch Circuits: Class RK5.

PART 3 - EXECUTION

3.01 INSTALLATION
   A. Install fuses in accordance with manufacturer's instructions.
   B. Install fuse with label oriented such that manufacturer, type, and size are easily read.

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 SECTION INCLUDES
   A. Fusible Switches
   B. Nonfusible Switches

1.03 RELATED SECTIONS
   A. Section 262813- Fuses.

1.04 REFERENCES
   A. NECA - Standard of Installation (published by the National Electrical Contractors
      Association).
   B. NEMA FU1 - Low Voltage Cartridge Fuses.
   C. NEMA KS1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts
      Maximum).
   D. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution
   E. NFPA 70 - National Electrical Code.

1.05 SUBMITTALS FOR REVIEW
   A. Section 260500: Procedures for submittals.
   B. Product Data: Provide switch ratings and enclosure dimensions.

1.06 SUBMITTALS FOR CLOSEOUT
   A. Record actual locations of enclosed switches in project record documents.
1.07 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years experience.

1.08 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturers

1. Eaton Corporation
2. General Electric
3. Square-D
4. Siemens

2.02 FUSIBLE SWITCH ASSEMBLIES

A. Description: NEMA KS 1, Type HD, enclosed load interrupter knife switch. Handle lockable in OFF position.

B. Fuse Clips: Designed to accommodate NEMA FU1, Class R fuses.

2.03 NONFUSIBLE SWITCH ASSEMBLIES

A. Description: NEMA KS 1, Type HD enclosed load interrupter knife switch. Handle lockable in OFF position.

2.04 ENCLOSURES

A. Fabrication: NEMA KS 1.

1. Interior Dry Locations: Type 1.
2. Exterior Locations: Type 3R.
3. Elevator Locations: Type 4X.
PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with NECA "Standard of Installation".

B. Install fuses in fusible disconnect switches.

C. Apply adhesive tag on inside door of each fused switch indicating NEMA fuse class and size installed.

3.02 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Perform inspections and tests listed in NETA ATS, Section 7.5.

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 SECTION INCLUDES
   A. Enclosed circuit breakers.

1.03 RELATED WORK
   A. Section 260529 - Supporting Devices and Seals.
   B. Section 260553 - Electrical Identification: Engraved nameplates.

1.04 REFERENCES
   A. NECA (National Electrical Contractors Association) "Standard of Installation."
   B. NEMA AB 1 - Molded Case Circuit Breakers
   C. NFPA 70 - National Electrical Code.

1.05 SUBMITTALS
   A. Submit under provisions of Section 260500.
   B. Product Data: Provide catalog sheets showing ratings, trip units, time current curves,
      dimensions, and enclosure details.
   C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of
      use stipulated by Product testing agency specified under Regulatory Requirements. Include
      instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

1.06 QUALITY ASSURANCE
   A. Perform Work in accordance with NECA Standard of Installation.

1.07 QUALIFICATIONS
A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years experience.

1.08 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Furnish products listed and classified by UL and referenced standards as suitable for purpose specified and indicated.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturers
   1. General Electric
   2. Eaton
   3. Square-D
   4. Siemens

2.02 MOLDED CASE CIRCUIT BREAKER

A. Circuit Breaker: NEMA AB 1.

B. Service Conditions:
   1. Altitude: 6600 feet.

2.03 TRIP UNITS

A. Field-Adjustable Trip Circuit Breaker: Provide circuit breakers with frame sizes 200 amperes and larger with mechanism for adjusting long time, short time, continuous current setting for automatic operation.

B. Field-Changeable Ampere Rating Circuit Breaker: Provide circuit breakers with frame sizes 200 amperes and larger with changeable trip units.

2.04 ENCLOSURE

A. Enclosure: NEMA AB 1, Type 1 for interior locations; Type 4x for elevator locations.

B. Fabricate enclosure from steel.

C. Finish using manufacturer's standard enamel finish.

PART 3 - EXECUTION

ENCLOSED CIRCUIT BREAKERS

26 28 17 - 2
3.01 INSTALLATION

A. Install enclosed circuit breakers where indicated, in accordance with manufacturer's instructions.

B. Install enclosed circuit breakers plumb. Provide supports in accordance with Section 260529.

C. Height: 5 Ft to operating handle.

D. Provide engraved plastic nameplates under the provisions of Section 260553.

3.02 FIELD QUALITY CONTROL

A. Inspect and test each circuit breaker to NEMA AB 1.

B. Inspect each circuit breaker visually.

C. Perform several mechanical ON-OFF operations on each circuit breaker.

D. Verify circuit continuity on each pole in closed position.

E. Determine that circuit breaker will trip on overcurrent condition, with tripping time to NEMA AB 1 requirements.

F. Include description of testing and results in test report.

3.03 ADJUSTING

A. Adjust trip settings so that circuit breakers coordinate with other overcurrent protective devices in circuit.

B. Adjust trip settings to provide adequate protection from overcurrent and fault currents.

END OF SECTION
SECTION 26 43 13

TRANSIENT VOLTAGE SURGE SUPPRESSION (TVSS)
(Selenium Enhanced)

PART 1 - GENERAL

1.01 SUMMARY

A. This specification includes requirements for a high energy, dual-listed, surge arrester and transient voltage surge suppressor (TVSS) electronic filtering system used to protect AC electrical distribution from the effects of lightning, utility switching events, temporary over voltages (TOV), and impulses generated internally within a facility.

1.02 RELATED DOCUMENT

A. The specified unit shall be designed, manufactured, tested and installed in compliance with the following standards:

- ANSI/IEEE C62.1 and C62.11
- Canadian Standards (CUL)
- Federal Information Processing Standards Publication 94 (FIPS PUB 94)
- National Electrical Manufacturers Association (NEMA LS1-1992 Guidelines)
- National Fire Protection Association (NFPA 70 [NEC], 75 and 78)
- Underwriters Laboratories (UL 96, 198, 248-1, 489, 1283 and 1449-Second Edition)

1.03 SUBMITTALS

A. Product Data: Provide complete product data detailing manufacturer’s model number, specifications, features and options. Substitute/alternate products require pre-approval, and shall only be considered if the Attachment 1 TVSS Submittal Compliance Form is fully completed and submitted at least fourteen (14) days prior to bid date.

B. Test Data: Certified documentation shall be provided of the product’s UL 1449 Second Edition listing, clamping values (to include ratings with internal disconnects, if applicable), surge current fuse testing, independent test lab single pulse surge current capacity testing, and minimum repetitive surge current capacity testing.

C. Shop Drawings: Provide electrical and mechanical drawings that include detail on unit dimensions, weights, field connections and mounting provisions.

D. Installation, Operation and Maintenance Manuals: Provide one copy of the installation, start-up, operation and maintenance data for each unit supplied.

1.04 ACCEPTABLE MANUFACTURER

A. These specifications detail performance requirements for a selenium-enhanced suppression system manufactured by Current Technology. Substitute, value-engineered or alternate products shall meet all performance and reliability aspects of this specification. The surge suppression and noise filtering unit shall be as follows:
1. Service Entrance Location: Current Technology Model # SL2-150
2. Panelboard Locations: Current Technology Model #TG100.

1.05 SUBSTITUTION PRE-APPROVAL PROCEDURES

A. Manufacturers requesting approval of their products shall identify the full model number and submit product data, specifications and complete the Attachment 1 TVSS Submittal Compliance Form at least fourteen (14) days prior to the bid date.

1.06 WARRANTY

A. The manufacturer shall provide a fifteen (15) year limited warranty from the date of shipment against failure when installed in compliance with applicable national/local electrical codes and the manufacturer's installation, operation and maintenance instructions.

1.07 LOCAL SERVICE SUPPORT

A. A dedicated support organization shall be located within 150 miles of the project location, and shall have experience supporting at least twenty other projects of similar complexity within the last three years. Personnel shall perform a start-up service to verify correct installation of the filters, perform transient voltage tests for reliability and performance using appropriate surge generating test equipment, and respond on-site to investigate user concerns.

PART 2 - PRODUCTS

2.01 HIGH PERFORMANCE SUPPRESSION SYSTEM

A. The suppression system shall incorporate a hybrid design of selenium cells (for service entrance location only), metal oxide varistor (MOV) arrays and filtering capacitors. These components shall optimally share surge currents to ensure maximum performance and long-term reliability. The system shall not utilize gas tubes, spark gaps, silicon avalanche diodes, or other components that might short or crowbar the line, thus leading to power interruption.

2.02 UL DUAL LISTED - SURGE ARRESTER and SURGE SUPPRESSOR

A. The system shall be UL listed as category XUHT (UL 1449 Second Edition, manufactured after February 2007) and CUL approved as a transient voltage surge suppressor (TVSS), as well as UL listed as category OWHX (UL96) as a secondary surge arrester, and UL listed as category FOKY (UL 1283) as an electromagnetic interference filter.

2.03 UNIT OPERATING VOLTAGE

A. The operating voltage and configuration shall be 120/208 grounded wye for service entrance location and 120/208 Volt grounded wye for panelboard locations.
2.04 MAXIMUM CONTINUOUS OPERATING VOLTAGE (MCOV)

A. The MCOV shall be greater than 115 percent (%) of nominal voltage, but no greater than 130 percent (%). Test and evaluation shall be as outlined in NEMA LS1-1992, paragraphs 2.2.6 and 3.6.

2.05 PROTECTION MODES

A. Per the definitions in NEMA LS 1-1992, paragraph 2.2.7, all modes shall be protected (e.g., line-to-line, line-to-neutral, line-to-ground and neutral-to-ground).

2.06 RATED SINGLE PULSE SURGE CURRENT CAPACITY

A. Calculations for single pulse surge current capacity shall use the component manufacturer's individual component rating multiplied by the respective number of per mode components. Documentation shall be provided with submittals on the Attachment 1 TVSS Submittal Compliance Form. Component manufacturer’s ratings shall be derived using the ANSI/IEEE C62.41-1991 Category C1 8 X 20 micro sec, 3000A current waveform. The per mode single pulse surge current rating shall be calculated based upon the component manufacturer's catalog rating for each device. The minimum rated single pulse surge current capacity per mode shall be as follows:

<table>
<thead>
<tr>
<th>Location</th>
<th>L-N</th>
<th>L-G</th>
<th>N-G</th>
<th>L-L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service Entrance</td>
<td>150,000 A</td>
<td>150,000 A</td>
<td>150,000 A</td>
<td>150,000 A</td>
</tr>
<tr>
<td>Panelboards</td>
<td>100,000 A</td>
<td>100,000 A</td>
<td>100,000 A</td>
<td>100,000 A</td>
</tr>
</tbody>
</table>

2.07 TESTED SINGLE PULSE SURGE CURRENT CAPACITY

A. The suppression filter system shall be single pulse surge current tested in all modes at rated surge currents by an industry-recognized independent test laboratory. Units with surge current capacities of 200,000 amps or less shall be tested as a unit, not individual modules. Due to industry test equipment limitations, units with surge current capacities greater than 200,000 amps shall be tested as a unit to 200,000 amps; and certified for surge current ratings above 200,000 amps by testing individual components or sub-assemblies within a mode. Units that sustain any component or overcurrent device failure or degradation are unacceptable.

2.08 MINIMUM REPETITIVE SURGE CURRENT CAPACITY

A. Per ANSI/IEEE C62.41 and ANSI/IEEE C62.45-1992, every mode of the suppression filter system shall be designed to survive multiple Category C3, 20 KV, 10 KA impulses. Test documentation shall detail the unit's ability to survive the following number of events (at one minute intervals) without any performance degradation.
2.09 TEMPORARY OVERVOLTAGE (TOV)/SWELL VOLTAGE RATING

A. For service entrance locations only, suppression components shall be capable of withstanding continuous temporary overvoltage events (swells). Based on a source impedance of 0.7 Ohms, the unit shall withstand an overvoltage of 200 percent (above RMS nominal voltage) for at least 60 cycles, without component failure (including fuses).

2.10 HIGH FREQUENCY EXTENDED RANGE FILTER

A. EMI-RFI noise rejection/attenuation (per NEMA LS-1-1992 and MIL-STD-E220A 50 ohm insertion loss methodology) shall be as follows:

<table>
<thead>
<tr>
<th>Attenuation Frequency</th>
<th>50 KHz</th>
<th>100 KHz</th>
<th>1 MHZ</th>
<th>10 MHZ</th>
<th>100 MHZ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insertion Loss (dB)</td>
<td>50</td>
<td>41</td>
<td>31</td>
<td>35</td>
<td>53</td>
</tr>
</tbody>
</table>

B. For installations that install multiple downstream filters, the filters shall be coordinated to provide minimum noise rejection/attenuation as follows:

<table>
<thead>
<tr>
<th>Attenuation Frequency</th>
<th>50 KHz</th>
<th>100 KHz</th>
<th>1 MHZ</th>
<th>10 MHZ</th>
<th>100 MHZ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insertion Loss (dB)</td>
<td>85</td>
<td>83</td>
<td>68</td>
<td>67</td>
<td>84</td>
</tr>
</tbody>
</table>

C. NOTE: Insertion loss data shall be based on a minimum of 100 feet of #4 AWG conductor between filters.

2.11 SUPPRESSION VOLTAGE RATING

A. In compliance with procedures outlined in NEMA LS 1-1992, paragraphs 2.2.10 and 3.10, the maximum suppression voltage rating (with integral fused disconnect) shall be as follows:

<table>
<thead>
<tr>
<th>Locations</th>
<th>L-L</th>
<th>L-N</th>
<th>L-G</th>
<th>N-G</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service Entrance</td>
<td>&gt;12,000</td>
<td>&gt;12,000</td>
<td>&gt;12,000</td>
<td>&gt;12,000</td>
</tr>
<tr>
<td>Panelboards</td>
<td>&gt;4500</td>
<td>&gt;4500</td>
<td>&gt;4500</td>
<td>&gt;4500</td>
</tr>
</tbody>
</table>
TRANSIENT VOLTAGE SURGE SUPPRESSION (TVSS)

2.12 REDUNDANT OVERCURRENT PROTECTION

A. Each suppression element shall utilize individual UL 248-1 recognized, 200 KAIC tested fuses to ensure that the failure of a single suppression component, or operation of any single fuse does not render the entire mode, phase or product deficient by more than ten percent (10%). At service entrance locations only, in the event a catastrophic or swell voltage occurrence causes the failure of all the MOV elements, the fusing for the selenium cells shall be independent to provide redundancy. The filter shall be capable of withstanding the rated single pulse surge current capacity without fuse failure.

2.13 INTERNAL CONNECTIONS

A. Internal surge current paths shall utilize low-impedance copper bus bar. No plug-in modules or quick-disconnect terminals shall be used in the surge current-carrying paths.

2.14 BUILT-IN FIELD TEST CAPABILITY

A. The unit shall incorporate an integral test point for off-line diagnostic testing to verify operational integrity of the suppression filter system. Testing shall include injection of an impulse at least two times the nominal system voltage, and provide metering to indicate the resultant clamping voltage. The unit shall also include an integral test point for a secondary test meter that displays the status of the internal fusing, to include indication of partial degradation of surge current capacity capability.

2.15 ENCLOSURE

A. The service entrance unit shall utilize a NEMA 4 metallic enclosure.

2.16 ADDITIONAL FEATURES/EQUIPMENT

A. Advanced Monitoring Feature. A battery-powered audible alarm with event counter display and two sets of form C dry contacts (N.O. or N.C.) shall be provided. The alarm shall indicate single or multiple phase failure of the filter.

PART 3 - EXECUTION

3.01 INSTALLATION
A. The service entrance and panelboard filters shall be installed external to the switchgear/panelboard as close as possible to the connection point following the manufacturer’s recommendations for conductor size and minimal bends.

3.02 EQUIPMENT MANUAL

A. An equipment manual shall be provided that details installation, operation, and maintenance instructions for the filter. Information shall include unit dimensions, weights, mounting provisions, connection details and a layout diagram.
## ATTACHMENT 1 - TVSS SUBMITTAL COMPLIANCE FORM

### (SERVICE ENTRANCE)

<table>
<thead>
<tr>
<th>Performance/Feature</th>
<th>Specification Requirement</th>
<th>Proposed</th>
</tr>
</thead>
<tbody>
<tr>
<td>UL Dual Listed (Surge Suppressor and Surge Arrester)</td>
<td>Surge Suppressor - Yes</td>
<td>Surge Suppressor - ____</td>
</tr>
<tr>
<td></td>
<td>Surge Arrester - Yes</td>
<td>Surge Arrester - ____</td>
</tr>
<tr>
<td>Single Pulse Surge Rating Per Mode</td>
<td>150 KA L-N</td>
<td>____ L-N</td>
</tr>
<tr>
<td></td>
<td>150 KA L-G</td>
<td>____ L-G</td>
</tr>
<tr>
<td></td>
<td>150 KA N-G</td>
<td>____ N-G</td>
</tr>
<tr>
<td>Single Pulse Surge Rating Per Phase</td>
<td>300 KA L-N + L-G</td>
<td>____ L-N + L-G</td>
</tr>
<tr>
<td>Number Of Components Used For Above Rating (Attach Component Manufacturer’s Product Data)</td>
<td>L-N: 16, L-G: 16; N-G: 16 Each component rated for 10,000 transient Amps (Manufacturer: Harris Ultra MOV V20E320)</td>
<td>Number of MOV’s/Mode L-N _____ L-G _____ N-G _____</td>
</tr>
<tr>
<td>Documentation of Rating</td>
<td>Independent Test Reports</td>
<td></td>
</tr>
<tr>
<td>Warranty For Damage To TVSS Due To Lightning</td>
<td>15 years</td>
<td></td>
</tr>
<tr>
<td>Dispatch Location For Local Support And Start-Up</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum Continuous Operating Voltage (MCOV) For All Suppression Components</td>
<td>Greater than 115 percent and less than 130 percent</td>
<td></td>
</tr>
<tr>
<td>Temporary Overvoltage Capacity</td>
<td>200% for 60 cycles</td>
<td></td>
</tr>
<tr>
<td>Protection Modes Provided</td>
<td>L-L, L-N, L-G and N-G</td>
<td></td>
</tr>
<tr>
<td>Category C3 Repetitive Surge Current Capacity</td>
<td>&gt; 12,000 impulses</td>
<td></td>
</tr>
<tr>
<td>High Frequency Noise Filtering Attenuation</td>
<td>50 KHz 50 dB</td>
<td>50 KHz _____ dB</td>
</tr>
<tr>
<td></td>
<td>100 KHz 41 dB</td>
<td>100 KHz _____ dB</td>
</tr>
<tr>
<td></td>
<td>1 MHz 31 dB</td>
<td>1 MHz _____ dB</td>
</tr>
<tr>
<td></td>
<td>10 MHz 35 dB</td>
<td>10 MHz _____ dB</td>
</tr>
<tr>
<td></td>
<td>100 MHz 53 dB</td>
<td>100 MHz _____ dB</td>
</tr>
<tr>
<td>Internal Surge Current Path</td>
<td>Copper Bus Bar</td>
<td></td>
</tr>
<tr>
<td>Field Test Capability With Surge Generator and Secondary Fuse Meter?</td>
<td>Required? ___ No X Yes</td>
<td>Provided? ___ No ___ Yes</td>
</tr>
<tr>
<td></td>
<td>If Yes, How? _________________________</td>
<td></td>
</tr>
<tr>
<td>Individually Fused Elements UL 248-1 Recognized Fuses</td>
<td>Required? ___ No X Yes</td>
<td>Provided? ___ No ___ Yes</td>
</tr>
<tr>
<td>Individual Fuse - Surge Current Rating</td>
<td>Required? ___ No X Yes</td>
<td>Provided? ___ No ___ Yes</td>
</tr>
<tr>
<td></td>
<td>~12,000 Transient Amps</td>
<td>________ Transient Amps</td>
</tr>
<tr>
<td>Disturbance Counter</td>
<td>Required? ___ No X Yes</td>
<td>Provided? ___ No ___ Yes</td>
</tr>
<tr>
<td>Microprocessor-Based Diagnostics</td>
<td>Required? ___ No X Yes</td>
<td>Provided? ___ No ___ Yes</td>
</tr>
<tr>
<td>Enclosure</td>
<td>Metal NEMA 4</td>
<td></td>
</tr>
</tbody>
</table>
# ATTACHMENT 1 - TVSS SUBMITTAL COMPLIANCE FORM

**PANELBOARDS**

<table>
<thead>
<tr>
<th>Performance/Feature</th>
<th>Specification Requirement</th>
<th>Proposed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Pulse Surge Rating Per Mode</td>
<td>100 KA, L-N&lt;br&gt;100 KA, L-G&lt;br&gt;100 KA, N-G</td>
<td>L-N&lt;br&gt;L-G&lt;br&gt;N-G</td>
</tr>
<tr>
<td>Single Pulse Surge Rating Per Phase</td>
<td>200 KA, L-N + L-G</td>
<td>L-N + L-G</td>
</tr>
<tr>
<td>Number Of Components Used For Above Rating (Attach Component Manufacturer’s Product Data)</td>
<td>L-N: 11, L-G: 11; N-G: 11&lt;br&gt;Each component rated for 10,000 transient Amps&lt;br&gt;(Manufacturer: Harris Ultra MOV V20E320)</td>
<td>Number of MOV's/Mode&lt;br&gt;L-N _______ L-G _______ N-G _______</td>
</tr>
<tr>
<td>Documentation of Rating</td>
<td>Independent Test Reports</td>
<td></td>
</tr>
<tr>
<td>Warranty For Damage To TVSS Due To Lightning</td>
<td>10 years</td>
<td></td>
</tr>
<tr>
<td>Dispatch Location For Local Support And Start-Up</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum Continuous Operating Voltage (MCOV) For All Suppression Components</td>
<td>Greater than 115 percent and less than 130 percent</td>
<td></td>
</tr>
<tr>
<td>Protection Modes Provided</td>
<td>L-L, L-N, L-G and N-G</td>
<td></td>
</tr>
<tr>
<td>Category C3 Repetitive Surge Current Capacity</td>
<td>&gt; 4500 impulses</td>
<td></td>
</tr>
<tr>
<td>High Frequency Noise Filtering Attenuation</td>
<td>50 KHz 50 dB&lt;br&gt;100 KHz 41 dB&lt;br&gt;1 MHz 31 dB&lt;br&gt;10 MHz 35 dB&lt;br&gt;100 MHz 53 dB</td>
<td>50 KHz _____ dB&lt;br&gt;100 KHz _____ dB&lt;br&gt;1 MHz _____ dB&lt;br&gt;10 MHz _____ dB&lt;br&gt;100 MHz _____ dB</td>
</tr>
<tr>
<td>Internal Surge Current Path</td>
<td>Copper Bus Bar</td>
<td></td>
</tr>
<tr>
<td>Field Test Capability With Surge Generator and Secondary Fuse Meter?</td>
<td>Required? ___ No X Yes</td>
<td>Provided? ___ No ___ Yes&lt;br&gt;If Yes, How? ____________________________</td>
</tr>
<tr>
<td>Individually Fused Elements UL 248-1 Recognized Fuses</td>
<td>Required? ___ No X Yes&lt;br&gt;Required? ___ No X Yes&lt;br&gt;~12,000 Transient Amps</td>
<td>Provided? ___ No ___ Yes&lt;br&gt;Provided? ___ No ___ Yes&lt;br&gt;_________ Transient Amps</td>
</tr>
<tr>
<td>Individual Fuse - Surge Current Rating</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disturbance Counter</td>
<td>Required? ___ No x Yes</td>
<td>Provided? ___ No ___ Yes</td>
</tr>
<tr>
<td>Microprocessor-Based Diagnostics</td>
<td>Required? ___ No x Yes</td>
<td>Provided? ___ No ___ Yes</td>
</tr>
</tbody>
</table>

---

END OF SECTION
SECTION 26 51 00
INTERIOR LIGHTING

PART 1 - GENERAL

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

1.02 SUMMARY
   A. This Section includes the following:
      1. Interior lighting fixtures, lamps, and ballasts.
      2. Emergency lighting units.
      3. Exit signs.
      4. Lighting fixture supports.
      5. Retrofit kits for fluorescent lighting fixtures.
   B. Related Sections include the following:
      1. Division 26 Section "Wiring Devices" for manual wall-box dimmers for
         incandescent lamps.

1.03 DEFINITIONS
   A. BF: Ballast factor.
   B. CRI: Color-rendering index.
   C. CU: Coefficient of utilization.
   D. HID: High-intensity discharge.
   E. LER: Luminaire efficacy rating.
   F. Luminaire: Complete lighting fixture, including ballast housing if provided.
   G. RCR: Room cavity ratio.

1.04 SUBMITTALS
   A. Product Data: For each type of lighting fixture, arranged in order of fixture designation.
      Include data on features, accessories, finishes, and the following:
      1. Physical description of lighting fixture including dimensions.
      2. Emergency lighting units including battery and charger.

B. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Lighting fixtures.
2. Suspended ceiling components.
3. Structural members to which suspension systems for lighting fixtures will be attached.
4. Other items in finished ceiling including the following:
   a. Air outlets and inlets.
   b. Speakers.
   c. Sprinklers.
   d. Smoke and fire detectors.
   e. Occupancy sensors.
   f. Access panels.
5. Perimeter moldings.

C. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.

1.05 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

1.06 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. In Interior Lighting Fixture Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
B. Incandescent Fixtures: Comply with UL 1598.

C. Fluorescent Fixtures: Comply with UL 1598.

D. HID Fixtures: Comply with UL 1598.

E. Metal Parts: Free of burrs and sharp corners and edges.

F. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

G. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

H. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
   1. White Surfaces: 85 percent.
   2. Specular Surfaces: 83 percent.
   3. Diffusing Specular Surfaces: 75 percent.
   4. Laminated Silver Metallized Film: 90 percent.

I. Plastic Diffusers, Covers, and Globes:
   1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
      a. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless different thickness is indicated.
      b. UV stabilized.
   2. Glass: Annealed crystal glass, unless otherwise indicated.

2.03 BALLASTS FOR LINEAR FLUORESCENT LAMPS

A. Electronic Ballasts: Comply with ANSI C82.11; programmed-start type, unless otherwise indicated, and designed for type and quantity of lamps served. Ballasts shall be designed for full light output unless dimmer or bi-level control is indicated.
   1. Sound Rating: A.
   2. Total Harmonic Distortion Rating: Less than 10 percent.
   3. Transient Voltage Protection: IEEE C62.41, Category A or better.
   4. Operating Frequency: 42 kHz or higher.
   5. Lamp Current Crest Factor: 1.7 or less.
   6. BF: 0.85 or higher.
   7. Power Factor: 0.98 or higher.
   8. Parallel Lamp Circuits: Multiple lamp ballasts shall comply with ANSI C 82.11 and shall be connected to maintain full light output on surviving lamps if one or more lamps fail.

B. Electronic Programmed-Start Ballasts for T5 and T5HO Lamps: Comply with ANSI C82.11 and the following:
   1. Lamp end-of-life detection and shutdown circuit for T5 diameter lamps.
2. Automatic lamp starting after lamp replacement.
3. Sound Rating: A.
4. Total Harmonic Distortion Rating: Less than 20 percent.
5. Transient Voltage Protection: IEEE C62.41, Category A or better.
6. Operating Frequency: 20 kHz or higher.
7. Lamp Current Crest Factor: 1.7 or less.
8. BF: 0.95 or higher, unless otherwise indicated.
9. Power Factor: 0.98 or higher.

C. Ballasts for Low-Temperature Environments:

1. Temperatures 0 Deg F (Minus 17 Deg C) and Higher: Electronic type rated for 0 deg F (minus 17 deg C) starting and operating temperature with indicated lamp types.
2. Temperatures Minus 20 Deg F (Minus 29 Deg C) and Higher: Electromagnetic type designed for use with indicated lamp types.

D. Ballasts for Dimmer-Controlled Lighting Fixtures: Electronic type.

1. Dimming Range: 100 to 5 percent of rated lamp lumens.
2. Ballast Input Watts: Can be reduced to 20 percent of normal.
3. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.

2.04 BALLASTS FOR COMPACT FLUORESCENT LAMPS

A. Description: Electronic programmed rapid-start type, complying with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated:

1. Lamp end-of-life detection and shutdown circuit.
2. Automatic lamp starting after lamp replacement.
3. Sound Rating: A.
4. Total Harmonic Distortion Rating: Less than 20 percent.
5. Transient Voltage Protection: IEEE C62.41, Category A or better.
6. Operating Frequency: 20 kHz or higher.
7. Lamp Current Crest Factor: 1.7 or less.
8. BF: 0.95 or higher, unless otherwise indicated.
9. Power Factor: 0.98 or higher.
10. Interference: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.

B. Ballasts for Dimmer-Controlled Lighting Fixtures: Electronic type.

1. Dimming Range: 100 to 5 percent of rated lamp lumens.
2. Ballast Input Watts: Can be reduced to 20 percent of normal.
3. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.
2.05 EMERGENCY FLUORESCENT POWER UNIT

A. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with ballast. Comply with UL 924.

1. Emergency Connection: Operate 1 fluorescent lamp(s) continuously at an output of 1100 lumens each. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
2. Night-Light Connection: Operate one fluorescent lamp continuously.
3. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.
   a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
   b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
5. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
6. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

2.06 BALLASTS FOR HID LAMPS

A. Electronic Ballast for Metal-Halide Lamps: Include the following features unless otherwise indicated:

1. Lamp end-of-life detection and shutdown circuit.
2. Sound Rating: A.
3. Total Harmonic Distortion Rating: Less than 15 percent.
4. Transient Voltage Protection: IEEE C62.41, Category A or better.
5. Lamp Current Crest Factor: 1.5 or less.
6. Power Factor: .90 or higher.
7. Interference: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.
8. Protection: Class P thermal cutout.

2.07 EXIT SIGNS

A. Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:

1. Lamps for AC Operation: LEDs, 70,000 hours minimum rated lamp life.
2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
   a. Battery: Sealed, maintenance-free, nickel-cadmium type.
   b. Charger: Fully automatic, solid-state type with sealed transfer relay.
   c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal
voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.

d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.

e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

f. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

2.08 EMERGENCY LIGHTING UNITS

A. Description: Self-contained units complying with UL 924.

1. Battery: Sealed, maintenance-free, lead-acid type.
2. Charger: Fully automatic, solid-state type with sealed transfer relay.
3. Operation: Relay automatically turns lamp on when power supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
6. Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or fixtures.
7. Integral Time-Delay Relay: Holds unit on for fixed interval of 15 minutes when power is restored after an outage.
8. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

2.09 FLUORESCENT LAMPS

A. Low-Mercury Lamps: Comply with EPA’s toxicity characteristic leaching procedure test; shall yield less than 0.2 mg of mercury per liter when tested according to NEMA LL 1.

B. T8 rapid-start low-mercury lamps, rated 32 W maximum, nominal length of 48 inches (1220 mm), 2800 initial lumens (minimum), CRI 82 (minimum), color temperature 3500 K, and average rated life 20,000 hours, unless otherwise indicated.

C. T8 rapid-start low-mercury lamps, rated 17 W maximum, nominal length of 24 inches (610 mm), 1300 initial lumens (minimum), CRI 82 (minimum), color temperature 3500 K, and average rated life of 20,000 hours, unless otherwise indicated.

D. T5 rapid-start low-mercury lamps, rated 28 W maximum, nominal length of 45.2 inches (1150 mm), 2900 initial lumens (minimum), CRI 85 (minimum), color temperature 3500 K, and average rated life of 20,000 hours, unless otherwise indicated.

E. T5HO rapid-start, high-output low-mercury lamps, rated 54 W maximum, nominal length of 45.2 inches (1150 mm), 5000 initial lumens (minimum), CRI 85 (minimum), color temperature 3500 K, and average rated life of 20,000 hours, unless otherwise indicated.
F. Compact Fluorescent Lamps: 4-Pin, low mercury, CRI 80 (minimum), color temperature 3500 K, average rated life of 10,000 hours at 3 hours operation per start, and suitable for use with dimming ballasts, unless otherwise indicated.

1. 13 W: T4, double or triple tube, rated 900 initial lumens (minimum).
2. 18 W: T4, double or triple tube, rated 1200 initial lumens (minimum).
3. 26 W: T4, double or triple tube, rated 1800 initial lumens (minimum).
4. 32 W: T4, triple tube, rated 2400 initial lumens (minimum).
5. 42 W: T4, triple tube, rated 3200 initial lumens (minimum).
6. 55 W: T4, triple tube, rated 4300 initial lumens (minimum).

2.10 HID LAMPS

A. Metal-Halide Lamps: ANSI C78.1372, with a minimum CRI 80, and color temperature 3000 K, unless otherwise indicated.

B. Pulse-Start, Metal-Halide Lamps: Minimum CRI 65, and color temperature 3000 K, unless otherwise indicated.

C. Ceramic, Pulse-Start, Metal-Halide Lamps: Minimum CRI 80, and color temperature 3000 K, unless otherwise indicated.

2.11 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two, 1/2-inch (13-mm) steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).

E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage (2.68 mm).

F. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.

G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

2.12 REQUIREMENTS FOR INDIVIDUAL LIGHTING FIXTURES

A. Reference luminaire schedule on drawings.
PART 3 - EXECUTION

3.01 INSTALLATION

A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.

B. Support for Lighting Fixtures in or on Grid-Type Suspended Ceilings: Use grid as a support element.
   1. Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 6 inches (150 mm) from lighting fixture corners.
   2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
   3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch (20-mm) metal channels spanning and secured to ceiling tees.
   4. Install at least one independent support rod or wire from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.

C. Suspended Lighting Fixture Support:
   1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
   3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.

D. Adjust aimable lighting fixtures to provide required light intensities.

E. Connect wiring according to Division 26 Section "Building Wire and Cable."

3.02 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

END OF SECTION
SECTION 26 56 00
EXTERIOR LIGHTING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following:

1. Exterior luminaires with lamps and ballasts.
2. Poles and accessories.

B. Related Sections include the following:

1. Division 26 Section "Interior Lighting" for exterior luminaires normally mounted on
   exterior surfaces of buildings.

1.03 DEFINITIONS

A. CRI: Color-rendering index.
B. HID: High-intensity discharge.
C. Luminaire: Complete lighting fixture, including ballast housing if provided.
D. Pole: Luminaire support structure, including tower used for large area illumination.
E. Standard: Same definition as "Pole" above.

1.04 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

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

B. Live Load: Single load of 500 lbf (2224 N), distributed as stated in AASHTO LTS-4.

C. Ice Load: Load of 3 lbf/sq. ft. (143.6 Pa), applied as stated in AASHTO LTS-4.

D. Wind Load: Pressure of wind on pole and luminaire, calculated and applied as stated in
   AASHTO LTS-4.

1. Wind speed for calculating wind load for poles exceeding 50 feet (15 m) in height
   is 150 mph.
2. Wind speed for calculating wind load for poles 50 feet (15 m) or less in height is 150 mph.

1.05 SUBMITTALS

A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:
   1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
   2. Ballasts, including energy-efficiency data.
   3. Lamps, including life, output, and energy-efficiency data.

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

1.06 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.


C. Comply with NFPA 70.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Store poles on decay-resistant-treated skids at least 12 inches (300 mm) above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

B. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. In Exterior Lighting Device Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
2.02 LUMINAIRES, GENERAL REQUIREMENTS

A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.

B. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

C. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.

E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.

G. Exposed Hardware Material: Stainless steel.

H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.

J. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:

   1. White Surfaces: 85 percent.
   2. Specular Surfaces: 83 percent.
   3. Diffusing Specular Surfaces: 75 percent.

K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

L. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

M. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

   1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

   a. Color: As selected by Architect from manufacturer's full range.

N. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Luminaire, arm and pole top fitting shall receive integral color, Aluminum Association Architectural Class I anodizing (Duranodic or kalcior) after fabrication, Black. Pole should be provided with paint to match luminaire anodized color. A three-stage finishing process consisting of: (a) acid etching, (b) priming, and (c) baked enamel finish, 5 mil thick, shall be considered an acceptable alternate to anodizing.

2.03 BALLASTS FOR HID LAMPS

A. Comply with ANSI C82.4 and UL 1029 and capable of open-circuit operation without reduction of average lamp life. Include the following features, unless otherwise indicated:

1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
2. Minimum Starting Temperature: Minus 22 deg F (Minus 30 deg C).
4. Ballast Fuses: One in each ungrounded power supply conductor. Voltage and current ratings as recommended by ballast manufacturer.

2.04 HID LAMPS

A. Metal-Halide Lamps: ANSI C78.1372, with a minimum CRI 65, and color temperature 4000 K, unless otherwise noted.

B. Pulse-Start, Metal-Halide Lamps: Minimum CRI 65, and color temperature 4000 K, unless otherwise noted.

C. Ceramic, Pulse-Start, Metal-Halide Lamps: Minimum CRI 80, and color temperature 4000 K, unless otherwise noted.

2.05 POLES AND SUPPORT COMPONENTS, GENERAL REQUIREMENTS

A. Structural Characteristics: Comply with AASHTO LTS-4.

1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in Part 1 "Structural Analysis Criteria for Pole Selection" Article, with a gust factor of 1.3.
2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.
B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts, unless otherwise indicated.

C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
   1. Materials: Shall not cause galvanic action at contact points.
   2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication, unless stainless-steel items are indicated.
   3. Anchor-Bolt Template: Plywood or steel.

D. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."

E. Breakaway Supports: Frangible breakaway supports, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-4.

2.06 STEEL POLES

A. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig (317 MPa); 1-piece construction up to 40 feet (12 m) in height with access handhole in pole wall.
   1. Shape: Round, tapered.
   2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

B. Intermediate Handhole and Cable Support: Weathertight, 3-by-5-inch (76-by-127-mm) handhole located at 18" up from base of pole with cover for access to internal welded attachment lug for electric cable support grip.

C. Grounding and Bonding Lugs: Welded 1/2-inch (13-mm) threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

D. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
   1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
   2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.
   3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
      a. Color: As selected by Architect from manufacturer's full range.
2.07 ALUMINUM POLES

A. Poles: Seamless, extruded structural tube complying with ASTM B 429, Alloy 6063-T6 with access handhole in pole wall.

   1. Shape: Round, tapered.
   2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

C. Grounding and Bonding Lugs: Welded 1/2-inch (13-mm) threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

D. Aluminum Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
   1. Luminaire, arm and pole top fitting shall receive integral color, Aluminum Association Architectural Class I anodizing (Duranodic or kalcolor) after fabrication, Black. Poe should be provided with paint to match luminaire anodized color. A three-stage finishing process consisting of: (a) acid etching, (b) priming, and (c) baked enamel finish, 5 mil thick, shall be considered an acceptable alternate to anodizing.

2.08 REQUIREMENTS FOR INDIVIDUAL EXTERIOR LIGHTING DEVICES

A. Exterior Lighting Device Type: Reference luminaire schedule on drawings.

PART 3 - EXECUTION

3.01 LUMINAIRE INSTALLATION

A. Install lamps in each luminaire.

B. Fasten luminaire to indicated structural supports.
   1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Adjust luminaires that require field adjustment or aiming.

3.02 POLE INSTALLATION

A. Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.
B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features, unless otherwise indicated on Drawings:

1. Fire Hydrants and Storm Drainage Piping: 60 inches (1520 mm).
2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet (3 m).
3. Trees: 15 feet (5 m).

C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 03 Section "Cast-in-Place Concrete."

D. Raise and set poles using web fabric slings (not chain or cable).

3.03 BOLLARD LUMINAIRE INSTALLATION

A. Align units for optimum directional alignment of light distribution.

B. Install on concrete base with top 4 inches (100 mm) above finished grade or surface at bollard location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-Place Concrete."

3.04 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Division 26 Section "Raceway and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.05 GROUNDING

A. Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole, unless otherwise indicated.
2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

3.06 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.

1. Verify operation of photoelectric controls.

END OF SECTION
SECTION 27 00 10

BASIC COMMUNICATIONS REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section specifies the basic requirements for communications installations as indicated or required, and includes requirements common to more than one Specification Section of this Division (such as related documents, related Sections, definitions, governing requirements, Contractor requirements, warranty requirements, submittal requirements/procedures, and project closeout requirements/procedures, as well as other requirements).

1.02 RELATED DOCUMENTS

A. The General Provisions of the Contract (including General and Supplementary Conditions, and the General Requirements of Division 1), apply to the work of this Division.

B. This Section may expand upon or supplement the General Provisions of the Contract. In the event of a conflict or discrepancy between this Section and the General Provisions of the Contract, the General Provisions of the Contract shall govern. However, if the requirement of this Section (or portion thereof) exceeds that of the General Provisions of the Contract, and is furthermore not contrary to the General Provisions of the Contract, then the requirement of this Section (or portion thereof) shall prevail.

C. Examine the Construction Documents in their entirety (including Drawings and Specification Sections in the other Divisions) for requirements or work which may affect work under this Section, regardless of whether such requirements or work are specifically indicated in this Section.

1.03 RELATED SECTIONS

A. All Specification Sections in this Division.

B. The following Sections in other Divisions:
1. Division 16 – Electrical for Communications Systems

1.04 COMMUNICATIONS SYSTEMS

A. The following systems are included within this Division. Following each system is the name of the Division 27 series of Drawings relating to that system:
1. Communications Cabling: T-Series
2. Audiovisual: T-Series
4. Electrical Infrastructure: ET-Series

1.05 INTENT AND INTERPRETATIONS

A. It is the intent of the Construction Documents that the Contractor shall include all items necessary for the proper execution and completion of the Work by the Contractor, resulting in complete and fully operational system(s) ready for the Owner’s use, in full compliance with all applicable standards, codes and ordinances.
1. Work or product not specifically indicated in the Construction Documents, but which are necessary to result in complete and fully operational system(s) ready for the Owner’s use, shall be provided by the Contractor.
2. The specification of certain products in the Construction Documents shall not be construed as a release from furnishing such additional products and materials.
necessary to furnish complete and fully operational system(s) ready for the Owner's use.

B. The Construction Documents include certain conventions in the use of language and the intended meaning of certain terms, words, and phrases when used in particular situations or circumstances. These conventions include:

1. Abbreviated Language: Language used may be abbreviated. Implied words and meanings shall be interpreted as appropriate. Words implied, but not stated, shall be interpreted as the sense requires. Singular words shall be interpreted as plural and plural words interpreted as singular where applicable and where the full context so dictates.

2. Imperative and Streamlined Language: Imperative and streamlined language is used generally. Requirements expressed in the imperative mood are to be performed by the Contractor. At certain locations in the text, for clarity, subjective language is used to describe responsibilities that must be fulfilled indirectly by the Contractor, or by others when so noted.

3. Abbreviations and Names: Trade association names and titles of general standards are frequently abbreviated. Where abbreviations and acronyms are used, they mean the recognized name of the trade association, standards generating organization, authority having jurisdiction, or other entity applicable to the context.

4. Words used in the singular shall also mean the plural, wherever the context so indicates, and likewise words in the plural shall also mean the singular, wherever the context so indicates.

5. Unless otherwise stated, words which have well known technical or construction industry meanings are used in accordance with such recognized meanings.

6. The terms "directed", "required", "permitted", "ordered", "designated", or "prescribed", as well as similar words shall mean the direction, requirement, permission, order, designation or prescription of the Engineer.

7. The terms "approved", "acceptable", "satisfactory", and similar words shall mean approved by, acceptable, or satisfactory to the Engineer.

8. The terms "necessary", "reasonable", "proper", "correct" and similar words shall mean necessary, reasonable, proper, or correct in the judgment of the Engineer.

C. Assignment of Specialists: The individual Specification Sections may require that certain specific construction activities be performed by specialists who are recognized experts in the operations to be performed. The specialists must be engaged for those activities, and such assignments are requirements over which the Contractor has no choice or option. Nevertheless, the ultimate responsibility for fulfilling the contract requirements shall remain with the Contractor.

1. This requirement shall not be interpreted to conflict with the enforcement of local building codes and similar regulations governing the work.

D. Drawings:

1. Drawings are diagrammatic and approximate in character, are not intended to show all features of required work, and do not necessarily indicate every required component.

2. Symbols used on the Drawings are defined in the legend on the Drawings. Symbols indicated on the legend may not necessarily be required.

E. Drawings and Specifications are complementary. Items required by either are binding as though they are required by both.

1.06 DEFINITIONS

A. The definitions below are applicable to this Division:

1. General
   a. Accepted/Acceptable: Work or materials conforming with the intent of the project, and in general, conforming to the pertinent information in the Construction Documents.
   b. Approved/Approval: The written approval of the Engineer.
c. Accessible: Easy access. Access attained without requiring extensive removal of other materials to gain access.
d. Accessible Ceiling: Acoustical tile hanging ceilings ("Hard-lid" ceilings (concealed spine or sheetrock/gypsum ceilings), even when provided with access panels, are not considered an Accessible Ceiling.)
e. Agreement: The contractual agreement between the Owner and the Contractor.
f. Concealed: Hidden from sight in interstitial building spaces, chases, furred spaces, shafts, crawl spaces, etc.
g. Construction Documents: Collective term for the entire set of bound or unbound material describing the construction and services required, including all Drawings, Specifications, addenda issued prior to execution of the contract, and modifications issued after execution of the Contract (such as change orders, construction change directives, supplemental instructions, etc.).
h. Contract Documents: The Agreement (including other documents listed in the Agreement), Conditions of the Contract (General, Supplementary and other conditions), and the Construction Documents.
i. The Contract: The Contract Documents form the Contract. The Contract represents the entire and integrated agreement between the Owner and the Contractor and supersedes any prior negotiations, representations or agreements, either written or oral. The Contract shall not be construed to create a contractual relationship of any kind (1) between the Engineer and the Contractor, (2) between the Owner and a subcontractor, or (3) between any persons or entities other than the Owner and Contractor.
j. Contractor: The party responsible for providing the system(s) as indicated herein.
k. Drawings: The graphic and pictorial portions of the Contract Documents, wherever located and whenever issued, showing the design, location and dimensions of the Work, generally including (but not limited to) plans, elevations, sections, details, schedules and/or diagrams.
l. Engineer: The party responsible for producing the communication system(s) Construction Documents.
m. Exposed: Not concealed (see above) and not installed underground.
n. Final Completion: The date when the Engineer confirms in writing that the Contractor has completed the work in accordance with the Construction Documents, including completion of all punch list items, cleanup work and delivery of all required guarantees, warranties, licenses, releases and other required deliverables.
o. Furnish: To purchase, supply, and deliver to the project materials in new and operable condition, ready for installation.
p. Governing Requirements: Collective term for regulations, laws, ordinances, codes, rules, standards, requirements, guidelines, and recommendations that govern the installation and inspection of the work defined in the Contract Documents.
q. Governing Authority: Entities or their representatives charged with formation and/or enforcement of Governing Requirements, such as the Authority Having Jurisdiction (AJH).
r. Install: To place in final position in fully operable, tested condition.
s. Inside Plant (ISP): Infrastructure within a building.
t. Or Equal: Materials approved for use by the Engineer and which are dimensionally suitable and operationally identical to the specified item.
u. Outside Plant (OSP): Infrastructure exterior to a building.
v. Owner: The Owner and the Owner’s designated representative(s).
w. The Project: The total construction of which the Work performed under the Contract Documents may be the whole or a part, and which may include construction by the Owner and/or separate Contractors.
x. Provide: To furnish and install, complete, tested and ready for intended use.
y. Substantial Completion: The date when all work required by the Construction Documents shall be complete (subject to the final punch list to be prepared by the Engineer) and on which the applicable jurisdictional authorities have issued a temporary certification of occupancy.

z. Section: An individual Section of the Specifications.

aa. Shown on Drawings: Noted, indicated, scheduled, detailed, or any other written reference made on the Drawings.


c. Specification Section(s): One or more Sections of the Specifications.

d. Section(s): An abbreviated form of Specification Section(s).

e. The Work: The construction and services required by the Contract Documents, whether completed or partially completed, and all other labor, materials, equipment and services provided or to be provided by the Contractor to fulfill the Contractor’s obligations. The Work may constitute the whole or a part of the Project.

2. Communications Systems

a. Audiovisual System: Includes (but is not limited to) audiovisual cables, connectors, terminations and termination equipment, audiovisual equipment, equipment racks, equipment required for system configuration, programming and testing, and other incidental and miscellaneous product and labor as required.

b. Communications Cabling System: Includes (but is not limited to) communications cables and patch cables, connectors, terminations and termination equipment and panels, equipment racks and distribution equipment, equipment required for the build-out of communications rooms and spaces, and other incidental and miscellaneous product and labor as required.

c. Communications Infrastructure System: A Communications Cabling System in conjunction with a Communications Pathway System.

d. Electrical for Communications Systems

1) Communications Pathway System: Includes (but is not limited to) device boxes, pull boxes, conduit, cable tray, duct/ductbank, and other pathway and raceway components necessary to provide pathway for, support, and route communications cables.

2) Telecommunications Grounding System: Includes (but is not limited to) providing a permanent grounding and bonding infrastructure for the Communications Cabling System.

e. Security System: Includes (but is not limited to) security cables, connectors, terminations and termination equipment, security equipment, equipment racks, equipment required for system configuration, programming and testing, and other incidental and miscellaneous product and labor as required.


1.07 ABBREVIATIONS

A. Refer to the individual Specification Sections and Drawings for abbreviations and their definitions.

1.08 GOVERNING REQUIREMENTS

A. All work shall be executed in compliance with the applicable portions of the following Governing Requirements:

1. General

a. ACI: American Concrete Institute (www.aci-int.org)
b. AHJ: Authority Having Jurisdiction
c. ANSI: American National Standards Institute (www.ansi.org)
d. ASTM: American Society for Testing and Materials (www.astm.org)
e. BELLCORE: Bell Communications Research (www.telecorrdia.com)
f. BICSI: A Telecommunications Association (www.bicsi.org)
g. ETL: Electrical Testing Laboratories
h. IBC: International Building Code
i. ICEA: Insulated Cable Engineers Association (www.icea.net)
j. IEEE: Institute of Electrical and Electronic Engineers (www.ieee.org, www.standards.ieee.org)
k. IES: Illuminating Engineering Society of North America (www.iesna.org)
l. FCC: Federal Communications Commission Rules and Regulations
m. NAB: National Association of Broadcasters
n. NFPA: National Fire Protection Association (www.nfpa.org)
q. NEMA: National Electrical Manufacturers Association (www.nema.org)
r. OSHA: Occupational Safety and Health Administration (www.osha.gov)
s. RUS: Rural Utilities Service (http://www.usda.gov/rus/)
t. SMPTE: Society of Motion Picture and Television Engineers
w. UBC: Uniform Building Code
x. UFC: Uniform Fire Code (www.nfpa.org)
z. State and local codes, ordinances, and regulations
aa. Requirements and guidelines of local utility companies
bb. Applicable state, local and/or federal laws, regulations, and/or specifications
cc. Manufacturer installation requirements, guidelines and recommendations

2. Communication System Specific: The following portions of the General Governing Requirements above are particularly relevant to a given Communications System. Omission from this list does not alleviate the Contractor from responsibility for executing all Work for all Communications Systems in compliance with all applicable portions of the Governing Requirements above:
a. Communications Cabling
   1) TIA/EIA 568: Commercial Building Telecommunications Cabling Standard
   2) TIA/EIA 569: Commercial Building Standard for Telecommunication Pathways and Spaces
   3) TIA/EIA 606: The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
   4) ANSI J-STD-607: Commercial Building Grounding and Bonding Requirements for Telecommunications
   5) TIA/EIA 758: Customer-owned Outside Plant Telecommunications Cabling Standard
   6) ANSI/EIA 310-D: Cabinets, Racks, Panels and Associated Equipment
   7) TIA/EIA: Technical Service Bulletins (TSBs) (related to the above TIA/EIA standards)
   8) IEEE 802.3 (series): Local Area Network Ethernet Standards
   9) BICSI: Customer Owned Outside Plant Design Manual
12) BICSI: Telecommunications Distribution Methods Manual
14) NFPA 70: NEC: National Electrical Code (NFPA Article 70)
15) NFPA 75: Protection of Electronic Computer and Data Processing Equipment
16) NFPA 78: Lightning Protection Code
17) FCC Part 68: Connection of Terminal Equipment to Telephone Network.
18) FCC Part 76.611: CFR Title 47 Radiation Leakage Standards

b. Electrical for Communications:
1) TIA/EIA 569: Commercial Building Standard for Telecommunication Pathways and Spaces
2) TIA/EIA 606: The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
3) ANSI J-STD-607: Commercial Building Grounding and Bonding Requirements for Telecommunications
4) TIA/EIA 758: Customer-owned Outside Plant Telecommunications Cabling Standard
5) TIA/EIA: Technical Service Bulletins (TSBs) (related to the above TIA/EIA standards)
6) BICSI: Customer Owned Outside Plant Design Manual
7) BICSI: Telecommunications Cabling Installation Manual
8) BICSI: Telecommunications Distribution Methods Manual
9) NFPA 70: NEC: National Electrical Code (NFPA Article 70)
10) NFPA 75: Protection of Electronic Computer and Data Processing Equipment
11) NFPA 78: Lightning Protection Code
12) UL 467: Grounding and Bonding Equipment

c. Audiovisual:
1) IEEE C62.41: Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits
2) NAB: National Association of Broadcasters
3) UL 1449: Transient Voltage Surge Suppressors
4) SMPTE: Society of Motion Picture and Television Engineers
5) Sound Systems Engineering, 2nd Ed. Davis and Davis, Howard W. Sams Co., 1987

3. Owner Specific: The Contractor shall comply with the following Owner requirements. These requirements shall be incorporated by reference into these Specifications and shall be hereinafter considered a Governing Requirement:
a. University of Colorado at Boulder:
1) UCB Telecommunications Standards:
(http://fm.colorado.edu/construction/standards/TelecommunicationsStandards.html)
a) Work shall be executed and inspected in compliance with the UCB Telecommunications Standards (available at above hyperlink or through UCB ITS), including, but not limited to:
   i. UCB Division 27 Telecommunications Standards
   ii. UCB Construction Drawings As-built Requirements
   iii. UCB Cable Footage and Count Information
   iv. UCB Construction Inspection Report
   v. UCB Approved Rack Details
   vi. UCB ITS Telecom CAD Standards Guidelines
   vii. UCB Labeling and Testing Document
   viii. UCB Jack Numbering Document (T-5)
   ix. UCB Wireless Ceiling and Wall Security Box Instructions
x. UCB Typical Telecommunications Conduit Layouts Drawing

2) UCB Safety Requirements

B. Nothing in the Governing Requirements and Construction Documents shall be construed to permit work not conforming to all governing codes and regulations.

C. Errors or omissions in the Construction Documents do not relieve the Contractor from executing the work in accordance with the Governing Requirements, including all governing codes and regulations.

D. The applicable portions of the Governing Requirements shall be incorporated by reference into each related Specification Section in this Division.

1.09 PERMITS AND FEES

A. The Contractor shall obtain and pay for all licenses, permits and inspections required by the laws, ordinances and rules governing work specified herein. Such fees shall be included in the bid amount.

B. The Contractor shall pay all fees, including but not limited to fees for local utility service installation, connection charges, etc. Such fees shall be included in the bid amount.

C. Notations on permit or review documents shall be observed. Additional requirements noted by the Governing Authority shall be made part of the requirements for construction of the Project. Additional costs for implementing these requirements, if any, shall be submitted for review prior to construction.

D. Engineering Fees: The Specifications may identify work required of the Engineer due to improper action(s), lack of action(s), and/or deficiencies on the Contractor’s part. Such instances will be identified in the Specifications and the Contractor shall be responsible for these fees if they are incurred by the Engineer.

1. Fees charged to the Contractor will be at the Engineer’s billing rates at the time the services are performed. Travel time will be included, if applicable. Mileage will be charged for required automobile travel at the standard IRS mileage rate in effect at the time the services were performed. Expenses will be billed at cost plus 10 percent markup.

2. Fees will either be paid directly to the Engineer or will be deducted directly from payments (or the final payment) to the Contractor.

1.10 SUBSTITUTIONS AND DEVIATIONS

A. The requirements below expand upon and/or supplement the requirements in Division 1.

B. Substitution of product and deviations from the methods of construction specified which are used in the Contractor’s bid shall be at the sole risk of the Contractor, and as such are subject to rejection without consideration.

C. Proposed substitution and deviation requests shall be reviewed during the time of Submittal review:

1. Conditions for Consideration: Substitution and deviation requests will be received and considered only when one or more of the following conditions are satisfied:

   a. A substantial advantage is offered to the Owner, in terms of cost, time, or other considerations of merit.
   
   b. The specified product or method of construction cannot be provided with the contract period.
   
   c. The specified product or method of construction cannot receive necessary approval by a Governing Authority, and the requested substitution can be approved.
   
   d. The specified product or method of construction cannot be provided in a manner that is compatible with other materials.
   
   e. The product as specified includes the statement, “Or Equal.”
2. Conditions for Rejection: Substitution and deviation requests will be rejected for the following reasons, among others:
   a. The conditions for consideration (see above) have not been met.
   b. Extensive revisions to the Construction Documents are required to support the proposed changes.
   c. The proposed changes do not comply with the general intent of the Construction Documents.
   d. The substitution request is for product which does not include the statement, “Or Equal”, or is specified as “no substitute”, “substitutions are not acceptable”, “provide as specified” or similar.
   e. The proposed change is solely for the convenience or economic gain of the Contractor.

D. The Contractor shall not proceed with a substitution or deviation without written approval.
   1. Upon approval of the request, the Contractor shall be responsible for fees incurred by the Engineer for re-design work or modifications to the Construction Documents if necessitated by the nature of the request.

1.11 SUBMITTALS
A. The requirements below expand upon and/or supplement the requirements in Division 1.
B. General:
   1. Submittal review is a courtesy extended to the Contractor for the limited purpose of checking for general conformance with the design concept and the information shown in the Construction Documents.
   2. The Contractor shall provide submittal information as soon as practicable after the date of Notice to Proceed and prior to the purchase, delivery, fabrication, and installation of product and materials.
   3. In the event of discrepancies or conflict between Submittals and the Construction Documents, either prior to or after review, the requirements of the Construction Documents shall prevail.
   4. Submission of material for review, regardless of the outcome of the review, does not alter the Contractor’s obligation to follow the intent of the Construction Documents, nor the Contractor’s responsibility to comply with the Construction Documents.
   5. Submittals will not be reviewed and will be returned to the Contractor without review for the following reasons:
      a. Submittal package does not conform to the requirements listed herein.
      b. Submittal is for a product or method of construction not required by the Construction Documents.
      c. Submittal is partial or incomplete.
      d. Submittal contains information concerning the proposed implementation of means, methods, procedures, sequences or techniques, temporary aspects of the construction process, or other items, which are the sole responsibility of the Contractor.
      e. Submittal was not carefully reviewed by the Contractor prior to submission, as evidenced by poor organization, obvious or numerous errors, lack of correlation or cross-referencing, lack of clarity in presentation, or containing Shop Drawings which do not meet the standard of the Construction Drawings.
      f. Submittal was submitted directly from the Contractor’s subcontractor(s) or vendor(s).
      g. Subcontractor and/or vendor submittal information was not carefully reviewed and/or approved by the Contractor.
      h. Submittal does not bear the Contractor’s approval stamp, and/or contains subcontractor and/or vendor submittal information which does not bear the Contractor’s approval stamp.
i. Submittal contains substitution and/or deviation requests, which are not clearly identified as substitution or deviation requests in a separate “Substitution and Deviation Requests” section of the Submittal.

6. Submittals shall be submitted as a single package and shall include subcontractor and vendor submittal information.

7. Each submittal (or re-submittal) set shall bear a unique Contractor’s submittal sequence number.

8. Requests for substitution shall only be included under the “Substitution and Deviation Requests” section of the submittal (see below) and shall comply with the requirements of Part 1 – General: Substitutions and Deviations herein. Submission of substitution requests in any other portion of the Submittal does not constitute an acceptable or valid request for substitution, nor will review of such information constitute approval in any manner.

C. Submittal Format:
1. Submittals shall be bound in one letter-sized (8-1/2 inch by 11 inch) document and under separate cover from submittals furnished under other Divisions.
2. Front cover of Submittal shall indicate the name of the project, the project number, the name of the Owner, year of completion, the title “Telecommunications Submittals”, and the names of the Engineer and Contractor, as well as the General Contractor.
3. Submittals shall include a table of contents identifying sections, Specification Sections, and page numbers.
4. Information provided in the submittal shall follow the same general order of the Specifications.
5. Submittals shall be sectionalized (Indexed with titled tab dividers (by section name – not numbered and not handwritten).
   a. Sections shall be (see Submittal Sections below for more detail regarding each section):
      1) Product Data
      2) Shop Drawings
      3) Samples
      4) Substitution and Deviation Requests
      5) Other Information
   b. Within each section, information shall be organized by Specification Section and/or Drawing to which the information applies.
   c. Within each section, where section is not applicable (e.g. shop drawings, technical drawings, etc.), the section shall include a page denoting same.
6. Pages shall be numbered.
7. Drawings (except for full and half-size Shop Drawings), if not in 8-1/2 inch by 11 inch size, shall be bound and accordion folded to 8-1/2 inch by 11 inch size.
8. Quantity: Submit copies in quantities per the requirements of Division 1.

D. Submittal Sections: Submittals shall be sectionalized and shall include sections for Product Data, Shop Drawings, Substitution and Deviation Requests, and Samples, Other Information (see Submittal Format herein).
1. Product Data: Submit Product Data information as called for in the individual Specification Sections. Product Data shall include:
   a. For product which is being provided as specified, do not provide product data. Instead, provide a list of all products to be provided as specified and state in writing that each product in the list is being provided as specified.
   b. For all other product other than that specified, provide the following product information (as applicable):
      1) Specification Section to which the product applies.
      2) Catalog cut sheets, manufacturer data sheets, and/or specification sheets detailing the product, item, assembly and installation.
      3) Manufacturer’s printed recommendations (if not included in the above).
4) Written description.
5) Notation of dimensions verified by field measurement.
6) Notation of coordination requirements.
7) Compliance with recognized trade association and testing agency standards.
8) Highlighted details within the product data that identifies compliance with the Construction Documents or the intent of the Construction Documents.
9) Highlighted details within the product data that identifies deviations from the Construction Documents or the intent of the Construction Documents.

c. For products for which the Contractor is proposing a substitution, include the product as specified in the Submittal per the above requirements and list the reference to the proposed substitution in the “Substitution and Deviation Requests” section of the Submittal (see below).

d. Do not provide product quantities – quantities are the sole responsibility of the Contractor and will not be reviewed.

2. Shop Drawings: Submit Shop Drawings that are newly prepared, drawn to accurate scale, and that fully illustrate the Contractor’s understanding of the intent and requirements of the Construction Documents (i.e. Shop Drawings shall not be based upon or consist of a reproduction of the Construction Documents or standard printed data). Submit Shop Drawings as called for in the individual Specification Sections. Shop Drawings shall include:

a. Identification of products and materials
b. Schedules, including but not limited to:
   1) Equipment and components
   2) Cables: identify manufacturer, model number, outside diameter and connector
c. Notation of coordination requirements
d. Notation of dimensions established by field measurement
e. Notation of details that identify compliance with the Governing Requirements
f. Notation of details that identify compliance with the Construction Documents or the intent of the Construction Documents.
g. Notation of deviations from the Construction Documents or the intent of the Construction Documents. Highlight, encircle, or otherwise clearly indicate such deviations
h. Roughing-in and setting diagrams
i. Fabrication, installation, and adaptation details (including dimensions identification) including, but not limited to:
   1) Electronic equipment to be mounted within racks
   2) Cable routing between electronic equipment in racks or housings
   3) Equipment to be mounted within furniture
   4) Wall and ceiling mounted devices
   5) System labels, including but not limited to engraved, lamacoid, silk screen and paper labels
   6) Suspended loudspeaker mounting, including but not limited to tilt angle, splay angle, height above finished floor, coverage pattern, and assembled weight
   7) Non-standard manufactured or adapted equipment
   8) Other details as necessary to establish the intent of the Construction Documents
j. One-line diagrams detailing the interconnections of system components, including the identification of all devices, cabling, terminations, and termination techniques as required for fully functional systems
k. Applicable software block diagrams representing the internal operation of devices such as, but not limited to, control processors and digital signal processors
l. Templates
m. Floor plans identifying equipment locations, if not shown on the Construction Documents
n. Reflected ceiling plans identifying equipment locations, if not shown on the Construction Documents
o. Indication of sectionalized manufacturing of equipment (i.e. for oversized equipment that cannot be installed as a single component).
p. Shop drawings shall be provided in form, format and size identical to that of the Construction Drawings (the Construction Drawings set the standard). Shop Drawings that do not meet this standard shall be rejected without review.
   1) Title Block: May be the Contractor’s Title Block, but shall indicate Project name, manufacturer’s name and logo, date of submittal, content of sheet, and sheet number.
   2) Floor Plans: Plan titles, scales, north arrows, column lines, line types, fonts, and room names and numbers shall match that of the Construction Drawings.
q. For methods of construction for which the Contractor is proposing a deviation, include the method of construction as specified per the above requirements and list the reference to the proposed deviation in the “Substitution and Deviation Requests” section of the Submittal (see below).

3. Substitution and Deviation Requests: For each substitution and/or deviation request, include the following:
   a. Whether the request is for substitution of product or a deviation from a construction method.
   b. The Specification Section(s) or Drawing to which the request applies.
   c. Reason for the request. (Note: the reason must conform to the requirements of Part 1 – General: Substitutions and Deviations herein.)
   d. If a substitution, provide:
      1) Specified product to which the proposed substitution applies.
      2) Product Data for the substituted product.
      3) Notation of differences between the proposed substitution and the specified item. Highlight, encircle, or otherwise clearly indicate the substitution.
   e. If a deviation, provide:
      1) Specified Drawing and/or method of construction to which the proposed deviation applies.
      2) Shop Drawings showing the deviation.
      3) Notation of differences between the proposed deviation and the specified drawing and/or construction method. Highlight, encircle, or otherwise clearly indicate the deviation.
   f. Written statement signed by the Contractor stating that the proposed substitution or deviation is equivalent or superior in function, appearance, and quality to the specified product or construction method and that the proposed substitution or deviation will be at no additional cost to the Owner.

4. Samples: Submit Samples as called for in the individual Specification Sections.
   a. Samples shall be indexed in this section and provided as an attachment to the Submittal.

5. Other Information:
   a. Contractor Statement of Qualifications, per Division 27 Specification Section Contractor Qualifications.
   b. Bid Form or Bid Supplement Form, per Division 27 Specification Section Bidding.
   c. Owner Specific: Submit other information as required by Owner Specific Governing Requirements.
   d. Submit additional information as called for in the individual Specification Sections.
E. Submittal review:
1. The submittal review will not include review of the accuracy or completeness of details, such as quantities, dimensions, weights or gauges, fabrication processes, construction means or methods, coordination of work with other trades, or construction safety precautions, all of which are the sole responsibility of the Contractor.
2. Corrections or comments made on the Submittal by the reviewer during the submittal review do not relieve the Contractor from compliance with the requirements of the Construction Documents.
3. Review of a specific item shall not indicate that the reviewer has reviewed the entire assembly of which the item is a component.
4. Review does not relieve the Contractor from responsibility for errors, which may exist in the submitted data.
5. Review of substitutions and deviations:
   a. The reviewer shall not be responsible for review of substitutions and/or deviations that were not brought to the attention of the reviewer by specific inclusion of the substitution and/or deviation in the Substitution and Deviation Requests section of the Submittal.
   b. Where a substitution and/or deviation is not included in the Substitution and Deviation Requests section of the Submittal, the procurement and installation of the substitution and/or deviation is at the sole risk of the Contractor.
   c. If the reviewer does not specifically note substitutions and/or deviations, it remains the Contractor’s responsibility to comply with the Construction Documents.
6. After review, submittals shall be returned together with review comments and specific actions (if required) to be taken by the Contractor. Typical comments and actions will be:
   a. No Exception Taken
   b. Revise - Resubmittal Required
   c. Revise - Resubmittal Not Required
   d. Submit Specified Item
   e. Rejected
   f. Not Reviewed
7. The Contractor shall perform no portion of the Work requiring a submittal until the respective submittal has been reviewed and approved. Such Work shall be in accordance with the approved submittal.

F. Re-submission of submittals:
1. Submittals shall continue to be re-submitted and reviewed until all submitted items are marked by the Engineer as ‘No Exceptions Taken’ or ‘Revise - Re-submittal Not Required’.
2. Re-submittals shall be clearly identified as a re-submittal and shall identify changes on a separate Revisions page inserted after the Table of Contents page(s).
3. The Contractor shall be responsible for fees incurred by the Engineer resulting from subsequent review of re-submittals that fail to meet the requirements herein. Such fees will be incurred after the Engineer has reviewed the original submission and one re-submission.

1.12 RECORD DOCUMENTS
A. The requirements below expand upon and/or supplement the requirements in Division 1.
B. The Contractor shall maintain a set of Record Documents showing all additions, changes, and deletions that have been made to the original Drawings and Specifications throughout the course of construction, as well as reviewed Submittal data, including but not limited to Shop Drawings.
   1. Items to be noted shall include but shall not be limited to:
1. BASIC COMMUNICATIONS REQUIREMENTS

a. Final device box, pull box, floor box, sleeve and conduit stub/ poke thru locations
b. Final locations, sizes, and dimensions of equipment, including concealed equipment
c. Routing of concealed raceways/pathways
d. Raceways/pathways located more than 2 feet from where shown on the original Construction Documents
e. Raceways and main pathways (pathways with more than 30 cables) not shown on the Drawings
f. Building outline changes
g. Addenda, accepted Alternates, Change Orders, other document revisions which occurred after the award of the Contract and/or the start of construction activities
h. System component labels and identifiers for all major components
i. Shop Drawings, including those submitted for approval and those used for construction but not required for submission.

2. Notations shall be in a neat, legible and logical manner. Areas affected by the change shall be clouded.

C. Record Documents shall:
   1. Be kept current (i.e. no more than one week behind actual construction) throughout the course of construction.
   2. Be retained at the job site until Final Acceptance.
   3. Be made readily available at all times to the Owner’s representative.
   4. Not be the Contractor’s working documents.
   5. Be protected from deterioration and loss in a secure, fire-resistive location.
   6. Be made readily available to the Engineer for review of completeness and accuracy throughout the course of construction.
   7. At project closeout, be updated with the items on the Known Exceptions/Deviations List per the requirements of Part 3 – Execution: Project Close-Out, herein. Include only those items marked “Approved” by the Engineer.

   1. Handwritten notations on the Record Drawings shall be CAD drafted by the Contractor onto a final, fresh set of Construction Drawings prior to submission. Record Drawings shall be provided in form, format, size, and CAD version identical to that of the Construction Drawings (the Construction Drawings set the standard). Record Drawings that do not meet this standard shall be rejected without review.
   2. The Record Drawings shall be reviewed by the Contractor for accuracy and completeness prior to submission.

E. Owner Specific:
   1. Record Drawings shall be reformatted by Contractor to fully conform to UCB ITS Telecom CAD Standards Guideline For Documentation and Construction Projects.
   2. Submit other information as required by Owner Specific Governing Requirements.

F. Submit additional information as called for in the individual Specification Sections.

1.13 OPERATING AND MAINTENANCE (O&M) MANUALS

A. General:
   1. O&M Manuals shall be submitted in accordance with the applicable portions of Division 1.
   2. O&M Manuals shall be submitted as a single package and shall include subcontractor and vendor O&M information.
   3. O&M Manuals shall be prepared by personnel who are:
a. Completely familiar with the requirements of this Section
b. Trained and experienced in the maintenance and operation of the described products
c. Skilled as a technical writer to the extent required to communicate essential data
d. Skilled as a draftsperson competent to prepare the necessary Drawings

4. Catalog pages and data included in O&M Manuals shall be originals. Where not possible to obtain original copies in sufficient quantity, catalog pages and data shall be neat, clean copies of the originals.

5. O&M Manuals shall include the following:
   a. Table of Contents
   b. Operations: Assemble operations and instructions data which shall include all procedures necessary for activating and controlling each system and/or component in all modes of operation and for fulfilling all functional requirements.
   c. Product Data: Include the product data provided in the original Submittal(s) reflecting product as supplied and installed, as well as additional information such as manufacturer, installation, operation, routine maintenance information, and technical specifications.
   d. Shop Drawings: Include the Shop Drawings provided in the original Submittal(s) reflecting the system and/or components as installed.
   e. Service Information: Assemble service information (cleaning, adjustments, frequency, etc.) for each device requiring service. For devices requiring qualified service, compile an index of qualified service providers (and their contact information) able to service these devices. Provide a recommended maintenance schedule for each device.
   f. Spare Parts: Assemble a list of spare parts. Compile an index of spare parts providers (and their contact information) able to provide the spare parts.
   g. Tests Results: Assemble all test documentation made for each system, device, and/or component requiring testing.
   h. Calibration/Configuration Settings: Assemble and document all calibration/configuration settings made for each system, device and/or component requiring calibration and/or configuration. Include ‘normal’ settings for each component.
   i. Record Documents: Provide Record Documents per the requirements of Part 1 – General: Record Documents herein.
   j. Final punchlist: Provide the final punchlist including all corrective action taken and Contractor initials per the requirements of Part 3 – Execution: Project Close-Out.
   k. Certificates of Inspection: Provide certificates of inspection and final approval from all applicable Governing Authorities, the Manufacturer(s), the Contractor’s RCDD, etc.
   l. Warranty: Provide warranty documentation per the requirements of Division 27 Specification Section Warranty and the individual Specification Sections.
   m. Software, including but not limited to:
      1) All source code for custom programs. Source code shall be provided on CD-ROM.
      2) System software
      3) Computer system operating software
      4) Application software
      5) Version Documentation: Provide a spreadsheet in MS Excel format documenting all software and firmware versions for all programmable devices. Provide in both printed format and on CD-ROM.
   n. Other Information:
      1) Submit additional information as called for in the individual Specification Sections.
B. O&M Manual format:
1. O&M Manuals shall be bound in one letter-sized (8-1/2 inch by 11 inch) hard cover (hard back or loose leaf) binder.
2. Separate O&M Manuals shall be provided for each communications system (i.e. Communications Cabling, Audiovisual, Security, etc.)
3. Front cover of the O&M Manual shall indicate the name of the project, the project number, the name of the Owner, the title of the O&M Manual indicating the communications system (Communications Cabling System O&M Manual, Audiovisual System O&M Manual, Security System O&M Manual, etc.), the year of completion, the name of the Engineer, the name of the Contractor, and as applicable the names of the Architect and the General Contractor.
4. Side cover of the O&M Manual shall indicate the name of the project, the project number, the name of the Owner, and the title of the O&M Manual.
5. O&M Manual shall include each section defined under O&M Manual Requirements above.
6. O&M Manuals shall include tab dividers, titled (not numbered) for each section. Tab dividers shall not be handwritten.
7. O&M Manuals shall include a table of contents identifying sections and page numbers.
8. Pages within each section shall be numbered.
9. Drawings (excluding full size Record Drawings) shall be bound and accordion folded to 8-1/2 inch by 11 inch size.

C. O&M Manual submission:
1. The Contractor shall submit one draft copy of the O&M Manual for review and approval by the Engineer.
   a. The submission will be reviewed for accuracy, completeness, and compliance to the requirements herein. A submission which fails to meet these requirements will be rejected and returned to the Contractor together with review comments and specific actions to be taken by the Contractor. The Contractor shall revise the O&M Manual and re-submit for review and approval.
   b. The O&M Manual shall continue to be re-submitted and reviewed until such time as the O&M Manual is approved by the Engineer.
   c. The Contractor shall be responsible for fees incurred by the Engineer resulting from subsequent review of O&M Manuals that fail to meet the requirements herein. Such fees will be incurred after the Engineer has reviewed the original submission and one re-submission.
2. Upon approval of the draft copy, the Contractor shall submit final copies in quantities per the requirements of Division 1.

D. Final payment to the Contractor will not be authorized until the final copies of the O&M Manuals (including Record Documents) have been received and approved by the Engineer.

PART 2 - MATERIALS

2.01 GENERAL

A. Where one or more products are listed for a specified component:
1. The product listed first shall establish size, capacity, grade, quality, technical specifications, and the basis of design.
2. Products not listed first shall be considered “other acceptable” products. Should the Contractor choose to use those products, costs for changes to the
construction required to support the use of these products shall be borne by the Contractor.

B. If no product is listed, then any manufacturer able to meet the listed Specifications is acceptable.

C. Where product is specified without the statement "or equal", substitutions will not be entertained.

2.02 MATERIALS

A. The Contractor is responsible for providing all incidental and/or miscellaneous tools, scaffolding, consumable items, testing equipment appliances, and other hardware not explicitly specified or shown on the Drawings required for the installation of a complete and operable systems ready for the Owner’s use.

B. Products shall be:
   1. New and unused, free from blemish and defects.
   2. Standard products of manufacturers regularly engaged in the production of such products.
   3. Of the manufacturer’s latest standard design at the time of procurement,
   4. Designed to ensure satisfactory operation and life in the environmental conditions that prevail in their installation location.
   5. Designed for application in commercial/professional systems, except as otherwise specifically noted.

C. All products, whether stock or custom, shall be supported by replacement parts and manufacturer schematic drawings as applicable. “Black box” and/or unidentified components are not acceptable.

D. All products of the same or similar type shall be the product of one manufacturer.

E. All component products within a unified system shall be the product of one manufacturer.

F. Equipment shall be UL listed, or equivalent.

2.03 DELIVERY, STORAGE, AND HANDLING

A. Prior to ordering and delivery of equipment, the Contractor shall:
   1. Verify that the equipment shall adequately pass through building openings and passageways with unobstructed access to the final equipment location. When building openings and passageways will not permit the equipment to pass through unobstructed, equipment shall be manufactured and shipped in sections for final assembly at the equipment location.
   2. Verify that the equipment shall properly fit the space allocated, that required clearances can be maintained, and that the equipment can be located without interference from other systems, structural elements, or the work of other trades.

B. The Contractor shall arrange deliveries in accordance with the construction schedule. Deliveries shall be scheduled to maintain the progress of work, to avoid conflict with the work of other Trades, and to accommodate site conditions.
   1. The Contractor shall be responsible for coordinating and scheduling the timely delivery of products and materials indicated to be furnished by others or by the Owner.

C. Deliver, store and handle products and materials in full compliance with the manufacturer’s recommendations and/or instructions, using means and methods that will prevent damage, deterioration, and loss (including theft).

D. The Contractor shall protect products and materials until Final Acceptance. Such protection is the sole responsibility of the Contractor, and the Contractor shall be responsible for replacing damaged, deteriorated, stolen or lost product at no additional cost to the Owner.
   1. Where products and materials are indicated to be furnished by others or by the Owner, the Contractor shall make a complete and careful check of all materials
delivered. The Contractor shall provide a written and signed receipt acknowledging acceptance of the delivery and the condition of the materials delivered. After receipt, the Contractor shall assume full responsibility for the materials.

E. Products and materials subject to damage by the elements shall be stored above ground, under cover, in a weather tight enclosure, with ventilation adequate to prevent condensation. Temperature and humidity shall be maintained within the manufacturer’s recommendations.

F. The Contractor shall make provisions for receiving and storing products and materials, including products and materials to be furnished by the Owner (or by others) to be installed by the Contractor as part of the work.

G. Products and materials shall be carefully inspected for damage upon delivery. Defective or damaged products and materials shall be marked ‘Rejected’, removed from the site, and shall not be installed.

H. Products and materials shall be delivered to the site in the manufacturer’s original containers, complete with labels and instructions for the proper handling, storage, unpacking, protection and installation.

I. The Contractor shall ensure that products and materials to be installed are not temporarily used as steps, ladders, platforms, scaffolds, or for storage by the Contractor or by other trades during the construction process. Materials found to be used in such a manner will be considered “damaged”, shall not be installed, and shall be replaced at no additional cost to the Owner.

PART 3 - EXECUTION

3.01 GENERAL

A. Work shall comply with the applicable portions of the Governing Requirements in effect at the time of construction, including all addenda, errata, annexes, and technical service bulletins (TSBs), etc., except where a specific date, version, or edition is otherwise indicated, or where otherwise mandated by a Governing Authority.

B. In the event of a conflict between a code and the other Governing Requirements, or between a code and a requirement of the Construction Documents, the code requirement shall govern. However, if the non-code requirement (or portion thereof) exceeds that of the code, and is furthermore not contrary to the code, the non-code requirement (or portion thereof) shall prevail.

C. Installation shall be performed by workers skilled in the trade, familiar with the particular techniques and methods of construction applicable to the work of the trade.

D. Completed work shall present a neat and professionally installed appearance. The appearance of the work shall be of equal importance to its operation. Failure to present a neat and professionally installed appearance shall be considered sufficient reason for rejection of the system in part or in whole.

E. Completed work shall demonstrate quality workmanship. Quality workmanship shall be of equal importance to its operation. Failure to demonstrate quality workmanship shall be considered sufficient reason for rejection of the system in part or in whole.

F. In the event that supplemental information is required to confirm the intent of the Construction Documents, the Contractor shall notify the Engineer and await the Engineer’s response prior to procurement of materials and performance of the related work. Procurement of materials and work performed without such interpretation and/or clarification is at the sole risk of the Contractor, and as such, the Contractor shall correct such work at no additional cost to the Owner should the materials or work not conform to the intent of the Construction Documents.
G. The Contractor shall order and install materials and equipment with long lead times and/or those having a major impact on work by other trades so as not to jeopardize the project or project schedule.

H. The Contractor is responsible for ensuring that each installed component’s performance is within the Manufacturer’s published specifications, the Governing Requirements, and all other requirements as specified within this Division.

I. The Contractor is solely responsible for the safety of the public and workers in accordance with all applicable rules, regulations, building codes and ordinances, and Governing Requirements, including but not limited to employee training and Safety Program development, documentation and execution.

J. Notwithstanding any other provisions of the Contract Documents, the Contractor shall be solely responsible for location and protecting any and all utility service lines (both Owner controlled and Public) in the work area.

3.02 IDENTIFICATION

A. All Contractor personnel shall be clearly identified by uniform and/or company badge with photo ID, employee’s name, and company name. Contractor vehicles shall be equipped with signs on both sides of vehicle identifying the Contractor’s company name.

B. The Contractor may also be issued and required to wear Owner provided Contractor ID’s for the duration of the project (coordinate this requirement with the Owner prior to any on site work). Such identification will be for the purposes of entry into card access controlled locations and/or identification of authorized Contractor personnel. All Owner provided Contractor ID’s shall be returned to the Owner prior Final Acceptance. The Work will not be considered complete until all ID’s are returned.

3.03 SUPERVISION

A. The Contractor shall appoint a Project Manager who will be the single point of contact for all work accomplished under this Project and will be vested by the Contractor with the authority to make decisions on behalf of the Contractor.

   1. The Project Manager will be responsible to represent the Contractor and coordinate all aspects of this Project, including but not limited to:
      a. Overall and specific project responsibility
      b. Thorough knowledge of Project Specifications and Drawings
      c. Creation and maintenance of a project schedule, including milestones, task definitions and resource allocations
      d. Attendance at all Project Management meetings
      e. Supervision and direction of all Contractor personnel
      f. Documentation, including submittals and change orders
      g. Quality assurance of Project

   2. The Project Manager initially assigned to the Project shall be assigned to the Project for the duration of the Project. Once assigned by the Contractor, the Project Manager shall not be changed by the Contractor without Engineer and Owner approval.

B. The Contractor shall assign a qualified Foreman to the Project and shall keep the Foreman on site and in charge of the work at all times. The Foreman shall be equipped with a mobile phone during project working hours.

   1. The Foreman initially assigned to the Project shall be assigned to the Project for the duration of the Project. Once assigned by the Contractor, the Foreman shall not be changed by the Contractor without Engineer and Owner approval.

3.04 PERMITS AND FEES

A. The Contractor shall make arrangements to obtain and pay for necessary permits, licenses, and inspections.
B. No work shall be started prior to obtaining necessary permits and payment of required fees. Work installed prior to obtaining proper permits shall, if required by the Governing Authority (AHJ), be redone in compliance with requirements at no additional cost to the Owner.

3.05 INSTALLATION
A. The Contractor shall notify the Engineer and wait for direction/instruction prior to proceeding with procurement and installation for any portion of the Work which could be affected by the following:
   1. Required items and/or details have been omitted from the Construction Documents.
   2. Discrepancies or conflicts exist between the requirements of the Drawings and the Specifications, between the Governing Requirements and the Construction Documents, and/or between the various Governing Requirements.
   3. Discrepancies or conflicts between the requirements of this Division and those of Division 1.

B. Dimensions and clearances:
   1. Equipment dimensions and dimensions indicated for the installation of equipment are restrictive dimensions. Verify that the equipment will fit within the indicated locations and spaces.
   2. Maintain, at a minimum, code required clearances.
   3. Promptly notify the Engineer of any potential dimension or clearance conflicts, and await the Engineer's direction prior to purchase and rough-in of the equipment.

C. Access:
   1. Install equipment such that it is readily accessible for operation and maintenance.
   2. Access to equipment shall not be blocked or concealed by conduits, supporting devices, boxes, or other items.
   3. Do not install equipment such that it interferes with the normal operation or maintenance requirements of other equipment.

D. Equipment shall be installed level, plumb, parallel, and perpendicular to building structures and to other building systems and components, except where otherwise indicated.

E. Equipment shall be securely fastened. Select fasteners so that the load applied to any one fastener does not exceed 25 percent of the proof-test load.

F. Place equipment labels and/or other identification where the label and/or identification can be easily seen and read without difficulty.

G. Grounding/Bonding: Bond all non-current carrying raceway to the nearest TGB. Ground connections for conduit shall be exothermic weld.

H. Attachment of hanger rods, support cables, diagonal wall bracing, and any other connections made to the building structure after the application of fireproofing/firestopping materials, shall be made with minimal impact to the fireproofing/firestopping materials. The Contractor making such connections shall remove only as much fireproofing/firestopping as required for the attachment, and for scoring and over-cut only as required for the connection. The Contractor shall be held responsible for costs associated with patching of excessively removed fireproofing/firestopping material.

I. Cables, conduits, and other raceway shall be firmly secured and cleaned where penetrating fire rated barriers.

3.06 DRAWINGS
A. Drawings shall not be scaled for rough-in measurements or equipment locations. Field verification of dimensions, locations, and levels to suit field conditions is required. Final placement of devices, outlets, equipment, etc. shall be coordinated with field conditions.
B. Unless specifically dimensioned or detailed, Drawings indicate approximate locations, arrangement, and general character. To avoid interference with structural members and equipment of other trades, or for the convenience of the Owner, it may be necessary to adjust the locations shown on the Drawings prior to installation. Unless specifically dimensioned or detailed, and with the exception of locations of equipment and raceway in specialized communications rooms and spaces (such as Telecommunications Rooms, Data Centers, etc.), the Contractor may make minor location adjustments without obtaining the Engineer’s prior approval. All other adjustments require prior approval from the Engineer.

1. Minor adjustments are defined as distances not to exceed:
   a. 1 foot at grade, floor ceiling, and roof level in any direction in the horizontal plane
   b. 1 foot on walls in a horizontal direction within the vertical plane.

2. Particular attention shall be paid to door swings, piping, ductwork, structural steel, and other ceiling conflicts:
   a. In general, waste and vent lines, large pipe mains, and ductwork shall be given priority for the locations and spaces shown.
   b. In general, electrical lighting fixtures shall be given priority for ceiling space.

3. Where minor location adjustments are required, such adjustments shall be made at no additional cost to the Owner.

3.07 ASBESTOS/LEAD

A. The Owner manages asbestos/lead identification, removal and control. Normally the site of work operations will be identified by the Owner as suitable for construction to proceed and Owner EH&S documentation is provided for the Contractor to file. The Contractor shall refer to and comply with the EH&S report from UCB prior to performing any work. If that documentation is not available, the Contractor shall not proceed with the work until that documentation is available.

B. The Contractor shall be aware of and comply with Owner specific procedures and policies related to asbestos and lead (contact EH&S at 303-492-0216).

C. The Owner requires appropriate asbestos awareness training or Contractor employees. This training shall be provided to Contractor employees at no additional cost to the Owner.

D. In the event the Contractor encounters suspected asbestos/lead containing materials which have not been rendered harmless, the Contractor shall immediately stop work in the area affected and report the condition if the Owner verbally followed by written notice. If in fact the material contains asbestos/lead and has not been rendered harmless, the work in the affected area shall not be resumed except by written agreement between the Owner and the Contractor. In the absence of asbestos/lead, or after it has been rendered harmless, work shall be resumed by written agreement between the Owner and the Contractor.

3.08 RESTORATION

A. The Contractor shall restore all floors, ceilings, walls, furniture, grounds, pavement, etc. affected or damaged by the Contractor’s work. All such areas shall be restored to original condition at no additional cost to the Owner.

B. The Contractor shall restore to original finish all new products, materials, and equipment scratched, chipped, or otherwise marred by the Contractor.

C. Restoration in every instance consists of completing the work to match and blend with the adjoining existing work insofar as methods, materials, colors, and workmanship are concerned.

D. Restoration work shall be performed by workers qualified and skilled in the trades involved.
E. Where restoration work requires painting: Painting shall consist of cleaning, surface preparation, painting (primer, intermediate, and finish) and finishing surfaces, for items both new and existing, affected by the work of the Contractor. Surface painting shall match and blend with existing adjoining surfaces. The areas around penetrations, once sealed, shall be painted.

F. The Contractor shall be responsible for replacing improperly matched, blended, or poorly constructed restorative work at no additional cost to the Owner.

3.09 HOUSEKEEPING

A. During the course of construction:
   1. The Contractor shall keep the building, premises and surrounding area free from accumulated surplus, waste materials and rubbish at all times.
   2. At the conclusion of each work shift, remove empty boxes, crates, surplus and waste materials, and other debris, and sweep clean all work areas affected by the Contractor’s work.
   3. In occupied areas affected by the Contractor’s work, the Contractor shall remove all evidence of the Contractor’s work in those areas at the end of each work shift, including tools, equipment and scaffolding, leaving the area clean, unobstructed and fully useable by the occupants.

B. At project completion, and prior to Final Acceptance:
   1. Remove all tools, equipment and scaffolding.
   2. Remove temporary labels and adhesives.
   3. Thoroughly vacuum the interior of enclosures to remove debris.
   4. Clear surplus product, materials and debris from the job site.
   5. Turn over equipment to the Owner in unblemished condition.
   6. Thoroughly clean equipment and facilities inside and out, and remove all residue -- all areas affected by the Work shall cleaned.
   7. Turn over the Work to the Owner in a fully operational state.

C. All final cleanup work shall be performed by professional cleaners qualified and skilled in the trade. The Contractor shall not make use of unqualified personnel for cleanup work.

D. The Project shall not be considered complete until all area affected by the Work are left in a clean, neat, orderly, and fully operable condition.

3.10 SUBSTANTIAL COMPLETION

A. Due to the technical nature of the Work, as well as the requirement that certain Owner provided equipment, systems, and training may necessitate use of the Work by the Owner prior to Substantial Completion, the Owner reserves the right to use the Work prior to Substantial Completion (when ready for use) without obligation to the Contractor and without implying Acceptance of the Work.

B. Pre-Substantial Completion Submittal: Three weeks prior to Substantial Completion, the Contractor shall prepare and submit the following:
   1. Known Exceptions/Deviations List:
      a. The Contractor shall compile a thorough list of known exceptions/deviations (in materials, construction, and/or workmanship) from that specified in the Contract Documents, and for which there was not associated documentation in the form of Change Orders (CO), Construction Change Directives (CCD), Architects Supplemental Instructions (ASI), or responses to a Request for Information (RFI).
      b. The Contractor shall submit the list to the Engineer for review. The Engineer shall review each item and mark as either Accepted or Not Approved.
         1) Items marked “Not Approved” shall be corrected by the Contractor to conform with the intent of the Contract Documents at no additional cost to the Owner.
2) The Contractor shall perform corrective action for “Not Approved” items prior to notifying the Engineer that the work is Substantially Complete.

2. Other information as called for in the individual Specification Sections.

3. Owner Specific: Submit other information as required by Owner Specific Governing Requirements.

C. Notice of Substantial Completion: When the Work nears Substantial Completion, the Contractor shall notify the Engineer in writing the date that the work will be Substantially Complete and ready for review by the Engineer.

3.11 PROJECT CLOSE-OUT

A. Punchlist:

1. Once notice of Substantial Completion is received, the Engineer shall visit the site to review the Work, and shall prepare a punchlist of items determined to be incomplete, deficient or otherwise not in compliance with the intent of the Contract Documents.
   a. During the review of the Work, if the Engineer finds that the Known Exceptions/Deviations List provided by the Contractor was insufficiently thorough, that the Work is not Substantially Complete, or that deficiencies in the work are excessive, the Engineer will cease review and inform the Contractor that the work is not Substantially Complete. The Contractor shall be responsible for fees incurred by the Engineer for this partial review.

2. The Contractor shall perform corrective action for each item noted in the punchlist. When complete, the Contractor shall submit the original punchlist with each item initialed attesting to the fact that the item was corrected.
   a. If necessary, the Engineer will perform a subsequent review after receipt of the Contractor initialed punchlist.

3. Should additional reviews beyond the original punchlist review be required of the Engineer due to the Contractor’s failure to correct all incomplete, deficient, or non-compliant work, the Contractor shall be responsible for fees incurred by the Engineer for the additional reviews.

B. Provide O&M Manuals per the requirements of Part 1 – General: Operating & Maintenance (O&M) Manuals herein.

END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY
   A. This Section defines Contractor qualifications and requirements for bidding the various systems in this Division.

1.02 QUALIFICATIONS FOR BIDDING
   A. Contractors must be qualified to bid per the requirements of Part 1 – General: Contractor Qualifications herein.
      1. Contractors shall submit their Statement of Qualifications (see Part 1 – General, Statement of Qualifications herein) with their bid. Bids which are submitted without a Statement of Qualifications or bids submitted with a Statement of Qualifications that is incomplete or does not clearly demonstrate that the qualification requirements have been met shall be rejected.

1.03 CONTRACTOR QUALIFICATIONS
   A. General
      1. Experience:
         a. Governing Requirements: The Contractor shall have demonstrated, in-depth and working knowledge of the applicable portions of the Governing Requirements as noted in Division 27 Specification Section Basic Communications Requirements and as they pertain to the systems to be installed by the Contractor. The Contractor shall provide a signed statement stating same.
         b. Design and Installation Practices: The Contractor shall have demonstrated, in-depth and working knowledge of the generally accepted design and installation practices for the systems to be installed by the Contractor. The Contractor shall provide a signed statement stating same.
         c. Contractor References:
            1) Project: The Contractor shall provide references for no less than five similar projects (in terms of size and construction cost) performed by the Contractor within the past three years.
               a) The reference list shall detail, for each project:
                  i. Project name and location
                  ii. Construction cost
                  iii. A brief description of the project and the components involved
                  iv. Contact names, phone numbers, and addresses
                  v. Date completed
               b) A minimum of two of the references shall be in the vicinity of the Project and shall be available for the Owner and Engineer to visit and inspect the installation. The Contractor shall highlight or otherwise make note of these particular references.
            2) Service Department: The Contractor shall provide a minimum of two references for the Contractor’s Service Department. A minimum of one of the references shall be in the vicinity of the Project.
      2. Manufacturer(s) Certification:
         a. The Contractor shall be trained and certified by the Manufacturer(s) to install, test, and maintain the major components of the system, shall be
certified to perform service and equipment modifications without voiding the Manufacturer(s) warranty, and shall be certified by the Manufacturer(s) to provide these services in the location in which the Work is to be performed. The Contractor shall provide evidence of same for each major component Manufacturer – statements on letterheads from distributor, importer or local sales representatives are not be acceptable.

3. Offices:
   a. Locations: Provide locations of all regularly/fully staffed and operational offices and the number of administrative staff and technical personnel in each. Indicate which office(s) have a Service Department, and of those offices, indicate the number and type of personnel staffing the Service Department.
   b. Service Department: The Contractor shall maintain a permanently staffed and equipped Service Department, regularly providing services for the systems to be installed by the Contractor. The Contractor shall provide a signed statement stating same.
   c. The Contractor shall be licensed, bonded, and insured in the State in which the Work is to be performed. The Contractor shall provide evidence of same.
   d. If required by the locality, the Contractor shall be licensed by the locality. The Contractor shall provide evidence of same.

4. Personnel:
   a. Project Manager: The Contractor’s Project Manager assigned to this project shall have a minimum of three years continuous contracting project management experience on projects of similar size and complexity. The Project Manager shall have the authority to act for the Contractor, shall serve as the technical liaison between the Contractor and the Engineer, shall represent the Contractor at all meetings, shall be responsible for supervision of all work required to execute the Contract, shall review and approve all submittals prior to submission, and shall be present at the job site during final inspection. The Contractor shall provide a resume for the Project Manager which shall include:
      1) A summary of the Project Manager’s experience, including education, with emphasis on key skills relating to project management and the technical aspects of the systems for which the Project Manager will have responsibility.
      2) A listing of continuous projects (with dates) over the past three years on which the Project Manager performed project management duties. Project information shall include:
         a) Project name and location
         b) Construction cost
         c) A brief description of the project and the components involved
         d) Contact names, phone numbers, and addresses
         e) Date completed
   b. Foreman: The Contractor’s Foreman assigned to this project shall have a minimum of three years continuous supervision experience on projects of similar size and complexity. The Contractor shall provide a resume for the Foreman which shall include:
      1) A summary of the Foreman’s experience, including education, with emphasis on key skills relating to installation supervision and the technical aspects of the systems for which the Project Foreman will have responsibility.
      2) A listing of continuous projects (with dates) over the past three years on which the Foreman performed supervisory duties. Project information shall include:
         a) Project name and location
         b) Construction cost
c) A brief description of the project and the components involved
d) Contact names, phone numbers, and addresses
e) Date completed

c. Employee Certification: Contractor personnel directly involved with the supervision, installation, testing, and certification of the system shall be trained and certified by the major component Manufacturer(s). The Contractor shall provide evidence of same.

B. Systems Specific Qualifications: Additional Contractor Qualifications are required for each system as follows:

1. Communications Cabling
   a. The Contractor shall be completely familiar with and have extensive working knowledge of the TIA/EIA standards for telecommunications systems, the design and installation practices as defined in the BICSI Telecommunications Distribution Methods Manual, and the installation practices as defined in the BICSI Telecommunications Cabling Installation Manual. The Contractor shall provide a signed statement stating same.
   b. RCDD: The Contractor shall assign an RCDD (Registered Communications Distribution Designer) to the project. The RCDD shall be a permanent member of the Contractor's staff (i.e. an RCDD consultant/sub-contractor to the Contractor is not acceptable) and shall be in current good standing with BICSI. The Contractor shall provide the name of and evidence of certification for the Contractor's RCDD to be assigned to the project.
   c. Manufacturer Certification: The Contractor shall be trained and certified by the specified communications cabling system Manufacturer to install, test, and maintain the communications cabling system, shall be certified by the Manufacturer to provide the Manufacturer's most comprehensive performance and product warranty per the requirements of Division 27 Specification Section Warranty and it's related sub-sections, and shall be certified by the Manufacturer to provide this warranty in the location in which the work is to be performed. The Contractor shall provide evidence of same.
      1) The Contractor shall be Manufacturer Certified as the following:
         a) Hubbell/Mohawk Mission Critical Certified Installer (CI)
   d. Employee Certification: Contractor personnel shall be trained and certified by the Manufacturer as follows. The Contractor shall provide evidence of same:
      1) Project Foreman and Supervisors: All (100 percent) shall be trained/certified by the Manufacturer for design, installation and testing.
      2) Technicians (responsible for testing, termination, connectorization, and determination of pathway/routing, and technical labor): All (100 percent) shall be trained/certified by the Manufacturer for installation and testing.
      3) Installers (responsible for cable installation, non-technical labor, etc.): Not required (subject to the requirements of the Manufacturer's warranty and that of the next paragraph). However, these technicians must be directly supervised by a certified Installation Technician in an on site ratio of not less than one Manufacturer certified Installation Technician per two non-certified installers.
      4) Other personnel: Personnel not directly responsible for installation supervision, installation, testing or certifying the communications cabling system (i.e. project managers, cleanup crew, etc.) are not required to be manufacturer trained and certified.
2. Audiovisual
   a. Programmer Certification: The Contractor shall have Manufacturer certified programmers for all equipment requiring programming. The Contractor shall provide evidence of same.
   b. In-House Capabilities: The Contractor shall have in-house capabilities and facilities for rack assembly, shop fabrication, and programming. The Contractor shall provide a signed statement stating same.
   c. Product Dealer Information: Provide a list of manufacturers/products for which the Contractor is a Dealer. Provide the duration of the relationship and the extent of manufacturer/product training.

3. Security
   a. Programmer Certification: The Contractor shall have Manufacturer certified programmers for all equipment requiring programming. The Contractor shall provide evidence of same.
   b. In-House Capabilities: The Contractor shall have in-house capabilities and facilities for rack assembly, shop fabrication, and programming. The Contractor shall provide a signed statement stating same.
   c. Product Dealer Information: Provide a list of manufacturers/products for which the Contractor is a Dealer. Provide the duration of the relationship and the extent of manufacturer/product training.

4. Electrical
   a. Refer to Division 16 for Electrical Contractor requirements.

1.04 STATEMENT OF QUALIFICATIONS (SOQ)

A. The Contractor shall prepare a Statement of Qualifications which shall include all documentation verifying compliance with the requirements of and as called for in Part 1 – General: Contractor Qualifications herein. The Statement of Qualifications shall include, at a minimum:

1. General:
   a. Governing Requirements Statement
   b. Design and Installation Practices Statement
   c. Contractor Project References
   d. Contractor Service Department References
   e. Evidence of Manufacturer(s) Certification
   f. Office locations and information
   g. Service Department Statement
   h. Evidence of licensing, bonding, and insurance
   i. Project Manager Resume
   j. Foreman Resume
   k. Evidence of Manufacturer(s) Training/Certification for those personnel for which training/certification is required.

2. Systems Specific Statement of Qualifications: There are additional SOQ requirements for each system. The Contractor shall include the following system specific documentation within the Statement of Qualifications specified above:
   a. Communications Cabling
      1) TIA/EIA Standards and BICSI Practices Statement
      2) Evidence of certification for the Contractor’s RCDD assigned to the project
      3) Evidence of Manufacturer(s) Certification and Warranty
      4) A list of personnel to be assigned to the project, the type of work they will be performing, and evidence of Manufacturer(s) Training/Certification for those personnel for which training/certification is required.
   b. Audiovisual
      1) Evidence of Programmer Certification
      2) In-house Capability Statement
      3) Product Dealer Information
   c. Security
1) Evidence of Programmer Certification
2) In-house Capability Statement
3) Product Dealer Information
   d. Electrical
      1) No additional information is required.

B. A Statement of Qualifications that is incomplete or does not clearly demonstrate that the qualification requirements have been met shall be rejected.

1.05 SUBMITTALS
   A. Provide the following per the criteria set forth in Submittals in Division 27 Specification Section Basic Communications Requirements:
      1. Other Information:
         a. Provide a Statement of Qualifications for each Contractor and for each system to be provided by the Contractor.

PART 2 - MATERIALS
   2.01 THIS SECTION NOT USED

PART 3 - EXECUTION
   3.01 THIS SECTION NOT USED

END OF SECTION
SECTION 27 00 30

BIDDING

PART 1 - GENERAL

1.01 SUMMARY

A. This Section provides requirements for bidding, including a format and definitions for the presentation of pricing for the base bid, and where applicable, alternate bid(s) and unit pricing. The contents of this Section are intended to establish pricing breakdowns which are useful to the Owner and the Engineer for evaluating bid responses.

B. Information as called for in this Section shall be provided per the requirements of the General Provisions of the Contract, Bidding Documents, Contract Forms, General Conditions, and the Construction Documents.

1.02 BASIS OF BID

A. The Contractor shall determine all existing conditions affecting the work, the type of construction to be used, and the nature and extent of work provided by other trades. Failure to do so shall be construed as willingness to provide complete and fully operational system(s) within the amount bid by the Contractor.

B. The Contractor shall notify the Engineer a minimum of ten (10) days prior to the bid date in the event of any of the following circumstances:
   1. Required items or details have been omitted from the Construction Documents
   2. Discrepancies or conflicts between the requirements of the Drawings and the Specifications, between the Governing Requirements and the Construction Documents, and between the various Governing Requirements.
   3. Discrepancies or conflicts between the requirements of this Division (27) and those of Division 0 or Division 1.

C. Where omissions, discrepancies, or conflicts are not brought to the attention of the Engineer, it shall be assumed that the most stringent requirement(s) constitute the basis for the Contractor’s bid, and as such shall be construed as willingness by the Contractor to provide complete and fully operational system(s) within the amount bid.

D. Fees for necessary or required licenses, permits, and inspections shall be included in the bid amount.

E. Bids shall be based on products, materials and methods of construction as specified. Bids based upon substitution of product and materials, as well as deviations from the methods of construction specified, shall be at the sole risk of the Contractor and as such are subject to rejection without consideration at the time of submittal review – should the Contractor be awarded the contract.

F. If the bidder proposes to sub-contract portions of the work, sub-contractors shall be identified and their Statement of Qualifications (per Division 27 Specification Section Contractor Qualifications) submitted as part of the Bidder’s bid submission.
   1. The Contractor is responsible for any and all work performed by a sub-contractor, and shall provide direct and continuous supervision of the sub-contracted work. Furthermore, this clause applies to any work provided by the Manufacturer(s) for equipment installation at the Contractor’s request.

G. By submitting a Bid, the Contractor agrees:
   1. To honor the Contractor’s Bid for 90 days subsequent to the date that bids are opened.
   2. To enter into and execute a Contract, if awarded, and to furnish all bonds and insurance required by the Contract Documents.
   3. To accomplish the Work in accordance with the Contract Documents.
4. To complete the Work within the schedule stipulated by the Contract.

1.03 BID FORMAT

A. The Bid shall contain the following mandatory documentation. Bids submitted without this documentation (in whole or in part) may be rejected without review. The documentation shall be provided in addition to any forms/documents required by the General Provisions of the Contract and/or the contracting authority.

1. **Statement of Qualifications:** Provide per Division 27 Specification Section Contractor Qualifications and/or its sub-sections.
2. **Bid Form:** A bid form summarizing the Contractor’s bid as required by the General Provisions of the Contract and/or the Contracting Authority.
3. **Bid Supplement:** Complete the Bid Supplement attached to the end of this Section.
   a. The Bid Supplement shall be completed in addition to any forms/documentation required by the General Provisions of the Contract and/or the contracting authority.

4. **Additional Information:**
   a. **Subcontractor Identification:** Identify sub-contractors and their responsibilities. Submit their Statement of Qualifications per Division 27 Specification Section Contractor Qualifications and/or its sub-sections.
   b. **Bill of Materials (BOM):** The BOM shall include each item individually priced, and shall reflect any and all required modifications, accessories, and labor for the item. Each item listed shall be complete with the following information:
      1) Description
      2) Part number (if applicable)
      3) Quantity included in bid
      4) Material cost (including all required modifications, accessories and incidental materials)
      5) Labor cost to install (if applicable)
      6) Total installed price

1.04 ALTERNATE PRICING

A. **An Alternate is an amount proposed by the Contractor and stated on the Bid Form for certain work defined in the Construction Documents that may be added to or deducted from the Base Bid amount.**
   1. The cost or credit for an alternate is the net addition to or deduction from the Base Bid to incorporate the alternate into the work.
   2. Alternate pricing shall include all costs of related coordination, modification, or adjustment of the work to accommodate and completely integrate the Alternate into the project, and shall include all necessary materials, labor, delivery, insurance, applicable taxes, overhead, markups and profit.

B. **Provide alternate pricing for the addition/deduction of the work specified below. Alternates are broken out by the system(s) to which they pertain:**
   1. **Communications Cabling:**
      a. **DEDUCT Alternate # 1: Splicing:** Delete copper splicing and fiber splicing at Armory Building.

1.05 UNIT PRICING

A. **Unit pricing is a price per unit of measurement for materials, equipment and/or labor added to or deducted from the Contract Sum by appropriate modification. Unit pricing is to be provided for common items which may be added or deleted during the course of construction.**
   1. It is the intent that components added by unit price during construction shall result in complete and operable components ready for the Owner’s use. It is further the intent that components deducted by unit pricing shall not adversely impact the remaining or adjacent work.
2. Unit prices shall include all costs of related coordination, modification, or adjustment of the Work to accommodate and completely integrate the component into the project, and shall include, but shall not be limited to, all necessary materials, labor, programming, incidentals, delivery, insurance, applicable taxes, overhead, markups and profit.

3. Unit pricing shall remain in effect until Final Acceptance.

B. Provide unit prices for the addition/deduction of the items specified below. Unit pricing is broken out by the system(s) to which they pertain.

1. Communications Cabling:
   a. Horizontal Outlet: Cable, faceplate, connectors (station and patch panel), terminations, incidental materials, testing, labeling, etc. for any location (regardless of distance from the Telecommunications Room). Provide pricing by outlet type and port quantities as follows:
      1) Prior to walls covered and ceiling installed:
         a) 1-port
         b) 2-port
         c) 3-port
         d) 4-port
      2) After walls covered and ceiling installed:
         a) 1-port
         b) 2-port
         c) 3-port
         d) 4-port
   b. Wireless Access Enclosure: One enclosure, including and all incidental materials for hanging and support, installed.

2. Audiovisual:
   a. Service Contract: Provide a one-year Service Contract to commence immediately after the expiration of the Warranty Period. The Service Contract shall cover the installed systems and shall include quarterly site visits to inspect, repair, and adjust the systems to restore them to like-new operation. Parts and shop labor are assumed to be beyond the scope of the Service Contract.
   b. Projector
   c. Loudspeaker
   d. Projection Screen

3. Security:
   a. Service Contract: Provide a one-year Service Contract to commence immediately after the expiration of the Warranty Period. The Service Contract shall cover the installed systems and shall include quarterly site visits to inspect, repair, and adjust the systems to restore them to like-new operation. Parts and shop labor are assumed to be beyond the scope of the Service Contract.
   b. Controlled Door
   c. Card Reader

4. Electrical:
   a. Outlet Box Raceway: One recessed single gang 4 inch by 4 inch deep outlet box at the horizontal outlet location with conduit raceway from the outlet box location to:
      1) Stub to accessible ceiling space
      2) Cable tray
      3) Telecommunications Room
   b. Cable Tray: One foot of cable tray, installed complete with all hanging/mounting hardware, bends, drops, etc. for a complete and functional cable tray system:
      1) 12 inch wide tray
   c. Door Control Raceway: One raceway system for an access controlled door, including conduit raceway and device box(es) necessary for all control devices.
1) Single Door
2) Double Door
d. Cable Pathway Firestopping Device: One device, installed.

PART 2 - MATERIALS
2.01 THIS SECTION NOT USED

PART 3 - EXECUTION
3.01 THIS SECTION NOT USED

END OF SECTION
SECTION 27 00 40

WARRANTY

PART 1 - GENERAL

1.01 SUMMARY

A. This Section defines general warranty requirements for the Communications System(s).

1.02 GENERAL

A. Warranty

1. The Contractor shall warrant the Work against all defects in materials, equipment and workmanship in compliance with the applicable requirements of Division 1.

2. Manufacturer Warranties: The Contractor’s Warranty shall include all Manufacturer Warranties. The Contractor shall represent and act on the Owner’s behalf in any and all Manufacturer warranty/replacement proceedings.

3. Manufacturer Support Contract(s): The Contractor shall provide any manufacturer backed maintenance, warranty and/or technical support contract necessary for the Contractor to configure, operate, service, repair and/or replace any component of the Communication System(s). The contract shall be valid for the duration of the warranty period. The Contractor shall purchase the contract in the Owner’s name and provide documentation and renewal information to the Owner at acceptance testing.

4. The Contractor shall comply with the Submittal portions of Division 27 Specification Section Basic Communications Requirements.

5. All labor, materials, equipment, and other costs and services necessary for the fulfillment of the Warranty shall be provided at no charge to the Owner.

B. Warranty Period

1. Unless otherwise noted, the minimum Warranty Period shall be 1 year or as otherwise called for in the General Provisions of the Contract.

2. The Warranty Period shall commence upon Final Acceptance.

3. Manufacturer Warranties:
   a. The Contractor shall honor Manufacturer Warranties for the full term established by the Manufacturer when said term is greater than the Warranty Period.
   b. In cases where Manufacturer Warranties are less than the Warranty Period, the Contractor is liable for and shall warrant the Manufacturer’s equipment for the entire term of the Warranty Period.
   c. Where the Contractor has modified equipment, the Manufacturer’s warranty may be voided. In such cases, the Contractor shall warrant the Manufacturer’s equipment for a term equivalent to that of the original Manufacturer Warranty term, or for the entire Warranty Period, whichever is greater.

C. Warranty Certificate

1. The Contractor shall provide a written Warranty Certificate on the Contractor’s letterhead, signed by the Contractor, with terms and conditions of the Warranty complying with the requirements detailed herein.

2. The Warranty Certificate shall include copies of all Manufacturer Warranties. Manufacturer Warranties shall be activated by the Contractor in the Owner’s name.

3. The Warranty Certificate shall be submitted as part of the O&M Manual submission.

D. Warranty Fulfillment

1. The Contractor shall provide a Warranty service visit within 24 hours of notification.
2. Defects shall be remedied within 72 hours of notification.

1.03 SYSTEM SPECIFIC

A. The Contractor shall include the following additional system specific items as part of the Warranty above:

1. Communications Cabling

a. Communications Cabling System Manufacturer Warranty: The Contractor shall provide a communications cabling system extended product, performance/application, and labor Manufacturer Warranty that shall warrant all passive components used in the communications cabling system. Additionally, this Warranty shall cover all components not manufactured by the Manufacturer, but approved by the Manufacturer for use in the communications cabling system (i.e. “Manufacturer Approved Alternative Products”).

1) The Manufacturer Warranty shall warrant:
   a) That the products will be free from manufacturing defects in materials and workmanship.
   b) That all cabling products of the installed system shall exceed the specification of TIA/EIA 568 performance standards. For copper based cabling products, the TIA/EIA 568 Category rating of the specified system shall be exceeded.
   c) That the installation shall exceed TIA/EIA 568 installation standards.
   d) That the system shall be application independent and shall support both current and future applications that use the TIA/EIA 568 component and link/channel specifications for cabling.
   e) That all labor and materials and other costs attributable to the fulfillment of the Manufacturer Warranty shall be provided at no additional cost to the Owner.

2) The Manufacturer Warranty shall be:
   a) Hubbell Mission Critical 25-Year Warranty and System Performance Guarantee

3) Manufacturer Warranty Period:
   a) The Manufacturer Warranty Period shall commence upon Final Acceptance or a Warranty Certificate being issued by the Manufacturer, whichever is later.

4) Manufacturer Warranty Certificate:
   a) The Manufacturer Warranty Certificate shall be included with the Contractor Warranty.

2. Audiovisual

   a. Replacement: Defective components which cannot be serviced within five business days due to unavailability of parts or services shall be replaced with new, identical components. If new and identical components are not available, the Contractor may provide new and equal substitutes upon Owner approval. Replaced components shall become the property of the Owner, and shall be warranted by the Contractor for the remaining term of the Warranty Period, or the term of Manufacturer’s Warranty, whichever is longer.

   b. Preventative Maintenance: The Contractor’s Warranty shall include 2 preventative maintenance visits during the Warranty Period for the purposes of verifying equipment operation, cleaning and lubrication, minor modifications to programming, adjustment and alignment of equipment, and other minor services as necessary and as requested by the Owner.
1) The Contractor shall submit a written summary of the maintenance work performed during each Preventative Maintenance visit within five business days of the visit.

c. Exclusions: Lamps, fuses, and exterior finishes are specifically excluded from the Warranty, except where failure or damage is attributable to defective materials or workmanship.

3. Security

a. Replacement: Defective components which cannot be serviced within five business days due to unavailability of parts or services shall be replaced with new, identical components. If new and identical components are not available, the Contractor may provide new and equal substitutes upon Owner approval. Replaced components shall become the property of the Owner, and shall be warranted by the Contractor for the remaining term of the Warranty Period, or the term of Manufacturer's Warranty, whichever is longer.

b. Preventative Maintenance: The Contractor's Warranty shall include 2 preventative maintenance visits during the Warranty Period for the purposes of verifying equipment operation, cleaning and lubrication, minor modifications to programming, adjustment and alignment of equipment, and other services as necessary and as requested by the Owner.

1) The Contractor shall submit a written summary of the maintenance work performed during each Preventative Maintenance visit within five business days of the visit.

c. Exclusions: Fuses and exterior finishes are specifically excluded from the Warranty, except where failure or damage is attributable to defective materials or workmanship.

4. Electrical

a. No additional warranty items required.

PART 2 - MATERIALS

2.01 THIS SECTION NOT USED

PART 3 - EXECUTION

3.01 THIS SECTION NOT USED

END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY
   A. This Section defines processes and procedures for quality assurance.

1.02 GENERAL QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)
   A. Pre-installation Meeting
      1. The Contractor shall schedule and attend a pre-installation meeting to review and coordinate the Contractor’s work with that of the other trades. The purpose of the meeting will be to review the communications pathway/raceway layout and identify and resolve any potential conflicts, to ensure a consistent installation for all cabling, to minimize interference with adjacent materials and equipment, and to ensure that communications cabling and equipment is accessible to the Owner for future modifications and maintenance. The meeting shall take place a minimum of 30 days prior to communications pathway/raceway rough-in. Attendees shall include:
         a. Communications Contractor(s)
            1) Communications Cabling
            2) Audiovisual
            3) Security
            4) Low Voltage
            5) Networks
            6) Others as applicable
         b. Electrical Contractor
         c. General Contractor
         d. HVAC/Mechanical Contractor
         e. Plumbing Contractor
         f. Engineer
         g. Owner
   B. Inspections
      1. The Contractor shall schedule and coordinate all inspections of the work as required by the Governing Authorities. The Contractor shall be solely responsible for scheduling inspections by the Governing Authorities at times appropriate to the stage of construction and the work to be inspected. The Contractor shall provide all assistance as required by the inspector(s) during their inspection(s).
         a. Should the Governing Authorities require remedial action on the Contractor’s part due to the failure of the Contractor to schedule inspections at appropriate times, such work shall be at no additional cost to the Owner.
         b. The Contractor is solely responsible for scheduling inspections such that, should the work fail inspection, enough time remains in the project schedule to take remedial action and re-inspect the installation.
   C. Observation of Work
      1. Work will be observed by the Engineer on a periodic basis. Work not found to be in compliance with the Construction Documents, or not in compliance with the intent of the Construction Documents, shall be brought into compliance at no additional cost to the Owner.
      2. The Contractor shall notify the Engineer at least one week in advance of the covering of concealed work so that the Engineer may schedule on-site observation of the work to be concealed. Work shall not be concealed until work...
has been tested (if applicable), observed by the Governing Authorities (if applicable), and at the Engineer’s discretion, observed by the Engineer. Should work be concealed prior to such testing and observation, it shall be uncovered, tested, observed, and restored by the Contractor to the finished condition at no additional cost to the Owner.

D. Coordination
1. The Contractor shall thoroughly examine the Construction Documents, including Drawings and Specification Sections of other Divisions, for construction details and methods that are dependent upon or will affect the work of other trades. The Contractor is responsible for identifying coordination issues and dependencies, and for preparing Shop Drawings, work plans and schedules to accommodate or mitigate coordination issues and dependencies before they arise. Changes necessitated by the failure of the Contractor to coordinate with the work of other trades shall be at no additional cost to the Owner.

2. The Contractor shall confer and cooperate with the other trades, throughout the entire construction process, in order to coordinate the work in the proper sequence. Typical coordination issues include but are not limited to:
   a. Electrical work, including but not limited to electrical receptacles, power panels, transformers, the telecommunications grounding system, and the installation of raceway, device boxes, conduits, cable tray, ladder racking and sleeves.
   b. Mechanical work, including but not limited to HVAC systems and ductwork, piping, and mechanical chases.
   c. Ceiling cavity spaces.
   d. Installation of acoustical ceiling tiles and similar finishes that may conceal the work.
   e. Build-in of oversized equipment during structure construction.
   f. Required separation distances.
   g. Access routes for equipment through the construction.
   h. Cutting/coring of floor, ceiling or wall structures.

3. Verify that the physical dimensions of each item of equipment fit the available space, promptly notify the Engineer of any potential conflicts, and await the Engineer’s direction prior to purchase and rough-in of the equipment.

4. Coordinate locations of devices with field conditions, unless such locations are specifically dimensioned or otherwise noted in the Construction Documents. If so noted, verify location with other affected trades and against existing field conditions, promptly notify the Engineer of any potential conflicts, and await the Engineer’s direction prior to purchase and rough-in of the equipment.

5. Coordinate locations for chases, slots, sleeves, and openings in the building structure. For new concrete coordinate, locate and provide chases, slots, sleeves, and openings prior to the pouring of the concrete.

6. Outages shall be coordinated and scheduled in advance with the Owner at a time and duration acceptable to the Owner. Outages scheduled at times other than the normal working hours shall not entitle the Contractor to additional compensation beyond the original amount bid. Outages without advance notice and prior approval by the Owner are not acceptable.

7. Furniture and Casework: Prior to procurement and installation of materials and equipment within furniture and casework, the Contractor shall coordinate with other trades and verify all locations, pathway requirements, etc. Materials and equipment installed in furniture and casework without prior coordination are solely at the Contractor’s risk, and as such, are subject to possible rejection by the Engineer. Rejected materials and equipment shall be replaced and modified furniture and casework shall be restored to its original condition at no additional cost to the Owner.

E. Verification and Validation
1. Measurements
   a. The Contractor shall physically verify and validate all measurements on site (i.e. actual measurements vs. those of the Drawings). Where
discrepancies exist which could affect the Work or the Intent of the Construction Documents, the Contractor shall notify the Engineer and await the Engineer's direction, prior to procurement and installation of materials.

2. Raceway/Pathway Sizes
   a. The Contractor is responsible for verifying and validating all raceway/pathway (conduit, sleeves, cable tray, surface raceway, etc.) sizes prior to procurement and installation of raceway/pathway and/or cable.
   b. The Contractor shall determine and coordinate with any and all trades which will make use of raceway/pathway for cable installation, shall determine the quantity, types, and outside diameters of the cables to be installed within each raceway/pathway, and shall calculate the cable fill ratios for each pathway based upon this information. The cable fill ratios shall include spare capacity as required elsewhere within these Specifications or on the Drawings.
   c. Where the calculated cable fill ratios exceed that recommended by the NEC and TIA/EIA 569, or where the ratios indicate that the raceway/pathway is of insufficient size, the Contractor shall notify the Engineer and await the Engineer's direction prior to procurement and installation of the raceway/pathway or cable.

3. No additional compensation will be approved for additional work or materials required due to the Contractor's failure to verify and validate the above.

F. Examination
   1. The Contractor shall carefully examine the project site and the Construction Documents and shall be responsible for identifying all utility, state, and local requirements that will affect the Work.
   2. The Contractor shall become familiar with the local conditions under which the work is to be performed and correlate those conditions with the requirements of the Construction Documents. No allowance will be made for claims of concealed conditions which the Contractor, exercising reasonable due diligence while examining the site, observed or should have observed.
   3. The Contractor shall be responsible for determining if the Work will affect the operation or code compliance of existing systems. Where this is the case, the Contractor shall notify the Engineer and await the Engineer's direction prior to procurement and installation.

1.03 SYSTEMS SPECIFIC QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

A. In addition to the quality assurance processes and procedures specified above, the Contractor shall provide the following for each system:
   1. Communications Cabling
      a. Coordination:
         1) The Contractor shall review the Drawings and Specifications of other Divisions for locations of devices and equipment requiring communications connectivity not specified or shown on the Drawings of this Division. The Contractor shall coordinate the locations of these items with the other trades, and shall verify locations with the Engineer and Owner prior to rough-in.
         2) The Contractor shall facilitate and coordinate Service Providers installations with the Owner and with the Service Provider(s).
      b. Verification: The Contractor shall physically verify the following on site, prior to procurement and installation:
         1) Backbone Cable: Verify total run lengths for each backbone cable (inside and outside plant) from origination to destination using the pathways provided (ductbank, conduits, raceway, conduit, cable-tray, sleeves, open/accessible pathways, etc.), and including slack loops, vertical transitions, jogs, etc. Pre-cut
cables of insufficient length are the sole responsibility of the Contractor.

2) Station Cable: Verify total run lengths for each station cable from outlet location to communications room using the pathways provided (conduit, cable tray, sleeves, open pathways, etc.), and including slack loops, vertical transitions, jogs, etc. For run lengths which may exceed 270 feet, the Contractor shall obtain the Engineer’s direction prior to proceeding with the installation.

c. Contractor RCDD Periodic Review:
   1) During the course of construction, the Contractor’s RCDD shall periodically perform an on-site review of the construction in progress and certify that the construction conforms to the requirements of the Governing Requirements, and in particular the TIA/EIA standards. The RCDD shall provide a written report to the Owner/Engineer on company letterhead that details the work reviewed and states that the work is in conformance with the Governing Requirements. The work in progress shall be reviewed and a report delivered to the Owner/Engineer on a bi-weekly basis.

   d. Inspections:
      1) Inspections shall occur no later than one week after Substantial Completion. Furthermore, inspections shall be completed and certified no later than three weeks prior to the scheduled use of the system by the Owner.

         a) Manufacturer Inspection: The installation is required to pass all Manufacturer certification requirements.

            i. The completed installation shall be inspected by Manufacturer personnel, shall pass the Manufacturer inspection, and shall be certified by the Manufacturer to meet and be covered by the Manufacturer extended product warranty.

            ii. The Contractor is solely responsible for all costs associated with scheduling the Manufacturer inspection, the inspection itself, and for making any modifications to the installation as required by the Manufacturer at no additional cost to the Owner.

         b) RCDD Inspection: The installation is required to comply with the Governing Requirements.

            i. The Contractor’s RCDD shall inspect the completed installation and prepare a certificate on company letterhead certifying that the work complies with the Governing Requirements. The written certification shall be complete with the RCDD’s stamp/certification number and shall bear the RCDD’s signature across the face of the stamp. The certification shall be submitted with the O&M documentation.

   2. Audiovisual

      a. Equipment locations: Prior to the installation of equipment, the Contractor shall coordinate with other trades and subsequently verify all equipment locations that mount on walls or within ceilings. This work shall include but shall not be limited to:

         1) Structural elements such as lighting devices, HVAC equipment, fire protection devices, and cable tray.

         2) Structural support elements for ceiling mounted devices such as projectors, projection screens, and speakers.

         3) Backing Board for wall mounted devices such as flat panel displays, speakers, and equipment room devices.
3. Security
   a. Equipment locations: Prior to installation of equipment, the Contractor shall coordinate with other trades and subsequently verify all equipment locations that mount on walls or within ceilings. This work shall include but shall not be limited to:
      1) Structural elements such as lighting devices, HVAC equipment, fire protection devices, and cable tray.
      2) Structural support elements for ceiling mounted devices.
      3) Backing Board for wall mounted devices such as equipment panels, power supplies, head-end equipment, etc.

4. Electrical
   a. Raceway/Pathway Size Validation: The Electrical Contractor is responsible for ensuring that the Raceway/Pathway sizes have been validated with all trades per the criteria set forth in Part 1 – General: General Quality Assurance/Quality Control (QA/QC), Verification and Validation, Raceway/Pathway Sizes above.
      1) Where discrepancies exist between the raceway/pathway sizes shown on the Drawings and the Contractor’s calculated sizes, the Contractor shall notify the Engineer and await the Engineer's direction prior to procurement and installation of the raceway/pathway.

PART 2 - MATERIALS
2.01 THIS SECTION NOT USED

PART 3 - EXECUTION
3.01 THIS SECTION NOT USED

END OF SECTION
SECTION 27 00 60

TRAINING

PART 1 - GENERAL

1.01 SUMMARY
A. This Section defines training requirements for the various communications systems.

1.02 GENERAL REQUIREMENTS
A. Trainer/Instructor
1. The Instructor leading the training session(s) shall be a qualified and experienced trainer. Where the Contractor does not have a qualified and experienced trainer on staff, the Contractor shall arrange to have appropriate Manufacturer Representative(s) lead the training session(s).
2. The Contractor shall have the Project Manager and/or Foreman present during the training session(s) in order to assist the Instructor by providing “hands-on” operational knowledge of the installation and operations of the systems.
3. For complex/sophisticated equipment, the Contractor shall arrange to have the appropriate Manufacturer Representatives present during the training session(s).

B. Schedule and Location
1. The data and time of the training sessions(s) shall be coordinated with and approved by the Owner and Engineer. The Engineer may attend the training session(s) at the Engineer’s discretion.
2. The training session(s) shall occur within one month of Substantial Completion, unless otherwise approved by the Owner.
3. Training session(s) shall occur at the site, in order to provide the participants with “hands-on” experience.
4. Training may not necessarily occur in contiguous periods, depending upon the needs of the Owner (e.g. if a total of 8 hours of training is required, depending upon the needs of the Owner, it may be that two 2-hour periods and one 4-hour period spread across several weeks may be necessary).

C. Follow-up Training
1. Unless otherwise noted, provide one follow-up training session during the Warranty Period, scheduled at the request of the Owner. The follow-up training session shall occur after the Owner has had the opportunity to fully operate the system(s). The Contract shall not be considered complete until training has been completed.

PART 2 - MATERIALS

2.01 GENERAL
A. The final version of the O&M Manual(s) shall be used as the primary training aid.

B. Training materials and presentations shall be professional in appearance, organized, bound, and suitable for re-use by the Owner in the future. Provide training materials to each participant, plus an additional 10 copies to the Owner for future use. Training materials shall be provided on CD-ROM in addition to hardcopy.

C. Videotaping
1. Unless otherwise noted, the Contractor shall schedule, arrange, and provide equipment and personnel to professionally videotape the Training session(s), and shall provide the subsequent recording to the Owner in both VHS and DVD formats.
PART 3 - EXECUTION

3.01 GENERAL

A. The Contractor shall provide training on the proper operation and routine maintenance of the various communications systems. Training shall include “hands-on” demonstrations.

B. Training shall not commence until the communications system(s) are complete, tested, and fully operational.

3.02 TRAINING

A. Provide training for each system as follows:

1. Communications Cabling
   a. Training Session(s)
      1) Provide a total of 1.5 hour(s) of training, broken out approximately as follows:
         a) Overview of the Communications Cabling System and Warranty process: Provide 0.5 hour(s) of training
         b) Backbone Cabling: Provide 0.25 hour(s) of training
         c) Horizontal Cabling: Provide 0.25 hour(s) of training
         d) Communications Rooms and Spaces: Provide 0.5 hour(s) of training
   b. Videotaping: Not required.
   c. Follow-up Training: Not required.

2. Audiovisual
   a. Training Session(s)
      1) Schedule training sessions to occur after the system is Substantially Complete but prior to Acceptance Testing.
      2) Provide a total of 8 hour(s) of training, broken out approximately as follows:
         a) Overview of the Audiovisual System and Warranty process: 2 hour(s)
         b) Laboratory(s): 2 hour(s)
         c) Meeting Room(s): 4 hours(s)
      3) After Acceptance Testing, update the training materials to reflect any issues, configuration changes, etc. resulting from the Testing. Provide updated materials to Owner.
   b. Follow-up Training Session: Provide one 2 hour session.

3. Security
   a. Training Session(s)
      1) Provide a total of 4 hour(s) of training, broken out approximately as follows:
         a) Overview of the Security System(s) and Warranty process: 2 hour(s)
         b) Access Control System: 2 hour(s)
   b. Follow-up Training Session: Provide one 2 hour session.

4. Electrical
   a. Not required.

END OF SECTION
SECTION 27 04 05
COMMON WORK - SLEEVES, PENETRATIONS, AND FIRESTOPPING

PART 1 - GENERAL

1.01 SUMMARY
A. This Section includes specific requirements for sleeves and penetrations common to the communications systems.

1.02 RELATED SECTIONS
A. The firestopping requirements of this Section are additional to, different from, or otherwise supplement the Section(s) in Division 7 which pertain(s) to thermal protection systems, such as firestopping and fire-resistive materials. The applicable requirements of these Section(s) shall serve as the basis for the requirements of this Section, and are incorporated by reference into this Section.

1.03 SUBMITTALS
A. Provide the following per the criteria set forth in Submittals in Division 27 Specification Section Basic Communications Requirements:
   1. Product Data
   2. Samples
      a. Provide samples of each type of Cable Pathway Firestopping Device.
      b. Provide samples of all firestop products/materials.

PART 2 - MATERIALS

2.01 SLEEVES
A. Provide sleeves for all locations where cable must pass-through building barriers such as walls, floors or foundations.
B. Sleeves consist of a penetration/opening in a barrier and a conduit section or Cable Pathway Firestopping Device passing through the penetration/opening.
C. Conduit sections used for sleeves shall be per the requirements of Division 27 Specification Section Electrical - Conduit and Boxes.
D. Sleeves shall be as follows:
   1. Through Concrete or Masonry barriers (including floors):
      a. Cast-in-place: Provide RMC conduit sections
      b. Cored: Provide EMT conduit sections
   2. Through all other barriers:
      a. Non-fire rated: Provide EMT conduit sections
      b. Fire rated: Provide Cable Pathway Firestopping Devices (see below)
E. Cable Pathway Firestopping Device
   1. Devices shall be pre-manufactured enclosed fire rated pathway devices with a built-in fire sealing system sufficient to maintain the hourly rating of the barrier being penetrated. The self-contained sealing system shall automatically adjust to the installed cable loading and shall permit cables to be installed, removed, or maintained without the need to remove or reinstall firestop materials. The pathway shall be UL classified and FM/Systems approved, and shall be examined and tested to the requirements of ASTM E814 (UL1479). Use shall be per local codes. Sleeves shall be:
      a. Specified Technologies, Inc.: EZ-Path
      b. Wiremold: FlameStopper
2.02 FIRESTOPPING

A. General:
1. Provide firestopping material for all through and membrane penetrations of fire-rated barriers.
2. Firestopping material used to seal open penetrations through which cable passes shall be re-usable/re-enterable.
3. Provide through-penetration firestop products that are compatible with one another, with the substrates forming openings, and with the penetrating items.
4. Provide firestop products that upon curing do not re-emulsify, dissolve, leach, breakdown or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water or other forms of moisture characteristic during and after construction.
5. Provide firestop sealants sufficiently flexible to accommodate motion such as pipe vibration, water hammer, thermal expansion and other normal building movement without damage to the seal.
6. Materials or sealants shall not contain flammable solvents or sodium silicate.
7. Products specified in this Section shall be UL Listed and Labeled.
8. Part Numbers: Refer to the equipment schedule at the end of this Section for specific part numbers. If no part number is provided, then any part meeting the requirements specified is acceptable.

B. Firestopping Materials
1. Material shall conform to both Flame (F) and Temperature (T) ratings as required by local building codes and as tested by nationally accepted test agencies per ASTM E814 or UL 1479 fire test in a configuration that is representative of the actual field conditions. Materials shall be complete with necessary accessory materials, as applicable, for complete UL listed and approved assemblies.
   a. Firestopping materials shall be:
      a) Hilti Re-enterable Putty
      b) Dow Corning RTV Silicon Foam
      c) Chase-Foam CTC PR-855 Foam

PART 3 - EXECUTION

3.01 GENERAL

A. Work shall comply with the Governing Requirements as defined in Division 27 Specification Section Basic Communications Requirements. Governing Requirements of particular relevance to this Section include, but are not limited to:
   1. NEC: National Electrical Code (NFPA Article 70)
   2. TIA/EIA 569: Commercial Building Standard for Telecommunication Pathways and Spaces

B. Installation shall be such that communications circuits, when installed in the pathways and penetrations specified herein, are able to fully comply with the following:
   1. TIA/EIA 568: Commercial Building Telecommunications Cabling Standard

3.02 SLEEVES

A. Provide sleeves for all locations where free hung cable must pass through building barriers such as walls, floors or foundations.

B. The Contractor shall provide all cutting, rough patching and finish patching as required for the installation of sleeves, and shall provide all penetrations, including core drilling, roto-hammering, etc. as required.

C. Sleeves shall be sealed and firestopped (as appropriate to the fire rating of the barrier) between the conduit section (or cable pathway firestopping device) and the barrier penetration/opening.
D. Unless otherwise noted on the Drawings or specified herein, sleeves shall be sized according to the quantity and outside diameter of the cable(s) they are to support per NEC fill ratios and TIA/EIA 569 cable capacity standards, plus an additional 25 percent for future expansion.

E. Sleeve size shown on the Drawings reflects the size of the conduit or device passing through, not the size of the penetration/opening.

F. Conduit section sleeves:
   1. Conduits shall be installed per the requirements of Division 27 Specification Section Electrical - Conduit and Boxes.
   2. Unless otherwise noted on the Drawings, sleeve size through floors shall be 4 inch diameter.
   3. Conduit sections shall be installed complete with insulated throat bushings.

G. Cable Pathway Firestopping Device:
   1. Provide Cable Pathway Firestopping Devices where cable trays must pass through fire rated barriers. Transition from cable tray to Cable Pathway Firestopping Devices at fire rated barriers.
      a. Provide devices in sufficient quantity such that the combined useable volume of the devices is greater than or equal to the volume of cable tray to be served.
   2. Provide Cable Pathway Firestopping Devices where free hung cables must pass through fire rated barriers.

3.03 PENETRATIONS

A. Properly size and locate penetrations required as construction progresses. For new concrete or masonry the Contractor shall coordinate, locate and provide required openings prior to the pouring of concrete or construction of masonry.

B. Penetration of concrete and structural elements shall be avoided where possible. Where not possible, obtain written approval from the Structural Engineer/Architect prior to penetration. Such penetrations shall be performed in a manner that will not reduce structural element load-carrying capacity or load-deflection ratio.

C. Penetrations shall be performed by workers qualified and skilled in the trades involved.

D. Penetrations (through and membrane) of fire rated barriers shall be firestopped and sealed. The fire rating of the barrier shall be strictly maintained.

E. Penetrations shall not be exposed on the exterior or in occupied spaces in a manner that would, in the Engineer’s opinion, reduce the aesthetic qualities of the structure or result in visual evidence of penetration and patching.

F. Penetrations shall be constructed using methods least likely to damage elements to be retained or adjoining construction.
   1. Provide temporary support for the work to be penetrated.
   2. In general, where cutting is required, use hand or small power tools designed for sawing or grinding, not for hammering or chopping. Cut holes and slots neatly to required size with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
   3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring of existing finished surfaces.
   4. Cut through concrete and masonry using a cutting device such as a Baborundum saw or diamond core drill.

G. Voids around penetrations shall be properly sealed, caulked or grouted as required.

H. Existing elements:
   1. The Contractor shall be responsible for identifying, locating, and protecting existing elements such as embedded conduits, pipe, ductwork, etc. when penetrating existing structures.
2. Cap, valve, plug or seal remaining portions of cut pipes or conduit to prevent entrance of moisture or other foreign matter.

3. The Contractor shall be responsible for repairing or replacing existing conduits, pipe, ductwork, etc. damaged by the Contractor during construction of penetrations. Repair or replacement shall be made at no additional cost to the Owner.

I. Penetrations (and subsequent patching) resulting from the Contractor’s failure to properly coordinate penetrations shall be at no additional cost to the Owner.

J. Penetrations shall be laid out and installed in advance to facilitate the installation of raceway through the penetrations.

3.04 FIRESTOPPING

A. Work shall be in accordance with the UL Fire Resistance Directory, fire test reports, fire resistance requirements, acceptable sample installations, manufacturer’s recommendations, local fire and building authorities, and codes.

B. Application of sealing material shall be accomplished in a manner acceptable to the local fire and building authorities.

C. The fire rating of all penetrated fire barriers shall be strictly maintained. All through penetrations as well as membrane penetrations of fire rated barriers shall be firestopped and sealed.

D. Installation shall be performed in strict accordance with manufacturer’s detailed installation procedures. Prepare surfaces per manufacturer’s instructions. After installation, clean all surfaces adjacent to sealed openings to be free of excess firestopping materials and soiling.

E. Personnel installing firestopping products shall be certified by the Manufacturer to install such products.

F. Install firestopping in open penetrations and in the annular space of penetrations for fire rated barriers.

G. Seal all openings or voids made by penetrations to ensure an air and water resistant seal.

H. Install firestopping such that the performance and effectiveness of other thermal and fire protective devices (such as fire/smoke dampers) in the area are fully maintained.

I. Protect materials from damage on surfaces subjected to traffic.

J. Apply a suitable bond-breaker to prevent three-sided adhesion in applications where this condition might occur such as the intersection of a gypsum wallboard/steel stud wall to floor or roof assembly where the joint is backed by a steel ceiling runner or track.

K. Where joint application is exposed to the elements, fire resistive joint sealant must be approved by the manufacturer for use in exterior applications and shall comply with ASTM C-920.

L. Do not install firestop products when ambient or substrate temperatures are outside limitations recommended by the manufacturer.

M. Do not install firestop products when substrates are wet due to rain, frost, condensation or other causes.

N. Schedule installation of firestopping after completion of penetrating item installation but prior to covering or concealing openings.

O. Firestopping devices shall not act as supports.
### EQUIPMENT SCHEDULE - FS

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END OF SECTION
SECTION 27 04 06
COMMON WORK - HANGERS AND SUPPORTS

PART 1 - GENERAL

1.01 SUMMARY
A. This Section includes specific requirements for hangers and supports within the Communications Pathway System. General requirements are covered in Division 27 Specification Section Electrical - General Requirements.

1.02 RELATED SECTIONS
A. The requirements of Division 27 Specification Section Electrical - General Requirements shall serve as the basis for the requirements of this Section, and are incorporated by reference into this Section.

1.03 DEFINITIONS
A. Hanger/Support System: All equipment, materials, and incidentals required to support the communications pathway and cabling systems, including but not limited to metallic hangers and supports, u-channels, threaded rods, clamps, concrete inserts, anchor bolts, etc.

1.04 SUBMITTALS
A. Provide the following per the criteria set forth in Submittals in Division 27 Specification Section Basic Communications Requirements:
   1. Product Data

PART 2 - MATERIALS

2.01 GENERAL
A. Part Numbers: Refer to the equipment schedule at the end of this Section for specific part numbers. If no part number is provided, then any part meeting the requirements specified is acceptable.

2.02 HANGERS AND SUPPORTS
A. A complete Hanger/Support System shall be provided to support all components of the communications pathways and cabling, including but not limited to conduit, pull boxes, cable tray, communications cables, etc.
B. The Contractor shall provide all materials, labor and incidentals as required for a complete Hanger/Support System.
C. The Hanger/Support System shall be of corrosion resistant or galvanized steel, shall be of an approved standard design, and shall be constructed to maintain the supported load in proper position and alignment under all operating conditions. Manufacturer shall be:
   1. B-line
   2. Caddy/Erico
   3. Kindorf
   4. Unistrut
   5. or Equal

2.03 CABLE SUPPORTS (J-HOOKS, STRAPS)
A. Cable supports exterior to Communications Equipment Rooms:
1. Provide cable supports suitable for the quantity of cables to be supported. Cable supports shall be complete with all incidental materials and assemblies required, including but not limited to mounting accessories to independently support supports from structure, extender brackets for mounting multiple hooks on a single support, clamps and fasteners, dedicated support wires, purlins and cable retainers as required. Supports, incidental materials, cable ties and cable retainers shall be plenum rated if used in a plenum environment, and shall be listed to UL Standard 2239. Supports shall be:
   a. Wide Base Cable Supports (J-Hooks): Supports shall be wide-based (minimum 1-inch) with flared edges. Provide larger sizes and multiple supports as required by cable quantities.
   b. Straps/Slings: Straps/slings shall be wide-based (minimum) 2-inch and adjustable. Provide sizes, quantities and universal mounting equipment as required.

B. Cable straps within Communications Equipment Rooms:
1. Cable Straps shall be used within communications rooms and spaces and shall be provided for strapping groups of cables to raceway and for controlling/managing patch cables. The use of plastic tie wraps for this purpose is not acceptable. Cable straps shall be self-gripping, reusable, constructed of Velcro, and hook-and-loop style. Cable straps to be used in plenum air handling spaces shall be plenum rated. Cable straps shall be manufactured by:
   a. Velcro
   b. Siemens
   c. Panduit
   d. Approved Equal
2. Size: Cable strap size shall be:
   a. For Patch Cables: ½ inch wide and minimum 8/maximum 12 inches in length.
   b. For Horizontal Cables: ½ inch wide and minimum 8/maximum 12 inches in length.
   c. For Backbone Cables: ¾ inch wide and minimum 12/maximum 18 inches in length.
3. Color: Cable strap color shall be the same color as the cable color of the bundle to be strapped.

PART 3 - EXECUTION

3.01 HANGERS AND SUPPORTS
A. Hanger/Support system shall be installed in such a manner as to prevent any strain being imposed on the equipment supported.
B. Coordinate with the building structure and the work of other trades.
C. Install individual and multiple trapeze raceway hangers and riser clamps as necessary to support raceways. Provide all incidental materials as necessary for hanger assembly and for securing hanger rods and conduits. Use 3/8 inch diameter or larger all-thread rods for support.
D. Hangers and supports shall be installed at intervals in compliance with NEC requirements.
E. Strength of each support shall be adequate to support a minimum of four times the present and future load. A minimum of 200 pound safety allowance for each support is required.
F. Cut threaded rods such that the bottoms have a maximum length of thread below the bottom nut equal to that of the rod diameter (i.e. a 3/8 inch rod would have a maximum length of 3/8 inches below the bottom nut).
G. Conduit and box support installation shall prevent displacement of conduit and box in any direction.

H. Provide plastic or rubber end caps for all Hanger/Support System components which are readily accessible and exposed to personnel.

I. Anchor Methods:
1. Hollow Masonry: Toggle bolts or spider type expansion anchors.
3. New Concrete: Preset inserts with machine screws and bolts.
4. Existing Concrete: Steel expansion bolts or explosive powder driven inserts.
5. Wood surfaces: Wood screws.
6. Steel: Welded threaded studs or galvanized steel clamps.
7. Light Steel: Sheet metal screws.

J. Firestopping devices shall not act as supports.

3.02 CABLE SUPPORTS (J-HOOKS, STRAPS)

A. Exterior to Communications Equipment Rooms:
1. Cable supports shall be used to support cables in open access environments. Supports shall be provided along the entire pathway. Multiple supports at hanger locations shall be provided as required by the quantity of cables to be supported (subject to the maximum load which can be supported by the hanger) as well as cable segregation requirements (see below).
2. Cable supports may be affixed to structural members or other supports, but shall not be attached to pipes, electrical conduit, mechanical items, existing cables, or the ceiling support system. Supports shall be hung from all thread rods, dedicated #8 galvanized ceiling drop wire, or from brackets connected directly to structure, and shall be installed above accessible ceilings.
3. Where cable pathways are shown on the Drawings, the Contractor shall follow the indicated pathways as closely as possible, subject to field conditions. Pathways, where not shown, including pathways for small cable counts, shall be designed and documented on the As-built drawings maintained by the Contractor. Supports shall be installed parallel and perpendicular to building lines.
4. Cable supports shall be mounted at varying intervals with each interval not to exceed 5 feet. Supports shall also be placed at all changes of direction. The Contractor shall ensure that intervals between cable supports shall vary along the pathway (i.e. a given interval should not be exactly the same length as the interval preceding or following it – "exact" intervals can degrade cable performance).
5. Cable supports shall not support more cables than for which they were designed and shall not exceed 50 percent of the manufacturer's recommended fill. Multiple cable supports shall be provided where the total cable fill exceeds this amount.
6. Installation of supports shall be fully coordinated with other elements such as mechanical ductwork, piping/plumbing, electrical conduit, and other systems such that the supports remain fully accessible after installation.
7. Group cabling in separate supports by the type of Communications System (Communications, Audiovisual, Security, etc.). Different systems shall not share cable supports.

B. Within Communications Equipment Rooms:
1. Install cable straps to secure cable bundles (see below) to cable runway and other supporting equipment. The use of plastic tie wraps for this purpose is not acceptable.
   a. Bundling:
      1) Cables shall be bundled by application (patch, horizontal, backbone) and by cable type (Cat 3, Cat 5E, Cat 6, Cat 6a, MM}
Fiber, SM Fiber, etc.). Cable applications and types shall not be intermixed within a bundle.

2) Cable bundles (of a given application and cable type) shall consist of relatively even cable quantities.

b. Quantity of cable per cable bundle shall be as follows:
1) For Patch Cables: 24 to 48 patch cables per cable bundle with straps applied at 1 foot intervals.
2) For Horizontal Cables: 50 to 100 horizontal cables per cable bundle with straps applied at 3 foot intervals.
3) For Backbone Cables: 4 to 8 backbone cables per cable bundle with straps applied at 3 foot intervals.

c. Provide excess cable straps to Owner.
# EQUIPMENT SCHEDULE - JS

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END OF SECTION
SECTION 27 05 00
ELECTRICAL - GENERAL REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY
A. This Section includes general requirements for raceway, pathways, grounding and bonding, and other electrical infrastructure necessary for the support of communications systems.

1.02 RELATED SECTIONS
A. The requirements of this Section are additional to, different from, or otherwise supplement similar Section(s) in Division 16. The applicable requirements of those Section(s) shall serve as the basis for the requirements of this Section, and are incorporated by reference into this Section.
B. Division 27 Specification Section Common Work - Sleeves, Penetrations and Firestopping. Provide sleeves, penetrations, and firestopping as required to support the work of this Section.
C. Division 27 Specification Section Common Work – Hangers and Supports. Provide hangers and supports as required to support the work of this Section.

1.03 SUBMITTALS
A. Provide the following per the criteria set forth in Submittals in Division 27 Specification Section Basic Communications Requirements:
   1. Product Data
   2. Shop Drawings:
      a. Raceway/pathway routing, including underslab conduits/duct runs:
         Provide a routing plan if such plan has not been shown on the Drawings, or if the Contractor is proposing a deviation from that shown.
      b. Routing Plan:
         1) If a routing plan is not required, submit written documentation stating that the routing will be provided as shown on the Drawings, that the Contractor has reviewed the routing shown on the Drawings with the other applicable trades and that all have agreed that it does not create conflicts between the trades, and the routing meets applicable codes, regulations and standards.
         2) If a routing plan is required, submit complete floor plans or detail drawings showing the proposed routing and raceway sizes and locations, and clearly showing that the proposed routing has been coordinated with electrical, plumbing, and other trades. Routing plans shall be submitted in a manner equal to that of the Construction Drawings. Ensure that any routing changes are coordinated with comparable changes to the communications cable routing. Specifically note each location where the proposed routing is different from the Drawings. Where deviations are proposed, submit written documentation detailing the reason for each. Each deviation must be approved in writing by the Engineer prior to proceeding with installation.

PART 2 - MATERIALS

2.01 THIS SECTION NOT USED
3.01 GENERAL

A. Work shall comply with the Governing Requirements as defined in Division 27 Specification Section Basic Communications Requirements. Governing Requirements of particular relevance to this Section include, but are not limited to:
   1. NEC: National Electrical Code (NFPA Article 70)
   2. TIA/EIA 569: Commercial Building Standard for Telecommunication Pathways and Spaces
   3. TIA/EIA 606: The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
   4. ANSI J-STD-607: Commercial Building Grounding and Bonding Requirements for Telecommunications

B. Installation shall be such that communications circuits, when installed in the pathway systems specified herein, are able to fully comply with the following:
   1. TIA/EIA 568: Commercial Building Telecommunications Cabling Standard

C. The Contractor shall pay particular attention to and comply with the following Owner Governing Requirements:
   1. University of Colorado at Boulder:
      a. UCB Construction Inspection Report
      b. UCB Construction Drawings As-Built Requirements

D. Telecommunications pathways shall be dedicated for use for telecommunications cabling only. No other type of cabling (e.g. intercom, audio, video, security, fire, etc.) may be placed in telecommunications pathways without prior written Owner approval.

E. Unless otherwise noted on the Drawings or specified herein, communications raceway/pathways (conduit, sleeves, cable tray, surface raceway, etc.) shall be sized according to the quantity and outside diameter of the cable(s) they are to support per NEC fill ratios and TIA/EIA 569 cable capacity standards, plus an additional 25 percent for future expansion.

F. Firestopping: All penetrations of fire rated barriers shall be firestopped and sealed. The fire rating of all fire barriers shall be strictly maintained.

G. Labels/identification: Label and identify components of the pathway system per TIA/EIA 606.

END OF SECTION
SECTION 27 05 26
ELECTRICAL - GROUNDING AND BONDING

PART 1 - GENERAL

1.01 SUMMARY
A. This Section includes specific requirements for providing a permanent grounding and bonding infrastructure for communications systems. General requirements are covered in Division 27 Specification Section Electrical - General Requirements.

1.02 RELATED SECTIONS
A. The requirements of Division 27 Specification Section Electrical - General Requirements shall serve as the basis for the requirements of this Section, and are incorporated by reference into this Section.

1.03 SUBMITTALS
A. Comply with the Submittal portion of Division 27 Specification Section Basic Communications Requirements. Provide submittal information for the following:
   1. Product Data

1.04 DEFINITIONS
A. TMGB: Telecommunications Main Grounding Busbar: This grounding busbar is typically directly bonded to the electrical service ground. There is typically one Telecommunications Main Grounding Busbar per building, located in the main telecommunications room (i.e. MDF or equipment room).
B. TGB: Telecommunications Grounding Busbar: The Telecommunications Grounding Busbar is connected both to the Telecommunications Main Grounding Busbar and to closest building structural steel or other permanent metallic systems. There is typically one Telecommunications Grounding Busbar per telecommunications room.
C. TBB: Telecommunications Bonding Backbone: The Telecommunications Bonding Backbone is a conductor used to interconnect the Telecommunications Main Grounding Busbar to one or more Telecommunications Grounding Busbars.
D. BC: Bonding Conductor: BC’s are used to bond all non-current carrying metal telecommunications equipment and materials to the nearest TGB.

PART 2 - MATERIALS

2.01 GENERAL
A. Manufacturer: Communications grounding and bonding equipment and materials shall be manufactured by a single Manufacturer unless specifically stated otherwise. The manufacturer shall be:
   1. Chatsworth Products, Inc. (CPI)
   2. Erico
   3. Cooper B-Line

B. Part Numbers: Refer to the equipment schedule at the end of this Section for specific part numbers. If no part number is provided, then any part meeting the requirements specified is acceptable.

C. Labels/Identification: Provide labels to identify all components of the communications grounding and bonding system. Labels shall be permanent (i.e. not subject to fading or erasure) and permanently affixed. Handwritten labels are not acceptable.
2.02  GROUND BUSBARS
   A.  Grounding busbars shall meet the specifications of TIA/EIA 607 and conform to BICSI recommendations, with standard NEMA bolt hole sizing. Grounding busbars shall be plated for reduced contact resistance:
      1.  Telecommunications Main Grounding Busbar (TMGB): TMGB’s shall be 20 inches (minimum) by 4 inches. Provide as shown on the Drawings. Where not shown, provide one TMGB per primary telecommunications room (i.e. MDF, Equipment Room, etc.).
      2.  Telecommunications Grounding Busbar (TGB): TGB’s shall be 10 inches (minimum) by 2 inches. Provide as shown on the Drawings. Where not shown, provide a minimum of one TGB per secondary communications room (telecommunications room, IDF, etc.).

2.03  TBB
   A.  Provide insulated (green) solid copper conductor. Unless otherwise noted on the Drawings, conductors shall be sized according to conductor length as follows:
      1.  Less than 13 feet: #6 AWG
      2.  13 to 20 feet: #4 AWG
      3.  20 to 26 feet: #3 AWG
      4.  26 to 33 feet: #2 AWG
      5.  33 to 44 feet: #1 AWG
      6.  44 to 52 feet: #1/0 AWG
      7.  52 to 66 feet: #2/0 AWG
      8.  Greater than 66 feet: #3/0 AWG

2.04  BC
   A.  Provide #6 AWG insulated (green) solid copper conductor.

PART 3 - EXECUTION

3.01  GENERAL
   A.  Work shall comply with the Governing Requirements as defined in Division 27 Specification Section Basic Communications Requirements. Governing Requirements of particular relevance to this Section include, but are not limited to:
      1.  ANSI J-STD-607: Commercial Building Grounding and Bonding Requirements for Telecommunications
      2.  NEC: National Electric Code (NFPA Article 70)
      3.  UL 467: Grounding and Bonding Equipment
   B.  Contractor shall ensure that bonding breaks through paint to bare metallic surface of all painted metallic hardware.
   C.  Labels/Identification: Label and identify all components of the communications grounding and bonding system.

3.02  GROUND BUSBARS:
   A.  Group protector, busbar bonding, and approved building grounding conductors toward the left, leaving space for equipment grounding conductors to the right.
      1.  TMGB:
          a.  Directly bond TMGB to electrical service ground and to associated TBB’s.
          b.  Label with “TMGB”.
      2.  TGB:
          a.  Directly bond TGB to its associated TBB.
b. Label with “TGB”.

3.03 TBB
A. TBB’s shall be used to connect the TMGB to each TGB. Route along the shortest and straightest path possible with minimal bends. Bends shall be sweeping. TBB’s shall be continuous (without splices), and shall be insulated from their support.
B. Label with “WARNING! TELECOMMUNICATIONS BONDING BACKBONE (TBB). DO NOT REMOVE OR DISCONNECT!” Labels shall be affixed at both ends and at accessible intermediate points.

3.04 BC
A. BC’s shall be used to bond all non-current carrying metal telecommunications equipment and materials to the nearest TGB. Route along the shortest and straightest path possible with minimal bends. Bends shall be sweeping. BC’s shall be continuous (without splices), and shall be insulated from their support.
B. Label with “WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR (BC). DO NOT REMOVE OR DISCONNECT!” Labels shall be affixed at both ends and at accessible intermediate points.
## EQUIPMENT SCHEDULE - GB

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END OF SECTION
SECTION 27 05 33
ELECTRICAL - CONDUIT AND BOXES

PART 1 - GENERAL

1.01 SUMMARY
A. This Section includes specific requirements for conduits and boxes within the Communications Pathway System. General requirements are covered in Division 27 Specification Section Electrical - General Requirements.

1.02 RELATED SECTIONS
A. The requirements of Division 27 Specification Section Electrical - General Requirements shall serve as the basis for the requirements of this Section, and are incorporated by reference into this Section.

1.03 SUBMITTALS
A. Comply with the Submittal portion of Division 27 Specification Section Basic Communications Requirements. Provide submittal information for the following:
   1. Samples:
      a. Provide one full size installation sample/mock-up for each of the following components. All samples are to be fully labeled per the Specifications and shall be complete with all associated components necessary to make a complete mock-up. Samples will be used to set the standard for the quality of work required of the Contractor throughout the project. Installation work not meeting the sampled standard will be rejected and shall be replaced by the Contractor at no additional cost to the Owner.
         1) Outlet box: Provide a mock-up of the box assembly. The sample assembly shall be complete with box, extension ring, mudring, and a 12 inch length of conduit.

1.04 DEFINITIONS
A. EMT: Electrical Metallic Tubing
B. RMC: Rigid Metal Conduit
C. RNC: Rigid Nonmetallic Conduit
D. IMC: Intermediate Metal Conduit

PART 2 - MATERIALS

2.01 GENERAL
A. Part Numbers: Refer to the equipment schedule at the end of this Section for specific part numbers. If no part number is provided, then any part meeting the requirements specified is acceptable.

2.02 CONDUIT
A. Conduit types:
   1. EMT shall be steel, hot-dipped galvanized or electro-galvanized, with an inner coating to protect cables and aid pulling, UL listed, and meeting the requirements of UL 797 and ANSI C80.3.
2. **RMC shall be steel, hot-dipped galvanized inside and outside with factory threaded ends full cut and galvanized after threading, UL listed, and meeting the requirements of UL 6 and ANSI C80.1.**

3. **RNC shall be PVC Schedule 40 rigid plastic unless otherwise noted on the Drawings, shall be rated for use with 90 degree C wire, and shall conform to UL 651, WC-1094C and NEMA TC 2.**

4. **RNC Type EB-20 shall be provided as shown on the drawings, shall be ETL listed, tested to UL-651-A, and shall meet the requirements of NEMA TC-6 and ASTM F-512.**

5. **Flexible (flex) conduit: Flex conduit is not approved and not acceptable. Where, in rare instances, flex conduit is the only remaining viable raceway option, the Contractor shall notify the Engineer and await the Engineer’s direction prior to procurement and installation.**

6. **Condulets (LB’s): Condulets (LB’s) are not approved and are not acceptable.**

**B. Fittings:**

1. **Provide fittings as follows:**
   a. **EMT fittings shall be steel compression type with a nylon insulated throat for rain-tight and concrete-tight applications, steel set screw type or steel compression type for all other connections. Conduit ends shall be fitted with bushings – bushings shall be threaded and have a nylon insulated throat.**
   b. **RMC fittings shall be threaded galvanized steel. Conduit ends shall be fitted with bushings – bushings shall be threaded and have a nylon insulated throat.**
   c. **RNC fittings shall be of same material and manufacturer as the conduit, shall be UL listed and conform to UL 514. Cement shall be as recommended by manufacturer.**

2. **Expansion fittings shall be provided across structural joints, shall be of a design to compensate for expansion and contraction, shall be sealed to prevent entrance of water and moisture, and shall safely deflect and expand up to twice the distance of the structural movement. Expansion fittings shall be approved for grounding duty.**

**2.03 OUTLET BOXES**

**A. Outlet boxes shall be provided to house communications outlets/connectors. Outlet boxes shall be galvanized stamped steel, deep drawn one piece (without welds or tab connections), with knockouts for conduit entrances, meeting NEMA OS 1, and with extension rings to suit construction and application.**

**B.** **Unless otherwise shown on the Drawings, outlet boxes shall be minimum 4 inch by 4 inch, with extension ring, single gang mud ring, and knockouts pre-manufactured to support the conduit size serving the outlet box (i.e. field modifications of the outlet box to support the conduit sizes specified are not acceptable). Combined depth of outlet box and extension ring shall be a minimum 3-1/2 inches.**

**C.** **Security Camera outlet box shall be minimum 4 inch by 4 inch, with extension ring, cover plate (in lieu of single gang mud ring), and knockouts pre-manufactured to support the conduit size serving the outlet box (i.e. field modifications of the outlet box to support the conduit sizes specified are not acceptable). Combined depth of outlet box and extension ring shall be a minimum 3-1/2 inches.**

**D.** **Wireless Access Point (WAP) outlet box shall be minimum 4 inch by 4 inch, with extension ring, cover plate (in lieu of single gang mud ring), and knockouts pre-manufactured to support the conduit size serving the outlet box (i.e. field modifications of the outlet box to support the conduit sizes specified are not acceptable). Combined depth of outlet box and extension ring shall be a minimum 3-1/2 inches.**

**E.** **Outlet boxes in modular furniture locations shall be deep device boxes.**

**2.04 JUNCTION BOXES**

**ELECTRICAL - CONDUIT AND BOXES**

27 05 33 - 2
A. Junction boxes shall be provided to serve as a transition point between pathways/raceways. Junction boxes shall be galvanized stamped steel, deep drawn one piece (without welds or tab connections), with knockouts for conduit entrances, meeting NEMA OS 1.

B. Junction boxes in walls:
1. Unless otherwise shown on the Drawings, junction boxes shall be minimum 4 inch by 4 inch, with extension ring, single gang mud ring, and knockouts pre-manufactured to support the conduit size serving the junction box (i.e. field modifications of the junction boxes to support the conduit sizes specified are not acceptable). Combined depth of junction box and extension ring shall be a minimum 3-1/2 inches.

2.05 PULL BOXES

A. Pull Boxes shall be code gauge sheet metal/fabricated steel continuously welded at seams and painted after fabrication. Boxes shall be complete with covers, trim, etc.

B. Minimum pull boxes sizes shall be as follows:

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<th>CONDUIT WIDTH</th>
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</table>

C. Pull Boxes for conduits sized larger than shown in the table above shall be provided as shown on the Drawings.

2.06 FLOOR BOXES

A. Floor boxes shall provide the interface for power, communication and/or audio/visual cabling in an above grade floor. Floor boxes shall be flush style, shall exceed UL scrub water exclusion requirements for tile and carpet floors, and shall be complete with covers, brackets and hardware to support installation as shown on Drawings.
1. Floor boxes may be combined for use by both power and communications where shown on the Drawings. When combined, provided metal dividers separating power from communications and provide separate conduits for power and communications.

B. Floor Box Types:
1. Floor Box (4-gang): Floor boxes shall be in a recessed box, shall be adjustable before concrete pour, and shall be complete with brackets to support power, communications, and/or audio/visual type connectors as shown on the Drawings and specified in Specifications. Covers for floor boxes shall be included and shall support carpet/floor trim to match surrounding floor area, shall be UL listed to safety standards for tile, carpet and wood floor installation, and shall prevent water, dirt, and debris from entering power/communication/audio/visual outlets.

2. Floor Box Covers: Covers shall be a cast aluminum cover assembly, shall incorporate floor box manufacturer's protection to prevent water, dirt, and debris from entering the power and communication devices, and shall meet or exceed

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Institute of Behavioral Science
October 17, 2008

2007025.00

Institute of Behavioral Science
UL scrub water exclusion requirements for tile and carpet floors. Coordinate color with Architect and Owner.

PART 3 - EXECUTION

3.01 CONDUIT

A. General:
1. Run conduit in the most direct route possible, parallel and perpendicular to building lines.
2. Route conduits as close to structure as possible.
3. Do not route conduit through areas in which flammable material may be stored, or over or adjacent to boilers, incinerators, hot water lines, or steam lines.
4. Conceal all conduit unless indicated otherwise, within finished walls, ceilings, and floors.
5. Keep conduits at least 6-inches away from parallel runs of flues and steam or hot water pipes.
6. Install conduits level and square and at proper elevations.
7. For conduit runs exceeding more than 100 feet in length, provide pull boxes (see Part 3 – Execution, Pull Boxes herein) so that no conduit segment between end points/pull boxes exceeds 100 feet.
8. For conduit runs which require more than two 90 degree bends, install pull boxes (see Part 3 – Execution, Pull Boxes herein) so that no conduit segment between end points/pull boxes contains more than two 90 degree bends.
9. Ream all conduits to eliminate sharp edges. Conduits shall be reamed after threads are cut.
10. Joints shall be cut square and shall butt solidly into couplings.
11. Terminate all metal conduits with metallic threaded insulated throat bushings, PVC conduit with PVC bushings.
12. Metallic conduits entering communication rooms shall be equipped with grounding lugs.
13. Prevent foreign matter from entering conduits by using temporary closure protection. After cable installation, cap each unused conduit with a mechanical-type seal (tape is not acceptable).
14. Conduits shall be installed in such a manner as to keep exposed threads to an absolute minimum and in no case shall more than three threads be left exposed.
15. Install expansion fittings where conduit crosses an expansion join in structure or is in an environment where temperature changes combined with conduit run length may produce expansion or contraction stress. Provide a flexible bonding jumper at least three times the nominal width of the joint.
16. Terminate conduits that protrude through a floor 1 to 3 inches above the surface of the floor.
17. Conduits shall be cleaned and dried prior to the installation of cables.
18. Route conduit through roof openings for piping and ductwork wherever possible. Where not possible, provide and route through roof jack with pitch pocket for waterproofing. Empty conduits passing through roof penetrations shall be capped and sealed weather tight.
19. Conduits passing through exterior walls and floors below grade shall be made watertight with duct plugs. Pipe sleeves and wall collars shall extend all around the conduit or entrance seals and be specifically manufactured for that purpose.
20. When using RNC, transition to RMC for all bends, stub-ups, and penetrations through foundation walls.

B. Conduit Schedule:
1. Buried or below grade level slab: RNC
2. Embedded in concrete slab: RNC
3. Through foundation walls: RMC
4. Corrosive/Hazardous Areas: RMC
5. Exposed or subject to mechanical injury: RMC
7. All other areas (unless otherwise noted): EMT

C. Minimum Conduit Sizing, where not shown on the Drawings:
1. Outlet Boxes: 1 inch
2. Junction Boxes in walls: 1 inch
3. Floor boxes: Provide per the Drawings. Where not shown, provide per the
   manufacture’s requirements and recommendations for the specified floor box.
4. Poke-throughs: The size of the conduit feeding the poke-through shall be the
   same size as the conduit stub of the poke-through.

D. Conduit bends:
1. A conduit bend shall not exceed 90 degrees and shall not be constructed in such
   a way as to reduce the effective diameter of the conduit.
2. Conduit bends shall be sweeping, shall conform to TIA/EIA 569 bend radius
   requirements, and shall be a minimum of no less than 10 times the internal
   diameter of the conduit.
3. For conduits larger than 1-1/4 inch, bends shall be factory-manufactured.
   Bending conduit larger than this in the field using manual or mechanical methods
   is not acceptable. 1 inch and 1-1/4 inch bends shall be made in an approved
   bending machine or shall be factory-manufactured.
4. The contractor shall test each conduit with a mandrel to prove compliance with
   TIA/EIA and cable manufacturer bend radius requirements throughout the
   conduit run and shall provide evidence of such testing immediately upon request
   of the Engineer.
5. The sum total of conduit bends for a conduit segment between end points/pull
   boxes shall not exceed 180 degrees, except one additional bend of up to 90
   degrees is acceptable if the bend is located within 12 inches of the cable feed
   end.
6. 90 degree condulets (LB’s) are not acceptable.

E. Conduit Stubs:
1. From boxes in partition walls: Conduit stubs shall extend a minimum of 6-inches
   above top of partition wall and shall be angled 30 degrees toward the nearest
   raceway/pathway for horizontal cabling.
2. To cable tray: Terminate conduits 2 to 4 vertical inches above the tray and within
   2 horizontal inches of the edge of the tray. Conduits shall not extend over the
   edge of the cable tray.
3. Through floor slabs: Arrange so curved portion of bend (if any) is not visible
   above finished slab.

F. Conduit/duct runs under slab: Coordinate with other trades (electrical, plumbing, etc.)
   prior to trenching and installation. Communications conduit/duct runs under slab shall not
   share a trench with conduit/duct runs from other trades.

G. Conduits embedded in slab: Not acceptable unless otherwise shown on the Drawings.

H. Pull Strings:
1. Equip all conduits over 3 feet long with plastic or nylon pull strings with printed
   footage indicators and a minimum test rating of 200 pounds. Extend pull string a
   minimum of 3 feet from each end. Pull strings shall be secured to avoid losing
   the pull string within the conduit by either securing tying the end of each string in
   place, or by tying the end of each string to a washer with a diameter larger than
   the conduit diameter.
2. Label each pull string in a clear manner by designating, at each end of the pull
   string, the location of the far end of the pull string (i.e. room name,
   communications closet name, pull box identifier, cable tray, station identifier, etc.
   Indicate pull string length on the label.

I. Bushings: The Contractor is solely responsible for ensuring that bushings (insulated
   throat for metallic conduit, PVC for PVC conduit) are installed at conduit end(s) prior to
   cable installation. Where cable is installed prior to the installation of bushings, the
Contractor shall remove the cable, install the bushing, and re-install the cable at no additional cost to the Owner.

J. Labels: Label each conduit end in a clear manner by designating, at each end of the conduit, the location of the far end of the conduit (i.e. room name, communications closet name, pull box identifier, cable tray, station identifier, etc.). Indicate conduit length on the label.

3.02 OUTLET AND JUNCTION BOXES

A. Unless specifically noted otherwise on the Drawings, boxes shall be dedicated to communications, and shall not be shared with power. Furthermore, the use of dividers to divide a single box into “separate” sections for communications and power (or another function) is not acceptable.

B. Unless otherwise indicated, boxes shall be recessed. Set boxes plumb, level, square and flush with wall. Do not exceed more than 1/16 inch tolerance for each condition. Recess outside edge and trim plates from finished surface in accordance with NEC.

C. Boxes shall be supported independently of the conduit system. Supports shall be noncombustible and corrosion resistant. Suspended boxes shall be supported with threaded rod hangers and galvanized steel clamps, or trapeze hangers such as Unistrut.

D. Install additional straps or cross-bracing to ensure a rigid installation in a steel stud system.

E. Boxes on opposite sides of fire rated walls and partitions shall be separated by a horizontal distance of at least 24 inches.

F. Unused knockouts in boxes shall be left sealed.

G. Outlet boxes shall be located within 3 feet of an electrical power receptacle. Where conditions are such that this is not possible, promptly notify the Engineer and await the Engineer’s direction prior to rough-in of the box.

H. Box locations may be adjusted by the Engineer by up to 10 feet from the location shown on the Drawings at no additional cost to the Owner.

I. For acoustical purposes, boxes on opposite sides of a wall shall not be located back-to-back.

J. Refer to the Drawings for box mounting heights. Where not shown on the Drawings, refer to the Architectural Drawings and the Architect.

K. For boxes to be installed in brick, masonry or concrete, offsets shall be provided to provide for proper adjustment to finished surfaces. Exposed mortar is not acceptable around device plates.

L. In the event of discrepancies between box locations shown on the Communications drawings and any other drawings in the Construction Documents, the Contractor shall notify the Engineer and await the Engineer’s direction prior to installation.

3.03 PULL BOXES

A. Install pull boxes in an exposed location, readily accessible both at time of construction and after building occupation. Pull boxes shall not be installed in interstitial or otherwise non-accessible building spaces.

B. If mounting a pull box on ceiling structure above ceiling grid, do not mount higher than 4 feet above grid (mount on wall instead).

C. Install pull boxes such that conduit enters and exits only from opposite ends of the box (i.e. only two sides of a box may be used for conduit entry and those two sides must be opposite one another).

D. Do not install conduits into pullboxes in such a manner as to obstruct the installation of future feeder conduits into or out of the pullbox.
E. A pull box shall not be substituted for a 90 degree bend.
F. Do not exceed one pull box per total conduit run between outlet box and termination point in a communications closet, unless otherwise shown on the Drawings. Where field conditions necessitate the use of additional pull boxes notify the Engineer and await the Engineer’s direction prior to procurement and installation.
G. Pull boxes shall be rigidly mounted. Unused knockouts shall be plugged with suitable blanking devices.
H. Labels: Label each pullbox with a unique identifier. Identifiers shall be of the form “RN-YY” where “RN” is the room name of the room closest to (or containing) the pull box, and “YY” is the sequential number of the pull box for each “RN”. For example: The second pull box in the vicinity of room “201” would have the label “201-02”.

3.04 FLOOR BOXES
A. Set boxes plumb, level, square and flush with floor. Do not exceed more than 1/16 inch tolerance for each condition.
B. Floor boxes shall have been tested for use in fire-resistance-rated assemblies applicable to the condition(s) present in Project, and shall be installed in accordance with the instructions included in the listing.
C. For floor boxes installed in concrete slab:
   1. Coordinate floor boxes with slab/concrete topping depth. Where depth of floor box conflicts with slab depth notify the Engineer and await the Engineer’s direction prior to procurement and installation.
   2. Adjust box prior to and after concrete pour.
D. Covers shall be installed per manufacturer’s recommendations.
E. For floor boxes with combined power and communications circuits, install metal dividers for separation of circuits and provide separate conduits for power and communications.
### EQUIPMENT SCHEDULE - CB

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<td>Wiremold RFB4 Special Rqmt</td>
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END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes specific requirements for cable trays within the Communications Pathway System. General requirements are covered in Division 27 Specification Section Electrical - General Requirements.

1.02 RELATED SECTIONS

A. The requirements of Division 27 Specification Section Electrical - General Requirements shall serve as the basis for the requirements of this Section, and are incorporated by reference into this Section.

PART 2 - MATERIALS

2.01 GENERAL

A. Part Numbers: Refer to the equipment schedule at the end of this Section for specific part numbers. If no part number is provided, than any part meeting the requirements specified is acceptable.

2.02 CABLE TRAY SECTIONS AND COMPONENTS

A. General: Except as otherwise indicated, provide metal cable trays, of types, classes and sizes indicated. Cable tray shall be complete with all materials and incidental and miscellaneous hardware required for a complete cable tray system, including but not limited to support hangers, connector assemblies, clamp assemblies, connector plates, splice plates, bolts, nuts and washers for connecting units. Construct units with rounded edges and smooth surfaces; in compliance with applicable standards; and with the following additional construction features.

B. Wire Basket Cable Tray System: Cable tray shall be “wire basket” type and shall be as follows:

2. Width: Sized as shown on the drawings. Where not indicated on the Drawings, width shall be sized according to manufacturer’s recommendations for the amount of cable to be carried by the tray, plus an additional 100 percent for future expansion capability.
3. Depth: 2 inch usable loading depth.
4. Mesh: 2 inch by 4 inch mesh pattern with intersecting wires welded together.
5. Fittings: Fittings shall be field fabricated through use of manufacturer’s hardware and in accordance with manufacturer’s instructions.
6. Supports: Supports shall be “trapeze” style and provided in quantities as recommended by cable tray manufacturer according to maximum load. Supports shall mount under the tray and shall mount to tray in a “tool-less” fashion. Support hangers shall be 1/4 inch or 3/8 inch diameter rods.
7. Load rating: NEMA 8A in accordance with NEMA VE 1.
8. Barrier strips: Provide cable tray sections with a single barrier for separation of telecommunications cabling from other low-voltage cables (such as CATV, security, etc.). Barriers shall be of same materials and finish as cable tray.
9. Grounding/bonding: Cable tray shall be complete with manufacturer’s hardware for grounding/bonding.
10. Seismic bracing: Provide to meet local codes.
11. Expansion fittings shall be provided across structural joints, shall be of a design to compensate for expansion and contraction, shall be sealed to prevent entrance of water and moisture, and shall safely deflect and expand up to twice the distance of the structural movement. Expansion fittings shall be approved for grounding duty.

12. Cable tray and all fittings and supports shall be manufactured by the same manufacturer and shall be:
   a. Cope CAT2-12SL-120

PART 3 - EXECUTION

3.01 CABLE TRAY

A. Cable Tray: Cable Tray shall be installed in the locations shown on the Drawings and as follows:

1. Cable tray installation shall comply with manufacturer’s instructions/guidelines and NEMA VE 2-2000 Cable Tray Installation Guidelines.

2. Cable tray installed for communications circuit distribution may not be used for distributing electrical power. Cable tray installed for communications circuit distribution may not be used for distributing other signals without prior approval from the Engineer.

3. Prior to installation, examine areas to receive cable tray. Notify the Engineer/Owner of conditions that may adversely affect the installation, subsequent use, or cause the tray (or circuits to be subsequently installed in the tray) to not comply with TIA/EIA standards.

4. Coordinate layout and installation of cable tray with other construction elements and trades to ensure adequate headroom, working clearance and access.

5. Install cable tray level and plumb in accordance with the manufacturer’s recommendations, coordination drawings, original design, and referenced standards.

6. Utilize only manufacturer’s approved tooling for the installation of cable tray system.


8. Provide sufficient space encompassing cable trays to permit access for installing and maintaining cables.

9. Route cable tray as follows:
   a. Maintain a minimum clearance of 12 inches between top of cable tray and other elements such as ceiling structure, ducts, equipment, and other raceways. Where this is not possible, for very short distances (3 feet or less), a minimum clearance of 3 inches is acceptable. For longer distances, Contractor shall obtain the approval of the Engineer prior to installation.
   b. Maintain a clearance of 6 inch between bottom of cable tray and ceiling grid or other equipment or raceway.
   c. Maintain a clearance of 4 feet from motors or transformers.
   d. Maintain a clearance of 1 foot from conduit or cables used for electrical power distribution.
   e. Maintain a clearance of 18 inches from fluorescent lighting.
   f. Pathways shall cross perpendicular to fluorescent lighting and electrical power cables or conduits wherever possible.
   g. Where cables in cable trays are required to maintain specific distances between each other, they shall be firmly secured to maintain this distance at fire rated penetrations.

10. Bends shall be long radius. Short radius bends and abrupt T-sections shall not be used unless specifically called out on the Drawings.

11. Seismic bracing: Brace cable tray to structure with diagonal braces spaced a maximum 30 feet on center or as is required per local codes.
12. Install barriers set at 6 inches from edge of cable tray. Barriers shall be on the same side of the cable tray for each run.

13. Cable tray supports shall be attached to the structural ceiling or walls with hardware or other installation and support aids specifically designed for the cable tray and designed to support the cable tray’s weight and required cable weight and volume.
   a. Do not attach cable tray supports to ceiling support system or other mechanical support systems.
   b. Load span criteria: Cable tray fitting supports shall be located such that they meet the strength requirements of straight sections for maximum load (based upon length, depth, and span). Install fitting supports per NEMA VE-2 guidelines, and in accordance with manufacturer’s instructions.

14. Connections: Tighten electrical connectors and joints according to manufacturer’s recommended torque-tightening values. Where such values are not indicated by the manufacturer, use those specified in UL 486A and 486B.

15. Cable tray shall be installed without burrs, sharp edges, or projections that may damage cable insulation. After installation, repair any damaged finishes.

16. Testing: Test cable tray system to ensure electrical continuity of bonding and grounding connections, and to demonstrate compliance with national and local codes.

17. Transition from cable tray to Cable Pathway Firestopping Devices at fire rated barriers. Provide Cable Pathway Firestopping Devices in sufficient quantity such that the combined useable volume of the devices is greater than or equal to the volume of cable tray to be served.

18. Transition from cable tray to Cable Pathway Firestopping Devices for penetrations into communications rooms and spaces:
   a. Provide in sufficient quantity such that the combined useable volume of the devices is greater than or equal to the volume of cable tray to be served.

END OF SECTION
SECTION 27 10 00
COMMUNICATIONS - GENERAL REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY
A. This Section includes general cabling requirements for the Communications Cabling System.

1.02 RELATED SECTIONS
A. Division 27 Specification Section Common Work - Sleeves, Penetrations and Firestopping. Provide sleeves, penetrations, and firestopping as required to support the work of this Section.
B. Division 27 Specification Section Common Work – Hangers and Supports. Provide hangers and supports as required to support the work of this Section.

1.03 SUBMITTALS
A. Provide the following per the criteria set forth in Submittals in Division 27 Specification Section Basic Communications Requirements:
   1. Product Data
   2. Shop Drawings:
      a. Cable Routing: Provide a cable routing plan if communications cable routing has not been shown on the Drawings, or if the Contractor is proposing a deviation from that shown.
         1) If a routing plan is not required, submit written documentation stating that the routing will be provided as shown on the Drawings, that the Contractor has reviewed the routing shown on the Drawings with the other applicable trades and that all have agreed that it does not create conflicts between the trades, and the routing meets applicable codes, regulations and standards.
         2) If a routing plan is required, submit complete floor plans or detail drawings showing the proposed routing, raceway sizes and locations, and cabling in a manner equal to that of the Drawings. Ensure that any routing changes are coordinated with comparable changes to the raceway routing. Specifically note each location where the proposed routing is different from the Drawings. Where deviations are proposed, submit written documentation detailing the reason for each. Each deviation must be approved in writing by the Engineer prior to proceeding with installation.
      b. Termination Block Wall Field Terminations and Elevations: Provide termination block wall field termination diagrams and elevation drawings where such diagrams and elevations have not been shown on the Drawings, or if the Contractor is proposing a deviation from that shown.
         1) Where changes to the wall field termination diagrams and elevation drawings are proposed, submit wall field termination diagrams and elevation drawings in a manner equal to that of the Drawings. Specifically note areas where deviations are proposed, and submit written documentation detailing the reason for each. Each deviation must be approved in writing by the Engineer prior to proceeding with installation.
   3. Samples:
      a. Provide one full size installation sample/mock-up for each of the following components. All samples are to be fully labeled per the
Specifications and shall be complete with all associated components necessary to make a complete mock-up. Samples will be used to set the standard for the quality of work required of the Contractor throughout the project. Installation work not meeting the sampled standard will be rejected and shall be replaced by the Contractor at no additional cost to the Owner.

1) Horizontal cable(s): Provide a mock-up of each type of outlet configuration shown on the Drawings. The samples shall be complete with the outlet box, 36 inch length(s) of horizontal cable(s), strain relief, faceplate, connector(s), and other incidental components as required for a complete outlet. Label each outlet per the Specifications. The cable shall show all cable markings.

2) Copper Backbone Cable: Provide a 24 inch length of each type of copper backbone cable. The outer jacket shall be stripped back 6 inches from one end to allow the individual pairs to be inspected. Label each cable per the Specifications. The cable shall show all cable markings.

3) Fiber Backbone Cable: Provide a 24 inch length of each type of fiber backbone cable. The outer jacket shall be stripped back 12 inches from one end to allow the individual fiber sub-cable groups to be inspected for all cables. Label each cable per the Specifications. The cable shall show all cable markings.

4. Other:
   a. Owner Specific: Submit other information as required by Owner Specific Governing Requirements.

PART 2 - MATERIALS

2.01 GENERAL

A. Manufacturer: Structured cabling system components shall be sourced by a single Manufacturer or formally partnered Manufacturers (collectively referred to as the "Manufacturer"). Products shall not be intermixed between different manufacturers unless the Manufacturer of the chosen communications cabling system has listed (in writing) another manufacturer’s component as an “approved alternative product” (or equivalent wording) and will warrant the “approved alternative product” as part of the Manufacturer’s extended Warranty, or if the product has been specifically called out as a special requirement in the Specifications. Additionally, for a given Manufacturer, all products shall be part of a single product line and the product line shall be specifically engineered “end-to-end” (e.g. the system and all of its components shall have been engineered to function together as a single, continuous transmission path). The structured cabling system shall be:
   1. Hubbell – Mission Critical

B. Plenum Rating:
   1. Cable shall be plenum (CMP, OFNP) rated if installed in a plenum environment, non-plenum rated (CM/CMR, OFNR) otherwise, or per local Governing Requirements or code as required.
   2. The Contractor is solely responsible for determining the plenum rating of the environment in which cable is to be installed, and for doing so prior to procurement and installation of the cable. Non-plenum cable installed in an environment determined to be plenum rated shall be removed and replaced by the Contractor at no additional cost to the Owner.
   3. All cabling shall bear plenum or non-plenum markings for the environment in which they are installed.

C. Color: All cables of the same type (i.e. Copper Backbone, Copper Horizontal, Fiber Horizontal, Coaxial CATV Trunk, 62.5µm MM, 50µm MM, SM, etc.) shall be of the same color. Multiple colors of the same cable type are not acceptable.
D. Part Numbers: Refer to the equipment schedule at the end of this Section for specific part numbers. If no part number is provided, then any part meeting the requirements specified is acceptable.

2.02 PERFORMANCE

A. Protocols/Services:
1. At a minimum, the communications cabling system shall support data network protocols/services at rates up to 1 Gbps for transmission on copper, and 10 Gbps for transmission on fiber. It shall support Ethernet, ATM and other network protocols. The communications cabling system shall additionally support RS-232 and other dedicated point-to-point protocols.
2. The communications cabling system shall support PBX telephone services. It shall support analog, digital, and ISDN services, and shall be compatible with direct trunk lines (POTS).

B. Category Rating: Copper components (cable, connectors, etc.) shall meet or exceed the TIA/EIA transmission requirements for the Category for which they are rated.
1. Horizontal Cable shall be rated Category 5e (350Mhz).
2. Backbone Cable shall be rated Category 3 or higher.

C. Performance Rating: All components (copper and fiber) shall meet or exceed TIA/EIA transmission requirements for their component type.

D. Fiber Performance:
1. Backbone Cable:
   a. 50/125 µm Laser Optimized Multimode: Provide cable with a maximum attenuation of 3.0 dB/km at 850 nm and 1.0 dB/km at 1300 nm. The minimum cable bandwidth shall be 2000 MHz-km at 850 nm and 500 MHz-km at 1300 nm. Color shall be aqua.
   b. Singlemode: Provide cable with a maximum attenuation of 1.0 dB/km @ 1310 nm and 1.0 dB/km at 1550 nm. Color shall be yellow.

PART 3 - EXECUTION

3.01 GENERAL

A. Work shall comply with the Governing Requirements as defined in Division 27 Specification Section Basic Communications Requirements. Governing Requirements of particular relevance to this Section include, but are not limited to:
1. TIA/EIA 568: Commercial Building Telecommunications Cabling Standard
2. TIA/EIA 569: Commercial Building Standard for Telecommunication Pathways and Spaces
3. ANSI/EIA 310-D: Cabinets, Racks, Panels and Associated Equipment
4. TIA/EIA 606: The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
5. ANSI J-STD-607: Commercial Building Grounding and Bonding Requirements for Telecommunications
6. TIA/EIA - 758: Customer-owned Outside Plant Telecommunications Cabling Standard
7. IEEE 802.3 (series): Local Area Network Ethernet Standards
8. BICSI: Customer Owned Outside Plant Design Manual

B. Owner required Governing Requirements of particular relevance to this Section include, but are not limited to:
1. University of Colorado at Boulder:
3.02 GENERAL INSTALLATION

A. Maintain separation from other conductors (power, fire alarm, etc.) per NEC requirements and TIA/EIA standards.

B. The bending radius and pull strength requirements of all cable as detailed in the Governing Requirements and Manufacturers recommendations shall be strictly observed during handling and installation.

C. Pull cables simultaneously where more than one cable is being installed in the same raceway.

D. Use pulling compound or lubricant where necessary. Use compounds that will not damage conductor or insulation.

E. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cable or raceway.

F. Cable jackets shall not be twisted during installation. Cables showing evidence of twisting shall be replaced at no additional cost to the Owner, regardless of the outcome of cable testing.

G. Cable shall be installed in a continuous (non-spliced) manner unless otherwise indicated on the Drawings. Where splicing may be required in areas not shown on the Drawings due to Cable Spool length limitations or otherwise, the Contractor shall obtain the approval of the Engineer prior to procurement and installation.

H. Provide strain relief to ensure durable connections at all cable termination locations.

I. Pathway/Raceway Validation: The Contractor is responsible for validating pathway/raceway sizing against the amount of cable it is to support for compliance with NEC and TIA/EIA 569 cable capacity standards. The Contractor shall notify the Engineer of all raceways the Contractor determines to be insufficient in size and shall await the Engineer’s direction prior to procurement and installation.

J. Copper Cables:
   1. Backbone Cable: All pairs shall be terminated. Unless otherwise noted on the Drawings, the installation of un-terminated cable pairs is not acceptable. For shielded cable, bond both ends of the metallic shield (or metallic strength member) to the nearest TGB.
   2. Horizontal Cable: Thoroughly clean and remove foreign material from outlet boxes prior to installation of cable.

K. Fiber Cables:
   1. Cables shall be tested on reel prior to installation. Cable which does not pass shall not be installed and shall be replaced at no additional cost to the Owner. “Repairing” cables which do not pass is not acceptable.
   2. All fiber strands shall be terminated. Unless otherwise noted on the Drawings, the installation of un-terminated (i.e. “dark fiber”) is not acceptable.
   3. Fiber splices shall be fusion. Mechanical splices are not acceptable. Each fusion splice shall be protected in a splice tray or similar protective device that is designed to mount within the enclosure. Bare/stripped optical fiber strands shall
be protected with a buffer tube, heat shrink or silicon adhesive to prevent exposure to moisture.

L. Provide Sleeves and Penetrations as necessary where cable must pass through building barriers such as walls, floors or foundations. Firestop all through and membrane penetrations of fire-rated barriers. Sleeves, Penetrations and Firestopping shall be per the requirements of Division 27 Specification Section Common Work - Sleeves Penetrations and Firestopping.

3.03 CABLE INSTALLED IN RACEWAY

A. In Conduit or Ducts:
   1. Fill ratios shall not exceed NEC requirements.
   2. Cable shall not be pulled into conduit/ducts until the conduit/duct ends have been prepared for cable installation (i.e. ducts cleaned and swabbed, reamed to eliminate sharp edges, bushings installed (insulated throat for metallic conduits, PVC for PVC conduits), etc.). Cables pulled into conduit/ducts prior to conduit/duct end preparation shall be removed and replaced (after the conduit/duct ends are prepared) at no additional cost to the Owner.
   3. Backbone (riser) cables shall not share conduits/ducts with horizontal cables.
   4. Reinstate pull-wires in conduits and ducts after use to facilitate future addition of cables.

B. In Cable Tray:
   1. Cable shall not be attached to the cable tray (i.e. cable shall be left “loose”).
   2. Cable shall be laid in tray in such a way as to present a neat and professional appearance. However, cable shall not be combed (for performance reasons).
   3. For cable tray serving both backbone (riser) and horizontal cabling, install cable in cable tray in such a manner that backbone cabling does not overlap with horizontal cabling – reserve approximately 25 percent of the space in the tray for backbone cabling and the remaining 75 percent for horizontal cabling.
   4. Where cables in cable trays are required to maintain specific distances between each other they shall be firmly secured to maintain this distance at fire rated penetrations.

3.04 CABLE NOT INSTALLED IN RACEWAY (E.G. “EXPOSED”):

A. Cables shall be strapped, fastened or tie-wrapped for support. Staples are not acceptable.
   1. Straps, fasteners, and tie-wraps shall not be over-tightened. Cables showing evidence of over-tightening shall be replaced at no additional cost to the Owner, regardless of the outcome of cable testing.
   2. Straps, fasteners, and tie-wraps installed in plenum spaces shall be plenum rated.
   3. Cables shall be loosely grouped by application (horizontal or backbone) and by cable type (Cat 3, Cat 5E, Cat 5, Cat 6, MM Fiber, SM Fiber, etc.). Cable applications and types shall not be intermixed within a grouping.

B. Cables in suspended cable runs shall be supported at varying intervals. Cable spans shall be limited to 5 feet or less, and the length of spans shall vary along the cable path (i.e. a given span should not be exactly the same length as the span preceding or following it – “exact” spans can degrade cable performance).

C. Cable installed on exposed surfaces or structural members shall be installed parallel and perpendicular to the surfaces. Surface contours shall be followed wherever possible. Cables shall be attached to surfaces at intervals not to exceed 3 feet, and the length of spans shall vary along the cable path (i.e. a given span should not be exactly the same length as the span preceding or following it – “exact” spans can degrade cable performance).
D. Attaching cables to pipes, electrical conduit, mechanical items, existing cables, or the ceiling support system (grids, hanger wires, etc. – with the exception of ceiling support anchors) is not acceptable.

E. Cables exiting floor or wall penetrations and running exposed into furniture or casework shall be bundled and wrapped in spiral wrap or split-loom tubing for protection.

F. The quantity of cables installed in j-hooks, straps, and other similar fasteners shall not exceed manufacturer maximum loads for the fastener. Provide additional fasteners as required to meet load and future capacity requirements.

G. Route cable to comply with the Governing Requirements standards and rules for avoiding potential EMI sources of interference and as follows:
   1. Provide clearances of:
      a. 18 inches from light fixtures
      b. 12 inches from electrical power distribution (including conduits and cables)
      c. 4 feet from motors and transformers
   2. Cable pathway shall cross perpendicular to potential EMI sources of interference.

3.05 CABLE IN COMMUNICATIONS ROOMS AND SPACES

A. Cable on backboards:
   1. Lay and dress all cables to allow other cables to enter raceway (conduit or otherwise) without difficulty at a later time by maintaining a working distance from these openings.
   2. Cable shall be routed as close as possible to the ceiling, floor, sides, or corners to insure that adequate wall or backboard space is available for current and future equipment and for cable terminations.
   3. Lay cables via the shortest route directly to the nearest edge of the backboard from mounted equipment or blocks. Secure all similarly routed and similar cables together and attach to D-rings vertically or horizontally, then route over a path that will offer minimum obstruction to future installations of equipment, backboards or other cables.

B. Cable Bundles:
   1. Cables shall be bundled by application (horizontal or backbone) and by cable type (Cat 3, Cat 5E, Cat 5, Cat 6, MM Fiber, SM Fiber, etc.). Cable applications and types shall not be intermixed within a bundle.
   2. Cable bundles shall be combed to present a neat and professional appearance. For performance reasons, combing shall occur from the cable end to a maximum of 35 feet back (or per the Manufacturer's recommendations, whichever is more stringent). For the portion of a cable bundle within the communications room exceeding this requirement (if any), the exterior cables in the cable bundle shall be combed straight. Interior cables shall not be combed (i.e. they shall be left “mixed”).

C. Cable in ladder rack on walls: Place larger cable bundles against wall, smaller cable bundles to the inside.

D. Cable straps: Install cable straps to secure cable bundles to cable runway and other supporting equipment. The use of plastic tie wraps for this purpose is not acceptable. Comply with Division 27 Specification Section Communications - Equipment Room Fittings.

3.06 CABLE SLACK:

A. Cable slack in communications rooms and spaces: Store slack by circling cable around communications room in the Cable Runway as shown on the Drawings.
   1. Provide Slack length as follows:
      a. Inside Plant Cable: 10 feet minimum for all cable types (horizontal and backbone)
      b. Outside Plant Cable:
1) Copper Backbone Cable: 10 feet minimum
2) Coaxial CATV: 10 feet minimum
3) Fiber Backbone Cable: 50 feet minimum

2. Where Cable Runway does not exist or where slack storage is not called out on the Drawings, slack shall be stored as follows:
   a. Copper Cable:
      1) Horizontal: Slack shall be stored in a serpentine loop manner, not in the form of a circular "loop" (for performance reasons).
      2) Backbone: Slack shall be stored in circular "loops".
   b. Coaxial CATV: Slack shall be stored in circular "loops".
   c. Fiber Cable: Slack shall be stored in circular "loops".

B. Cable slack at the work area outlet: Provide 1 foot of slack. Slack shall be stored in a serpentine loop manner, not in the form of a circular "loop" (for performance reasons).

C. In cases of extreme congestion, notify the Engineer and await the Engineer's direction prior to installation.

3.07 OUTSIDE PLANT INSTALLATION

A. Duct/Direct-Buried:
   1. Mandrels: Prior to installation of cable, each duct shall be cleaned of debris with a wire brush or swab and shall be proven out with a test mandrel of sufficient length to verify the TIA/EIA minimum bend radii requirements and with a diameter which is ¼ inch smaller than the inside diameter of the duct. Duct shall be cleaned a minimum of two times in the same direction and swabbed with clean rags until the rag comes out of the conduit clean and dry. Swab away from buildings for duct sections connected to buildings.
   2. Cables shall be installed in strict compliance with the Governing Requirements and manufacturers recommendations. Bending radius, pulling tension, other mechanical stresses, and pulling speed as detailed in the manufactures recommendations and TIA/EIA standards shall be strictly observed. Pulling tension shall be monitored for all runs of 300 feet or longer. Acceptable monitoring devices are:
      a. Winch with a calibrated maximum tension
      b. Breakaway link (swivel)
      c. In-line tensiometer
   3. Cable reels shall be set up on the same sides of UCV's as conduit sections in which cables are to be placed. Reels should be leveled and aligned with conduit sections to prevent twisting of cables during installation into conduits. Cables shall be pulled into conduits from tops of reels in long smooth bends. Cables shall not be pulled into conduits from bottoms of reels. A cable feeder guide (shoe) of suitable dimensions shall be used between the cable reel and the face of the duct to protect the cable and guide it into the duct. As the cables are paid off the reel, they shall be carefully inspected for sheath defects. If defects are found during the pulling operation or if the cable on the reel binds, twists, or does not pay off freely, the pulling operation shall be stopped immediately and the Owner's representative notified.
   4. Cables of 1-¼ inches or larger diameter shall be equipped with factory installed pulling eyes. Pulling grips are to be used for cables smaller than 1-¼ inches in diameter. Grips with rings to prevent the grips from slipping shall not be beaten into the cable sheath. A ball-bearing based swivel shall be used between the pulling-eyes or grips and the pulling strand.
   5. Once pulling begins, and tension is applied to the cable, the pull shall be continued at a steady rate. If it is necessary to stop the pull at any point, the pull should be stopped but the tension should not be released unless it is necessary to do so.
   6. Unless specified otherwise, coordinate duct usage with UCB.
   7. Where cables are pulled through UCV's, duct selections shall be the same at both ends of UCV's unless specifically noted on the Drawings. Changes in duct
selections, especially in elevations, shall be avoided to ensure that no damage occurs to the cable sheaths and that pulling tensions are kept as low as possible.

8. A sufficient length of cable shall be left in each UCV to properly rack the cable, and to provide for splicing operations which may be required outside of the UCV. In the event that the UCV contains cabling routed directly to a building entrance, a sufficient length of cable entering the building shall be left in the UCV to allow for re-termination in the building without the use of a splice in the event of future cable damage between the UCV and the building. Cables in UCV’s shall be racked as soon as practicable and in no case shall racking occur greater than one week after cable installation. Cables in UCV’s shall be routed to avoid blocking duct access.

9. Cables shall be fed into ducts from the end of the duct that creates the least sidewall pressure on a bend during installation (i.e. cable should be fed from the end closest to the bend).

10. Use pulling compound or lubricant where necessary. Lubricants shall be specifically produced for the installation of telecommunications cable, shall be compatible with the cable jacket material and shall be used in accordance with manufacturer’s recommendations. Soap-based lubricants shall not be used. Where cable is pulled through a UCV, the cable shall be re-lubricated prior to feeding into the next duct. Immediately after cables have been installed, exposed cables in UCV’s and at termination points shall be cleaned of lubricants using dry rags.

11. Cable ends shall be sealed and protected with end caps immediately after installation and until terminated in a termination enclosure, in order to prevent moisture entry into the core of filled cables and to prevent damage during installation.

12. Installation of outdoor rated cable at building entrances shall comply with the National Electric Code (NEC) Article 800 “50-ft rule” (i.e. total exposed outdoor rated cable length within a building shall not exceed 50 feet). Where this is not possible due to existing field conditions, the Contractor shall notify the Engineer and await direction prior to cable installation.

13. Building Entrances: All in-use and spare conduits entering the building from the outside plant shall be sealed to prevent intrusion of water, gases, and rodents.

END OF SECTION
SECTION 27 11 00
COMMUNICATIONS - EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.01 SUMMARY
A. This Section includes requirements for providing equipment and materials for TIA/EIA compliant communications equipment rooms and spaces including, but not limited to, telecommunications rooms, equipment rooms, entrance facilities, etc. General requirements for equipment room fittings are covered in Division 27 Specification Section Communications – General Requirements.

1.02 SUBMITTALS
A. Provide the following per the criteria set forth in Submittals in Division 27 Specification Section Basic Communications Requirements:
1. Product Data
2. Shop Drawings:
   a. Provide the following for each Communication Room, if: a) Communications Rooms are not shown on the Drawings; b) Communication Rooms are only shown as “Typical” on the Drawings; c) or the Contractor is proposing a deviation to the Drawings:
      1) Wall elevations (all four walls)
      2) Plan view/layout
   b. Provide the following only if elevations have not been shown on the Drawings, or if the Contractor is proposing a deviation.
      1) Wall Field Cable/Jumper Management Elevations, including designation of cable and pair terminations within the wall field.

PART 2 - MATERIALS

2.01 GENERAL
A. Manufacturer: Racks, frames, cabinets, enclosures, rack cable distribution hardware, cable runway (ladder rack), and other distribution and incidental components shall be manufactured by a single Manufacturer unless specifically stated otherwise. The manufacturer shall be:
   1. Chatsworth Products, Inc. (CPI)
B. Color: Unless otherwise indicated, the color of all cable runway, equipment racks, frame, and cabinets, distribution hardware, and other distribution and incidental equipment shall be:
   1. Gray: Cable runway and associated materials
   2. Clear Chem/Brushed aluminum: Equipment racks
   3. Black: Vertical management sections
C. Seismic Bracing: Equipment shall be seismically braced as required by code. Bracing shall be rigid – non-rigid bracing (chains, cables, etc.) is not acceptable, unless otherwise specified by code. Seismic bracing hardware shall be provided by the manufacturer, or shall be approved or recommended by the manufacturer. Where no manufacturer hardware, approval, or recommendation is available, the seismic assembly shall be approved by a licensed structural engineer.
D. Part Numbers: Refer to the equipment schedule at the end of this Section for specific part numbers. If no part number is provided, then any part meeting the requirements specified is acceptable.
2.02 CABLE RUNWAY (LADDER RACK)

A. Cable runway system shall be complete with all fittings, miscellaneous hardware, and other incidental hardware required for a complete and fully fitted system, including but not limited to splice kits, support hangers, rods, and brackets, center supports, j-bolts, foot kits, vertical wall brackets, wall angles, support hardware, grounding hardware, and protective end caps for exposed cable runway ends. Provide as shown on the Drawings or as defined below:

1. Straight Section (Standard Rung Spacing): Cable runway shall be available in 6 inch, 12 inch, 18 inch, 24 inch widths and shall have runway cross-members (rungs) spaced at 12 inch intervals, and shall be painted gray.

2. Straight Section (Alternate Rung Spacing): Alternate Rung Spacing Cable runway shall be available in 6 inch, 12 inch, 18 inch, 24 inch widths and shall have runway cross-members (rungs) spaced at alternating 12.5 inch and 13.81 inch intervals. Alternate rung spacing runway is used to simplify vertical alignment of cable runway installed across the top of equipment racks with standard 6 inch vertical cable management sections. Color shall be gray.

3. Corner Bracket: Corner brackets shall be used to create radii for T-junctions and corners.

4. Triangular Support Brackets: Triangular Support Brackets shall be provided for all locations where cable runway is to be mounted on a wall. Triangular Support Brackets shall be sized and provided in quantities according to the width and fully loaded capacity of the cable runway to be supported.

5. Radius Drop: Radius Drops shall be provided for all locations where cable is to drop from one section of cable runway to another lower section of cable runway, or is to drop from cable runway to equipment racks, frames, or cabinets. Radius Drops shall be either Cross Member or Stringer type according to their application, and sized in widths according required to support their application.

6. Elevation Kits: Elevation kits shall be provided for all equipment racks and frames where cable runway is routed across the tops of equipment racks and frames and is not mounted at the same height as the tops of the equipment racks or frames. Elevation Kit height shall be sized per the distance between the top of the rack or frame and the cable runway.

7. Rack-to-Runway Mounting Plate: Mounting Plates shall be provided for all equipment racks and frames where cable runway is mounted directly to the top of equipment racks or frame. Mounting Plate shall be 3 inches wide and sized according to the width of the cable runway to be attached.

8. Wall Angle Support: Wall Angle Supports shall be provided for all locations where cable runway stops at walls or where Triangular Support Brackets cannot be utilized due to field conditions. Wall angles shall be sized and provided in quantities according to the fully loaded capacity of the cable runway to be supported.

2.03 EQUIPMENT RACKS, EQUIPMENT FRAMES, SERVER FRAMES AND CABINETS

A. Equipment shall be free standing and shall be complete and fully fitted with all miscellaneous and incidental hardware required, including but not limited to hardware required for assembly, securing to floor, grounding, and seismic bracing (as required by local codes). Height shall be as shown on the Drawings. Provide as shown on the Drawings and as follows:

1. Equipment Racks: Equipment racks shall be 19 inch wide with universal alternating hole patterns on both sides of the posts, 3 inch channels, 2 posts, top angles, self-supporting bases, and assembly hardware.

2.04 RACK-MOUNT ACCESSORIES

A. Provide as shown on the Drawings and as follows:

1. Horizontal Power Strip: Provide as shown on Drawings. Power strips shall be rack-mountable, 1.75 inches (1U) high by 19 inches wide, shall be rated at 15 amps, and shall have a minimum of 10 outlets, and shall be equipped with a
power cord of sufficient length to route to the power receptacle serving the equipment rack/frame.

2. Storage Drawer: Storage drawers shall be, 5.25 inches (3U) high, and shall be capable of mounting flush with the face of the rack.

3. Single-sided Shelf: Shelf shall be single sided, with side mount brackets 5.25 inches (3U) high, and shall be capable of mounting flush with the face of the rack.


5. Dust covers: Dust covers shall cover the space between base angles of two-post racks.

2.05 CABLE MANAGEMENT

A. Provide as shown on the Drawings and as follows:

1. Back Wire Managers: Back wire managers (cable rings) shall provide vertical cable management space. Provide as needed to back of equipment racks.

2. Vertical Cable Management Sections: Vertical cable management sections shall be single sided, and shall be provided in widths and heights as shown on the Drawings.

3. Interbay Cable Organizer: Provide as shown on Drawings. Unless shown otherwise on Drawings, interbay cable organizers shall be mounted at the top of equipment racks, frames and enclosures to route patch cables and jumpers. Interbay cable organizers shall be 19 inches wide.

4. Distribution Rings: Provide for all locations where cable or jumpers will be routed on backboards and similar surfaces. Size shall be appropriate to the quantity of cable to be supported, and shall be a minimum of 2 inches in diameter. Rings shall be manufactured by CPI, or equal. Type of ring shall be as follows:
   a. C-Rings (“open” rings): Provide for those cables or jumpers which will likely be subjected to frequent moves, adds, or changes.
   b. D-Rings (“closed” rings): Provide for those cables or jumpers not likely to be subjected to frequent moves, adds, or changes.

2.06 BACKBOARDS

A. Provide backboards as shown on the Drawings. Backboards shall be ¾ inch exterior grade Douglas Fir A-C plywood, void free, 2440-mm (8 feet) high unless otherwise noted, capable of supporting attached equipment. Width shall be as required to fully cover walls. Backboards shall be as follows:

1. Backboards shall be fire-resistant or non-combustible, painted with two coats of light colored fire retardant paint.

2.07 GROUNDING AND BONDING

A. Bonding Conductor (BC): Provide #6 AWG insulated solid copper conductor (green) to bond all non-current-carrying metal telecommunications equipment and materials to the nearest TGB.

PART 3 - EXECUTION

3.01 GENERAL

A. Work shall comply with the Governing Requirements as defined in Division 27 Specification Section Basic Communications Requirements. Governing Requirements of particular relevance to this Section include, but are not limited to:

1. TIA/EIA 569: Commercial Building Standard for Telecommunication Pathways and Spaces
2. ANSI/EIA 310-D: Cabinets, Racks, Panels and Associated Equipment
3. TIA/EIA 606-A: The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
4. ANSI J-STD-607: Commercial Building Grounding and Bonding Requirements for Telecommunications
5. TIA/EIA 607: Commercial Building Grounding and Bonding Requirements for Telecommunications

B. Seismic Bracing: Install seismic bracing as required by code.

3.02 CABLE RUNWAY (LADDER RACK)
A. Cable Runway shall be installed per manufacturer’s instructions and shall be installed with flat (rung) side up/out. Install with ends cut square, and reamed to remove burrs and sharp edges. Cap cut ends with manufacturer’s recommended caps. Affix cable radius drop outs wherever cable will “waterfall” from one runway elevation to another, or from runway to equipment.

3.03 EQUIPMENT RACKS, EQUIPMENT FRAMES, SERVER FRAMES AND CABINETS
A. Install equipment complete with all required incidental hardware and materials.
B. Bond all non-current carrying metal telecommunications equipment and materials to the nearest TGB. Ensure that grounding is provided across all cable runway splices and between cable runway and all equipment racks/frames, etc.
C. Free Standing Equipment Racks and Frames:
   1. Secure cable runway to equipment racks/frames and to walls as shown on the Drawings. Secure racks/frames to floor per manufacturer’s instructions.
   a. Rack-to-Runway Mounting Plate: Secure to cable runway and equipment racks and frames. Mounting plates shall be mounted either parallel or perpendicular, depending upon the orientation of the ladder rack
   2. When installing Vertical Cable Management Sections between equipment racks/frames, install management such that the management trough is as far back as possible between the racks/frames, to ensure a clean/even front side of the rack/frame.
   3. When installing multiple adjacent equipment racks/frames, bolt adjacent racks (and management, where shown) together per manufacturer’s instructions to ensure a stable, rigid frame.

3.04 CABLE MANAGEMENT
A. Distribution rings: Mount at minimum 1 foot intervals.

3.05 BACKBOARDS
A. Mount backboards on walls in locations shown on the Drawings with base of backboard at +12 inches AFF (unless otherwise noted on the Drawings), with the “A” side exposed. Securely fasten plywood to wall-framing members to ensure that it can support attached equipment.

3.06 GROUNDING AND BONDING
A. Bonding Conductor (BC): Bond all non-current carrying metal telecommunications equipment and materials to the nearest TGB with a bonding conductor.
   1. Route along the shortest and straightest path possible with minimal bends.
   2. Bends shall be sweeping.
   3. Bonding conductors shall be continuous (without splices) and shall be insulated from their support.
   4. Ensure that bonding breaks through paint to bare metallic surface of all painted metallic hardware.
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END OF SECTION
SECTION 27 11 19

COMMUNICATIONS - TERMINATION EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes requirements for equipment to terminate communications cable in communications equipment rooms and spaces. General requirements for termination equipment are covered in Division 27 Specification Section Communications - General Requirements.

1.02 RELATED SECTIONS

A. The requirements of Division 27 Specification Section Communications - General Requirements shall serve as the basis for the requirements of this Section, and are incorporated by reference into this Section.

PART 2 - MATERIALS

2.01 GENERAL

A. Manufacturer: Unless otherwise indicated, equipment in this Section shall be of the same Manufacturer as that specified under Division 27 Specification Section Communications - General Requirements.

B. Part Numbers: Refer to the equipment schedule at the end of this Section for specific part numbers. If no part number is provided, then any part meeting the requirements specified is acceptable.

2.02 PATCH PANELS

A. Provide patch panels in sizes and quantities as required to support all cables to be terminated. The sizes and quantities shown on the Drawings are for representative purposes only, and may or may not be the final sizes and quantities required. The Contractor shall provide sizes and quantities as required to support all cables to be terminated.

1. Copper: Copper patch panels shall be rack mountable and sized as shown on the Drawings. Patch panel connectors shall be 8-position/8-conductor, insulation displacement (IDC), non-keyed, and shall accept modular 8-position/8-conductor plugs. Patch panels shall support a universal (T568A and T568B) wiring pattern, shall meet or exceed the transmission requirements for connecting hardware as specified in the Division 27 Specification Section Communications - General Requirements for the Category for which they are rated, shall be equipped with pre-manufactured cable management support bar/strain relief for supporting cables behind the patch panel, and shall be complete with all incidental materials necessary for mounting and installation of the panel and support of the cables which shall be connected to it. Patch panels shall be available in 24-port and 48-port styles.

a. Horizontal Copper Patch Panels: Provide for terminating copper horizontal cables. Patch panel Category rating shall be the same as that specified under Division 27 Specification Section Communications - General Requirements.

b. Tie Distribution Copper Patch Panels: Provide for termination of voice-grade Category 3 rated copper tie cables. Patch Panel shall be Category 3 rated or higher.
c. Utility Tie Cable Patch Panels: Provide as shown on Drawings. Provide for termination of voice-grade Category 3 rated copper utility tie cables in TRs. Patch Panel shall be Category 3 rated or higher.

2. Fiber: Fiber patch panels shall be dual purpose, capable of both termination/connectorization and splicing (fusion or mechanical) of fiber in the same enclosure, shall support both regular and high-density connectors, and shall be sized as shown on the Drawings. Fiber patch panels shall consist of enclosures pre-assembled with connector panels, blank connector panels (for unused connector slots), strain relief, splice trays (as required) and splice incidentals. Fiber patch panels shall be complete with bulkheads as required to accommodate all fiber strands within the panel, and filler plates as required for all unused bulkhead slots (see Division 27 Specification Section Communications - Faceplates and Connectors), and with all incidental materials necessary for mounting.
   a. Rack Mount: Patch Panel Rack mount patch panels shall be 19 inches wide and shall be available in 24/48 (1U), 48/96 (2U), and 72/144 (4U) port sizes.
   b. Rack mount Combination Shelf: Rack mount Combination Shelf is used for a combination of splicing and termination, shall have a sliding shelf, and shall be available in 24 (1U) and 48 (2U) port sizes.

2.03 COPPER TERMINATION BLOCKS
A. 66-Style:
   1. Termination blocks:
      a. Provide designation strips for each 66M-style termination block, with bridge clips as required. Termination blocks shall be provided with or without 89-brackets as required by the mounting application. Designation strips shall mount on fanning strips of 66M block, provide a labeling surface for circuit identification, and be manufactured by the manufacturer of the 66M-block. Termination blocks shall be UL listed. Termination blocks shall be provided in the quantities required for complete termination. Provide as shown on the Drawings or as required.
         1) For copper backbone and/or tie cable connectivity: Provide as shown on Drawings. Termination blocks shall be Category 3 rated or higher.

2.04 OTHER TERMINATION EQUIPMENT
A. Building Entrance Protectors: Provide Building Entrance Protectors (BEP's) for the protection all building-to-building copper cables. Each BEP shall be provided complete with plug-in protector modules. Protector modules shall provide over-voltage and sneak current protection and shall be 4B series. Provide with 66-type in/66-type out connectors. Provide in sizes and quantities as shown on the Drawings.

B. Splice Enclosures: Provide as shown on the Drawings and as required by Cable Spool length limitations.
   1. Copper Splice Enclosures: Splice enclosures shall be sized to accommodate the quantity of pairs to be spliced. Enclosures shall be re-enterable without the destruction of the housing. Enclosures shall be complete with all incidental and required hardware including, but not limited to, cans, end caps, grommet kits, covers, splice connectors, and grounding/bonding hardware. Enclosures shall be either butt or in-line depending upon the application and shall not require special tooling for entry and sealing of the enclosure.
      a. Outdoors: Provide re-enterable encapsulant for all outdoor splice enclosures. The enclosure shall be encapsulated with a manufacturer recommended waterblocking compound.

   2. Copper Splice Connectors: Splice connectors shall be RUS Listed and shall be either straight or bridge depending upon the application. Connectors shall be 3M 2-Type.
3.01 GENERAL

A. Work shall comply with the Governing Requirements as defined in Division 27 Specification Section Basic Communications Requirements. Governing Requirements of particular relevance to this Section include, but are not limited to:
1. TIA/EIA - 568: Commercial Building Telecommunications Cabling Standard
2. TIA/EIA 569: Commercial Building Standard for Telecommunication Pathways and Spaces
3. ANSI/EIA 310-D: Cabinets, Racks, Panels and Associated Equipment
4. TIA/EIA 606-A: The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
5. ANSI J-STD-607: Commercial Building Grounding and Bonding Requirements for Telecommunications
6. TIA/EIA - 758: Customer-owned Outside Plant Telecommunications Cabling Standard

3.02 PATCH PANELS

A. Copper:
1. Horizontal Patch Panels: Cables shall be terminated sequentially and alphabetically by room number and sequential outlet number (within a room) left to right, from patch panel to patch panel (e.g. ports which terminate outlet cables from room 215A shall be terminated prior to ports which terminate outlet cables from room 220). Use the T568B wiring pattern.
2. Voice-Grade Copper Backbone Patch Panels: Cable pairs shall be terminated 1-pair(s) per port sequentially in accordance with the United States color code.
3. Utility Distribution Copper Patch Panels: Cable(s) shall be terminated 4-pair(s) per port (T568B) sequentially in accordance with the United States color code.

B. Fiber:
1. Fiber Patch Panels: Strands shall be connected sequentially left to right and from top to bottom. Terminate singlemode fibers in first available ports and multimode in last available ports.

3.03 COPPER TERMINATION BLOCKS

A. Terminate cable sequentially across the termination strips. Punch down cable using only the Manufacturer approved impact tool.

B. Backbone Termination Blocks: Cables shall be terminated by the United States Color Code and sequentially top to bottom and from left to right.

C. Utility Distribution Termination Blocks: Cables shall be terminated by the United States Color Code and sequentially top to bottom and from left to right.

3.04 OTHER TERMINATION EQUIPMENT

A. Building Entrance Protectors (BEP’s): Install BEP’s for both ends of outside plant copper cables per manufacturer’s instructions. All outside plant copper cables shall be routed through BEP’s. Connect each BEP’s protector ground lug to the nearest TGB with #6 AWG copper grounding conductor.

B. Splice Enclosures:
1. Copper:
   a. Grounding/Bonding: Cable shields/sheaths shall be connected together at all splices and termination points to assure a continuous metallic shield. Shield/sheath continuity shall be tested. Enclosure shall be connected to ground connectors if located in an underground cable vault/manhole/pullhole.
      1) Testing: Copper splices shall be electrically tested for opens, shorts, crosses and grounds, prior to sealing the enclosure.
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END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY
A. This Section includes requirements for providing equipment and materials for TIA/EIA compliant enclosures. General requirements for enclosures are covered in Division 27 Specification Section Communications – General Requirements.

1.02 SUBMITTALS
A. Comply with the Submittal portion of Division 27 Specification Section Basic Communications Requirements. Provide submittal information for the following:
   1. Product Data
   2. Shop Drawings:
      1) Wireless Access Point Enclosure: Provide only if locations have not been shown on the Drawings, or if the Contractor is proposing a deviation. Provide a separate Drawing for each type of Wireless Access Point enclosure to be installed.

PART 2 - MATERIALS

2.01 GENERAL
A. Part Numbers: Refer to the equipment schedule at the end of this Section for specific part numbers. If no part number is provided, than any part meeting the requirements specified is acceptable.

2.02 WIRELESS ACCESS POINT ENCLOSURE
A. Ceiling mount:
   1. Provide ceiling mount enclosures as shown on the Drawings. Enclosure shall be plenum rated, have a continuous hinge swing-down door with keyed lock, capable of mounting in a 2 foot by 2 foot or 2 foot by 4 foot ceiling tile opening. Enclosure shall be complete with fire-rated foam kits, mounting plate components and fittings as required for a complete installation.

B. Wall Mount
   1. Provide wall mounted enclosures for Wireless Access Point (WAP) outlets as shown on the Drawings. Enclosure shall be a vented steel enclosure, have a continuous hinge swing down door with keyed lock, with two 1 inch antenna openings 5 inches apart located on the top of the enclosure, in a color to best match existing wall color. Enclosure shall have knockouts for cable ingress/egress, and shall be constructed of vented steel 11 inches by 8 inches by 3 inches. Enclosure shall be complete with fire-rated foam kits, mounting plate components and fittings as required for a complete installation.

PART 3 - EXECUTION

3.01 GENERAL
A. Work shall comply with the Governing Requirements as defined in Division 27 Specification Section Basic Communications Requirements. Governing Requirements of particular relevance to this Section include, but are not limited to:
   1. TIA/EIA 568: Commercial Building Telecommunications Cabling Standard
2. TIA/EIA 569: Commercial Building Standard for Telecommunication Pathways and Spaces
3. TIA/EIA 606: The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
4. TIA/EIA 607: Commercial Building Grounding and Bonding Requirements for Telecommunications
6. Manufacturer’s Installation Manual and Instructions

B. The Contractor shall pay particular attention to and comply with the following Owner Governing Requirements:
   1) UCB Telecommunications Standards: (http://fm.colorado.edu/construction/standards/TelecommunicationsStandards.html)

3.02 WIRELESS ACCESS POINT ENCLOSURE

A. Coordinate final enclosure locations with Owner after Owner has performed a wireless survey.

B. Install enclosures for wireless access equipment per manufacturer’s recommendations, including all accessories necessary and firestop materials.

C. Secure with toggle bolts when wireless wall enclosures are installed on gypsum board.

D. Wireless access point enclosures must comply with the UCB Wireless Ceiling and Wall Security Box Instructions.

E. Place one self tapping screw to ceiling grid through each of the support arms when ceiling enclosures are installed.
## EQUIPMENT SCHEDULE - WA

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END OF SECTION
SECTION 27 13 00
COMMUNICATIONS - BACKBONE CABLING

PART 1 - GENERAL

1.01 SUMMARY
A. This Section includes requirements for backbone cable within the Communications Cabling System. General requirements for backbone cable are covered in Division 27 Specification Section Communications - General Requirements.

1.02 RELATED SECTIONS
A. The requirements of Division 27 Specification Section Communications - General Requirements shall serve as the basis for the requirements of this Section, and are incorporated by reference into this Section.

PART 2 - MATERIALS

2.01 GENERAL
A. Manufacturer: Unless otherwise indicated, equipment and materials in this Section shall be of the same Manufacturer as that specified under Division 27 Specification Section Communications - General Requirements.

B. Part Numbers: Refer to the equipment schedule at the end of this Section for specific part numbers. If no part number is provided, then any part meeting the requirements specified is acceptable.

2.02 COPPER
A. General:
1. Cable shall be multi-pair 24 AWG solid copper conductors insulated with color coded PVC, and shall be sized in pair counts as shown on the Drawings.
2. Copper cable ratings shall be as specified under Division 27 Specification Section Communications - General Requirements.

B. Inside Plant (Interior): Provide indoor rated cable.
1. Multi-Pair Backbone: Provide as shown on the Drawings. Cable shall be unshielded.
2. Tie: Provide as shown on the Drawings and as required for connecting the back side of termination blocks to entrance protectors, splice enclosures, etc. Tie cables shall be unshielded and shall not be used in plenum environments.

C. Outside Plant (Exterior): Provide outdoor rated cable. Cable shall conform to RUS PE-89, shall be single jacketed, shielded, and provided as follows:
1. For Conduit/Duct Installation: Cable shall be armored and flooded (insulated with filling compound).
2. For Direct-Buried Installation: Cable shall be armored and flooded (insulated with filling compound).

2.03 FIBER
A. General: Provide fiber optic cable in quantities, strand counts, and types (singlemode, multimode, or hybrid) as shown on the Drawings. Fiber cable shall be all-dielectric, shall conform to Bellcore and RUS standards, and shall be as further specified under Division 27 Specification Section Communications - General Requirements.

B. Inside Plant (Interior): Provide indoor rated cable. Cable shall be tight buffered.
C. Outside Plant (Exterior): Provide indoor/outdoor rated cable. Cable shall be loose buffered (loose tube) with a central strength member, and shall be dry cable design with dry water blocking technology that eliminates the need for or use of flooding compound.

PART 3 - EXECUTION

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END OF SECTION
SECTION 27 15 00
COMMUNICATIONS - HORIZONTAL CABLEING

PART 1 - GENERAL

1.01 SUMMARY
A. This Section includes specific requirements for horizontal cable within the Communications Cabling System. General requirements for horizontal cable are covered in Division 27 Specification Section Communications - General Requirements.

1.02 RELATED SECTIONS
A. The requirements of Division 27 Specification Section Communications - General Requirements shall serve as the basis for the requirements of this Section, and are incorporated by reference into this Section.

PART 2 - MATERIALS

2.01 GENERAL
A. Manufacturer: Unless otherwise indicated, equipment and materials in this Section shall be of the same manufacturer as that specified under Division 27 Specification Section Communications - General Requirements.
B. Part Numbers: Refer to the equipment schedule at the end of this Section for specific part numbers. If no part number is provided, then any part meeting the requirements specified is acceptable.

2.02 COPPER
A. Horizontal Cable: Cable shall be 4 pair UTP, solid copper conductors insulated with color coded PVC. Copper cable Category rating shall be the same as that specified under Division 27 Specification Section Communications - General Requirements.
1. Color shall be:
   a. Category 3: White
   b. Category 5e: Blue
   c. Category 6
   d. Category 6A
      1) Plenum rated: Lime
      2) Non-plenum: Green

PART 3 - EXECUTION

3.01 GENERAL
A. Refer to UCB Jack Numbering Document for further information.
### EQUIPMENT SCHEDULE - HC

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END OF SECTION
SECTION 27 15 43
COMMUNICATIONS - FACEPLATES AND CONNECTORS

PART 1 - GENERAL

1.01 SUMMARY
A. This Section includes requirements for faceplates and connectors within the Communications Cabling System. General requirements for faceplates and connectors are covered in Division 27 Specification Section Communications - General Requirements.

1.02 RELATED SECTIONS
A. The requirements of Division 27 Specification Section Communications - General Requirements shall serve as the basis for the requirements of this Section, and are incorporated by reference into this Section.

PART 2 - MATERIALS

2.01 GENERAL
A. Manufacturer: Unless otherwise indicated, equipment in this Section shall be of the same Manufacturer as that specified under Division 27 Specification Section Communications - General Requirements.
B. Part Numbers: Refer to the equipment schedule at the end of this Section for specific part numbers. If no part number is provided, then any part meeting the requirements specified is acceptable.

2.02 FACEPLATES
A. General: Provide faceplates for outlets in the locations and gang counts as shown on the Drawings or as specified below. Faceplates shall be complete with blank inserts/fillers for covering unused connector openings. Faceplates and fittings shall be dimensionally suitable for securely mounting connectors, providing a snug and sure fit – loose connectors are not acceptable. Faceplates shall be complete with port identification labels, and shall be provided with appropriate adapters, fittings and adapters as required.
B. Color: The color of non-stainless steel faceplates shall be electric ivory unless specified below.
C. Faceplates/Fittings:
1. For wall-mount telephone locations:
   a. Faceplates shall be brushed stainless steel with stainless steel mounting lugs suitable for mounting wall-mount telephones. Faceplates shall be dimensionally suitable for securely mounting 8-position/8-conductor IDC (RJ45 style) connectors.
2. For specialized mounting requirements (including but not limited to furniture, furniture “pop-ups” and enclosures, floor-boxes, poke-throughs, surface mounted raceway, etc.):
   a. Provide faceplates and fittings as required to support the specialized mounting. Faceplates and fittings shall be manufactured specifically for the equipment that they are to be mounted into (“general purpose” faceplates field modified for the specialized use are not acceptable unless specifically noted otherwise on the Drawings). Faceplates and fittings shall be approved by both the equipment manufacturer and the communications cabling system manufacturer, and shall be coordinated and verified compatible by the Contractor, equipment manufacturer and...
cabling system manufacturer prior to procurement and delivery. The provision of the correct faceplates and fittings for use in specialized mounting requirements is the sole responsibility of the Contractor.

3. For Wireless Access Enclosure:
   a. Provide low profile surface housing.

4. For walls and other non-specialized locations:
   a. Faceplates shall be plastic and capable of flush-mounting connectors.
   b. Standard single gang faceplates shall have six jack openings.

5. For Security Camera (SC) locations:
   a. Provide surface housing outlet box. Surface housing shall be dimensionally suitable for securely mounting 8-position/8-conductor IDC (RJ45 style) connectors.

D. Provide blank faceplates, matching those faceplates in use, for all unused communications backboxes.

2.03 CONNECTORS

A. General: Connectors shall meet or exceed the TIA/EIA standards and as called for in the Governing Requirements.

B. Horizontal:
   1. Copper: Copper connectors shall be 8-position/8-conductor, insulation displacement connector (IDC), non-keyed, and shall accept modular 8-position/8-conductor plugs. Connectors shall have a universally color-coded wiring pattern for both T568A and T568B. Copper connectors Category rating shall be the same as that specified under Division 27 Specification Section Communications - General Requirements. Provide 25 additional connectors as spares to Owner.
      a. Provide blue connectors for standard outlets.
      b. Provide green outlets for all labs.
      c. Coordinate with UCB ITS to verify connector color prior to placing order.

C. Backbone:
   1. Fiber: Fiber connectors shall be complete with bulkheads, adapters and adapter plates where required for mounting in fiber patch panels. Connectors shall be specific to the fiber core size to be connectorized and shall be:
      a. Inside Plant:
         1) Multimode:
            a) Andover and Fire Alarm: ST (62.5/125)
            b) All other multimode: SC (50/125 LO)
         2) Singlemode: ST
      b. Outside plant:
         1) Multimode: ST
         2) Singlemode: ST

PART 3 - EXECUTION

3.01 FACEPLATES
   A. Install all faceplates level and perpendicular to the floor. If long side of existing outlet box is mounted horizontal, then rotate faceplate counter-clockwise.

3.02 CONNECTORS
   A. Horizontal:
      1. Copper: Terminate connectors using the <T568A><T568B> wiring pattern at both ends of the cable.

   B. Backbone:
      1. Copper:
         a. Comply with Division 27 Specification Section Communications - Termination Equipment.
2. Fiber: Connectorize fiber strictly according to Manufacturers instructions using manufacturer specified tools and termination kits. All fiber strands within a cable shall be connectorized – the installation of “dark fiber” is not acceptable unless shown otherwise on Drawings.
   a. Connectors: Visually verify connectorization after installation with a minimum 200x magnification microscope to ensure that no physical damage has occurred during the installation process.
### EQUIPMENT SCHEDULE - FC

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<tr>
<th>ID</th>
<th>DESCRIPTION</th>
<th>Manufacturer/Part Number</th>
<th>Hub/Mohawk</th>
<th>Special Reqmt</th>
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<tr>
<td>FC010</td>
<td>WALL MOUNT TELEPHONE FACEPLATE</td>
<td>P630SR1GJ8</td>
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<td>FC060</td>
<td>FLOOR BOX OUTLET FRAME/FACEPLATE</td>
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<td>Hubbell</td>
<td>FCX6441 &amp; HPS11</td>
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<td>FC090</td>
<td>WALL CUT-OUT FACEPLATE MOUNTING BRACKET</td>
<td>CADDY MPLSx, Panduit MWBA1, equal</td>
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<td>COPPER CONNECTOR (CAT5E)</td>
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<td>P2020C-Z-125</td>
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END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes specific requirements for communications patch cords within the Communications Cabling System. General requirements for patch cords are covered in Division 27 Specification Section Communications - General Requirements.

1.02 RELATED SECTIONS

A. The requirements of Division 27 Specification Section Communications - General Requirements shall serve as the basis for the requirements of this Section, and are incorporated by reference into this Section.

PART 2 - MATERIALS

2.01 GENERAL

A. Manufacturer: Unless otherwise indicated, equipment and materials in this Section shall be of the same manufacturer as that specified under Division 27 Specification Section Communications - General Requirements.

B. Part Numbers: Refer to the equipment schedule at the end of this Section for specific part numbers. If no part number is provided, then any part meeting the requirements specified is acceptable.

2.02 COPPER PATCH CABLES

A. Provide copper patch cables for modular copper cross-connects. Patch cables shall be pre-manufactured (factory-terminated), stranded UTP, with 8-pin modular plugs.
   1. Patch cables shall be 4-pair with bootless modular plugs. Copper patch cables Category rating shall be the same as that specified under Division 27 Specification Section Communications - General Requirements.
      a. EF and TR: Provide one (1) patch cord for each new horizontal cable. Coordinate color (blue and/or black) and exact length with Owner prior to ordering patch cords.
      b. For Work Area Outlets (Workstation): Provide one (1) desktop patch cord for each cable in the second through sixth position on the faceplate. Coordinate color and exact length with Owner prior to ordering patch cords.

B. Provide patch cords from termination block to patch panel. See equipment list at end of this Section for part numbers. Provide lengths as required.
   1. Voice: Provide one patch cord for each cable in the first position on the faceplate. Color shall be blue.
   2. Special Circuits: Provide 30 patch cords. Color shall be yellow.

2.03 FIBER PATCH CABLES

1. Fiber patch cables will be provided by Owner.

PART 3 - EXECUTION

3.01 PATCH CORD INSTALLATION
A. Refer to UCB Telecommunications Standards: (http://fm.colorado.edu/construction/standards/TelecommunicationsStandards.html) for installation of patch cords.

B. Provide 4-pair modular patch cords for ER/TR and Work Area Outlets to Owner 3 weeks prior to final acceptance.

C. Install patch cords from termination block to patch panel. Coordinate termination plan with Owner prior to ordering patch cords. The Contractor shall submit the pair count with the jack number for as-built documentation at three weeks and at one week prior to occupancy or as specified by Owner.
<table>
<thead>
<tr>
<th>ID</th>
<th>DESCRIPTION</th>
<th>Manufacturer/Part Number</th>
<th>Hub/Mohawk</th>
<th>Special Reqmt</th>
</tr>
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<tbody>
<tr>
<td>PC010</td>
<td>COPPER PATCH CORD, NO BOOT (CAT5E)</td>
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<td>PCX5EBx-CU</td>
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END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY
A. This Section includes requirements for testing and identification/administration of the
Communications Cabling System.

1.02 UCB REQUIREMENTS AND STANDARDS
A. The Contractor shall comply with the following UCB requirements and standards. These
requirements and standards shall be incorporated by reference into these standards and
shall be considered a Governing Requirement.
1. UCB Telecommunications Standards, Section 271700 – Testing, Identification
and Administration.
B. In the event of conflict/disagreement between UCB Telecommunications Standards and
these standards, the more stringent condition shall prevail.

1.03 SUBMITTALS
A. Comply with the Submittal portions of Division 27 Specification Sections Basic
Communications Requirements and Communications - General Requirements. Provide
submittal information for the following submittal sections below:
   a. Provide a list of proposed test equipment for use in verifying the
      installation of the communications cabling system.
      1) Provide for each testing device:
         a) Manufacturer and product number.
         b) Manufacturer documentation showing date and outcome
            of last re-calibration. Testing device shall have been re-
            calibrated within the manufacturer’s recommended
            recalibration period.
         c) Manufacturer documentation showing software revision.
            Software revision shall be most current revision available
            for the device and shall be based upon the most current
            TIA/EIA testing guidelines.
         d) Patch cords and other specialized components.
   b. Provide the calculated optical fiber cable loss budget for each optical
      fiber cable in the system (see Part 3 – Execution: Testing herein)
2. Identification and Administration (see Part 2 – Materials: Identification and
   Administration herein):
   a. Provide a list of proposed hand-carried or computer software based
      identification/label makers, and a list of proposed materials for
      identifiers/labels.
   b. Provide actual samples of labels to be created for each system
      component to be labeled.
   c. Complete and submit the UCB-provided T5 template spreadsheet
      designating all outlet and jack numbering.
      1) Spreadsheet shall be complete prior to installation.
      2) Update UCB-provided T5 template spreadsheet designating all
         outlet and jack numbering and submit to UCB three weeks prior
         to move-in date. The revised T5 submittal shall incorporate any
         changes from the original project design.
2.01 TESTING

A. General
1. Testing of the systems shall be in accordance with the manufacturer’s recommendations and with the Governing Requirements.
2. Test reports shall be complete and in accordance with the appropriate Governing Requirements.
3. Where testing discloses deficiencies in the work, the Contractor shall rework, repair, or replace equipment and systems found deficient. The Contractor shall continue remedial measures and retesting until satisfactory results are obtained. Remedial measures and retesting shall be at no additional cost to UCB.
4. Testing of product or equipment prior to installation shall include performance testing to establish the applicability of equipment for its intended purpose. The Contractor shall:
   a. Establish the required test procedures from required Governing Requirements and manufacturer’s recommendations.
   b. Provide necessary test equipment, power, and consumables to perform the test.
   c. Notify the Engineer of test schedule(s) at least one week in advance.
   d. Perform test.
   e. Provide test result documentation to the Engineer.
5. Final testing and start-up of product, equipment, and systems shall include establishing proper capacity, operation, maintenance, and compliance with Governing Requirements. The Contractor shall:
   a. Provide the services of manufacturer’s representatives for systems to be tested and started up.
   b. Establish the required test procedures from required Governing Requirements and manufacturer’s recommendations.
   c. Provide necessary test equipment, power, and consumables to perform the test.
   d. Notify the Engineer of test schedule(s) at least one week in advance.
   e. Perform tests and start-up functions.
   f. Provide documentation of test results and fully operational systems to the Engineer.
6. Test records shall be provided on a form approved by the Engineer.

B. Systems Specific: Test shall be performed for each of the following systems as follows:

1. Communications Cabling System
   a. Test records:
      1) Each cable in the system shall be tested. Test result forms shall include the cable identifier, tests performed, outcome of tests and indication of errors found, cable length, retest results, and name and signature of technician completing the tests. Test result forms shall be provided to UCB and Engineer for review and acceptance.
      2) Test records for each cable within the system shall be printed directly from the tester and shall be submitted in paper form (in a binder) and on compact disc to UCB and Engineer for review. Handwritten test results will not be accepted.
   b. Testing Devices: Testing devices shall be capable of storing and printing test records for each cable within the system.
      1) For copper cables:
         a) Testing device shall meet the following requirements for a level 3 ANSI/TIA/EIA-568-B.2 Annex B and Annex testing instrument:
            i. Be re-calibrated within the calibration period recommended by the manufacturer, with the
most current software revision based upon the most current TIA/EIA testing guidelines.

ii. Physical interface shall be modular RJ-45 and a serial port with DB-9 connector.

iii. Store test results including date stamp of tests and UCB jack designator for each tested link.

iv. Print test results in report form when connected to a PC.


vi. Measure NEXT for all pair combinations and attenuation on all pairs from 1.0 to 350 MHz.

2) For fiber cables:

a) Field test instruments for multimode fiber cabling shall meet the requirements of ANSI/TIA/EIA-526-14A.

b) Field test instruments for singlemode fiber cabling shall meet the requirements of ANSI/TIA/EIA-526-7.

c) Multimode light source shall:

i. Meet the launch requirements of ANSI/TIA/EIA-455-50B achieved within the field test equipment or by use of an external mandrel wrap (as described in clause 11 of ANSI/TIA/EIA-568-B.1) with a Category 1 light source.

ii. Provide stabilized 850 nm and 1300 nm +/- 20 nm wavelength LED light source.

iii. Have spectral width of sources of <50 nm of 850 nm wavelengths and <140 nm for 1300 nm wavelengths.

iv. Have output of light sources of 8 MW for 62.5 or 50 nm core optical fiber as appropriate.

v. Shall have an output stability of +/- 0.40 dB from 0 to 50 degrees C.

vi. Shall have long term output stability of +/- 0.10 dB at 25 degrees C.

vii. Shall support ST and SC connector types.

d) Singlemode light source shall:

i. Provide stabilized 1310 nm and 1500 nm +/- 20 nm wavelength laser light source.

ii. Shall have an output stability of +/- 0.40 dB from 0 to 50 degrees C.

iii. Shall have long term output stability of +/- 0.10 dB at 25 degrees C.

iv. Shall support ST connectors.

e) Optical power meter shall:

i. Be calibrated against National Institute of Standards and Technology (NIST) standard.

ii. Shall provide 850 nm and 1300 nm +/- 20 nm selectable wavelength test capability.

iii. Shall have a measurement range of 10 to -60 dBm.

iv. Shall have an accuracy of +/- 5 percent at 0 to 50 dBm.

v. Shall have an accuracy of +/- 10 percent at 10 to 0 dBm and -50 to -60 dBm.

vi. Shall have a resolution of 0.01 dB.

vii. Shall support ST and SC connector types.

f) Optical time domain reflectometer shall:
i. Have dual selectable wavelength (850/1300 nm for multimode, 1310/1500 nm for multimode).

ii. Have selectable cable index of refraction.

iii. Shall have a visual fault locator for continuity checks and dead zone fault location.

iv. Shall have a front display and printer connection for hard-copy documentation.

v. Shall be equipped with launch jumper cable of sufficient length to offset entry “dead zone”.

vi. Shall support ST and SC connector types.

To ensure quality connectorization, a microscope of not less than the 200x magnification shall be used to visually inspect connectors and splices after installation.

2.02 IDENTIFICATION AND ADMINISTRATION

A. Identifiers (labels) shall be as recommended in TIA/EIA 606-A, unless noted otherwise herein.

B. Identifiers (labels) shall be as determined by and coordinated with UCB.

C. Labels shall be permanent (i.e. not subject to fading or erasure) and permanently affixed. Handwritten labels are not acceptable.

D. For identification of materials and equipment interior to the facility:
   1. Faceplate labels: Labels shall be created with a hand-carried label maker (Dymo Electronic Labelmaker 5000 or equivalent) or an equivalent computer/software-based label making system.
   2. Termination sheets and labels for copper and fiber terminations and enclosures: to be provided by UCB ITS and installed by the Contractor. Replacement sheets and labels will be provided to the Contractor at an additional cost.
   3. Cable Marking: Label shall be a vinyl substrate with a white printing area and a clear “tail” that self laminates the printed area when wrapped around the cable. If cable jacket is white, provide cable label with printing area that is any other color than white (preferably orange or yellow), so that the labels are easily distinguishable.
   4. Pre-printed labels shall meet legibility, defacement, exposure and adhesion requirements of UL 969.
   5. Handwritten labels shall not be acceptable.

E. For identification of materials and equipment in the outside plant:
   1. Labels shall be waterproof (even when submerged) and engraved on hard plastic markers. Lettering shall be black, markers shall be white.

PART 3 - EXECUTION

3.01 GENERAL

A. Work shall comply with the references and standards listed in Specification Section – Communications - General Requirements.
   1. Testing:
      a. TIA/EIA - 455: Fiber Optic Test Standards
      b. TIA/EIA - 526: Optical Fiber Systems Test Procedures
      c. TIA/EIA - 568 Commercial Building Telecommunications Cabling Standard
      d. IEEE 802.3 (series): Local Area Network Ethernet Standard, including the IEEE 802.3z Gigabit Ethernet Standard
   2. Identification and Administration:
      a. TIA/EIA 606-A: The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
3.02 TESTING

A. General
1. Test devices shall be in calibration throughout the testing period. Tests performed on equipment without up to date calibration shall be rejected and shall be repeated at no additional cost to UCB.
2. The Contractor shall notify the Engineer and UCB 7 days in advance of each type of test to be conducted. UCB or Engineer may, at their discretion, witness all testing.
   a. UCB and Engineer shall be invited to attend and inspect the first instance of each type of test to be conducted. Tests conducted prior to first inspection shall be at the sole risk of the Contractor, and as such are subject to rejection. Such tests will be repeated at no additional cost to UCB.

B. Systems Specific Testing:
1. Communications Cabling System
   a. All interior (inside plant) and exterior (outside plant) fiber cables shall be tested on the reel upon delivery to the job site prior to installation.
      1) Test results shall be permanently affixed to the reel and a copy given to UCB and Engineer for review prior to installation.
      2) Testing shall demonstrate compliance with the factory test results as shipped with the reel. Cables that fail to pass shall not be installed, and the Contractor shall replace the cable at no additional cost to UCB. Repair of damaged cable is not acceptable.
   b. The contractor shall perform pre-testing of the installed telecommunications systems to determine compliance and notify UCB ITS personnel when the system is ready for final inspection and testing. UCB shall be obligated to schedule final inspection and testing within five (5) business days of notification by the contractor. Final testing shall be scheduled and conducted in the presence of the UCB ITS representative.
   c. Test the communications cabling system for compliance to the Governing Requirements and all applicable standards as follows:
      1) Visually inspect all labels at the outlet locations (faceplates/ports), patch panels/ports, and on each end of each cable to ensure that all cables and equipment are correctly identified.
      2) Copper Cable:
         a) For Horizontal Distribution: Test each copper horizontal cable, all pairs. To the extent possible, tests shall be performed with building electrical systems fully powered on (i.e. Lights, HVAC, etc.).
            i. Test each end-to-end Permanent Link (the entire link from the connector at the outlet to the connector or termination in the telecommunications closet) utilizing sweep tests, for Wire map (continuity), length, propagation delay/delay skew, attenuation (insertion loss), return loss, near-end cross talk (NEXT) loss, Equal Level Far-End Crosstalk (ELFEXT), attenuation-to-crosstalk ratio (ACR), power sum NEXT (PSNEXT) and power sum...
ELFEXT (PSELFEXT). Each cable shall be tested in both directions.

(a) Measure NEXT for all cable pair combinations and attenuation on all pairs from 1.0 to 350 MHz.

ii. Test results shall demonstrate compliance with:

(a) The criteria specified in TIA/EIA 568 for Category 5e cables
(b) The criteria specified in TIA/EIA TSB 95, and TIA/EIA 568-A-5
(c) The criteria specified in IEEE 802.3z (1000Base-X Gigabit Ethernet)

b) For Backbone Distribution (inside and outside plant):
Test each cable, all pairs, for length, shorts, opens, continuity, polarity reversals, transposition (wire map), and the presence of AC voltage.

i. Test entire channel, from termination block to termination block.

ii. Test results shall demonstrate compliance with:

(a) The criteria specified in TIA/EIA 568 for Category 3 cables

3) Fiber Cable:

a) Prior to testing, the cable loss budget shall be calculated by the Contractor for each optical fiber cable and shall be clearly shown on the test documentation. Maximum loss shall be calculated by the following formula, assuming no splices:

i. For Backbone Distribution (inside and outside plant):
   (a) Max Loss = (allowable loss/km) * (km of fiber) + (0.4db) * (# of connectors)
   (b) A mated connector-to-connector interface is defined as a single connector for the purposes of the above formula.

ii. A given fiber cable shall not exceed its calculated maximum loss (per the above formula).

b) Test all strands. Testing shall consist of a bi-directional end-to-end Optical Transmission Loss Test Instrument trace performed per TIA/EIA 455-61 and a bi-directional end-to-end power meter test performed per TIA/EIA 455-53A.

i. Loss numbers shall be calculated by taking the sum of the two bi-directional measurements and dividing that sum by two.

ii. All backbone fiber cables shall be tested with an OTDR in addition to attenuation testing performed with a power meter.
   (a) The number of samples (averages) for each OTDR test shall be such that the noise amplitude is significantly less than the smallest loss of any component under test.

iii. Multimode fiber testing shall incorporate use of a mandrel wrap of fiber jumper to induce macro bends in the fiber.

c) Test measurements shall be provided as follows:
i. For Multimode Cable: Test at both 850 and 1300nm.
ii. For Singlemode Cable: Test at both 1300 and 1550nm.

d) Test results shall demonstrate compliance with:
   i. The criteria specified in TIA/EIA-568A Annex H.
   iii. The criteria specified in ANSI/TIA/EIA-568-B.1, Section 11.3.3, Table 11-15.
   iv. The criteria specified in ANSI/TIA/EIA-526-7, Method A.1, One Reference Jumper.
   v. The Contractor’s calculated loss budget above.
   vi. The criteria specified in IEEE 802.3z (1000Base-X Gigabit Ethernet).

d. In addition to the above, tests performed shall be both those recommended and mandated by the communications cabling system Manufacturer.

e. Cables and equipment that do not pass shall be identified to the Engineer. The source of the non-compliance shall be determined, corrected or replaced, and re-tested at no additional cost to UCB. Provide new test results to the Engineer in the same manner as above.

1) In addition to the above, if it is determined that a cable is at fault, the contractor shall remove the damaged cable and replace it with a new cable. Cable “repairs” are not acceptable. The procedure for removing the cable shall be as follows:
   a) Prior to removal of the damaged cable and re-pull of the new cable:
      i. Any cables which are in the same conduit, duct or innerduct as the damaged cable shall be tested, regardless of whether or not they are new cables installed as part of this project or existing cables installed prior to this project.
      ii. If the damaged cable is a backbone or outside plant cable:
         (a) UCB and Engineer shall be informed of the schedule for the removal and re-pull.
         (b) The new cable shall be tested on the reel prior to installation.
      iii. All test results shall be provided to the Engineer for approval.
   b) The damaged cable shall be removed and the new cable shall be pulled in.
   c) After the removal of the damaged cable and re-pull of the new cable:
      i. The new cable shall be tested.
      ii. Any cables which are in the same conduit, duct or innerduct as the damaged cable shall be tested, regardless of whether or not they are new cables installed as part of this project or existing cables installed prior to this project.
      iii. All test results shall be provided to the Engineer for approval.
   d) Existing cables which are in the same conduit, duct or innerduct as the damaged cable, and which are damaged by the extraction and re-pull process, shall be removed and replaced at no additional cost to UCB.
i. Existing damaged cables that are replaced shall be subject to the testing procedures of this section in its entirety.

2) The contractor shall perform pre-testing of the installed telecommunications systems to determine compliance and notify UCB ITS personnel when the system is ready for final inspection and testing. UCB shall be obligated to schedule final inspection and testing within five (5) business days of notification by the contractor. Final testing shall be scheduled and conducted in the presence of the UCB ITS representative.

3.03 IDENTIFICATION AND ADMINISTRATION

A. General
1. The UCB standard outlet numbering plan to be used for labeling faceplates, 66-blocks, patch panels, and fiber terminations shall be as described in UCB document *Labeling and Testing*.
2. The Contractor is solely responsible for the completeness, accuracy, and placement of identifiers (labels). Incorrectly identified components are the sole responsibility of the Contractor.
   a. Identification and labeling for all copper and fiber optic cable terminations shall be coordinated with UCB ITS staff.
   b. Where questions arise regarding the correct identifier for a given component, the Contractor shall notify UCB ITS and Engineer and await direction prior to proceeding.
3. The Contractor shall install identifiers where indicated and at locations for best viewing convenience without interfering with the operation and maintenance of equipment.
4. The Contractor shall coordinate names, abbreviations, colors, and other designations with the corresponding designations indicated in the Construction Documents and as required by UCB, codes and standards.
5. The Contractor shall use consistent identifiers throughout the Project.
6. The Contractor shall clean surfaces of dust, loose material, and oily films before applying self-adhesive identifiers.
7. All copper and fiber optic cables shall be neatly and permanently labeled with the cable number at both ends.
8. Two weeks prior to a particular component or group of components being labeled, the Contractor shall review the proposed identification scheme, label(s), and procedure for affixing label(s) with UCB and Engineer. Contractor shall not proceed with labeling until UCB and Engineer have approved the proposed identification scheme, label(s), and procedure for affixing label(s).
9. The Contractor shall physically verify that the component to be identified matches the label to be affixed, prior to affixing the label.

B. The telecommunications rooms and spaces shall be labeled and 3 weeks prior to testing, including the outlet numbers on the patch panels as soon as the racks are installed) to allow pre-inspections.

C. UCB Jack Numbering Spreadsheet
1. Contractor shall complete UCB-provided T-5 template for Jack Numbering within 2 weeks of award. Additional T-5 lists shall be submitted to UCB for more than 5 additions or 5 deletions throughout the Project.
2. Contractor shall submit an updated UCB T-5 template three weeks prior to scheduled move-in date. The revised T-5 submittal shall incorporate any changes from the original project design.
3. Contractor shall submit an updated UCB T-5 template one week prior to occupancy, or as agreed on per the project schedule with UCB ITS. The T-5 template shall be provided in hard copy and electronic copy.
SECTION 27 40 00
AUDIOVISUAL - GENERAL REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY
A. This Section provides supplemental information to Division 27 Specification Section Basic Communications Requirements.
B. Provide all labor, materials, equipment, tools and services required for the installation of the Audiovisual Systems.

1.02 RELATED SECTIONS
A. Division 27 Specification Section Common Work - Sleeves, Penetrations and Firestopping. Provide sleeves, penetrations, and firestopping as required to support the work of this Section.
B. Division 27 Specification Section Common Work – Hangers and Supports. Provide hangers and supports as required to support the work of this Section.

1.03 SUBMITTALS
A. Provide the following per the criteria set forth for Submittals in Division 27 Specification Section Basic Communications Requirements:
1. Product Data
2. Shop Drawings

1.04 RECORD DOCUMENTS
A. Provide Record Documents per the criteria set forth for Record Documents in Division 27 Specification Section Basic Communications Requirements.

1.05 OPERATION AND MAINTENANCE MANUALS
A. Provide Operation and Maintenance Manuals per the criteria set forth for Operation and Maintenance Manuals in Division 27 Specification Section Basic Communications Requirements.

PART 2 - MATERIALS

2.01 THIS SECTION NOT USED

PART 3 - EXECUTION

3.01 GENERAL
A. Work shall comply with the Governing Requirements as defined in Division 27 Specification Section Basic Communications Requirements. Governing Requirements of particular relevance to this Section include, but are not limited to:
1. IEEE C62.41: Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits
2. UL 1449: Transient Voltage Surge Suppressors

3.02 SOFTWARE IMPLEMENTATION
A. The Contractor shall provide all software implementation as required to provide a fully functional and operating system ready for the Owner’s use. Software implementation shall include but not be limited to programming, configuration, modification, integration of
other systems, integration of exist systems, data entry and installation. Existing Audiovisual Systems shall be incorporated into new/expansion systems, as required.

3.03 HARDWARE CONFIGURATION
   A. The Contractor shall provide all hardware configurations as required to provide a fully functional and operating system ready for the Owner’s use. Hardware configuration shall include but not be limited to firmware configuration, data communication, system settings, power distribution and installation. Existing Audiovisual Systems shall be incorporated into new/expansion systems, as required.

3.04 INSTALLATION
   A. Pathways: Prior to installation of Audiovisual cabling, Contractor shall verify conduit sizing and quantity for correctness. Deviations from design documents shall be documented and Contractor shall contact Engineer with notification of deviation.
   B. Cabling:
      1. Circuits shall be physically separated by metal raceway or by a minimum distance of six inches when metal raceway is not applicable. Circuit separation shall be based upon signal level:
         a. Audio circuits -20dBm or less – Microphone signal
         b. Audio circuits -20dBm thru +20dBm - Line level audio
         c. Audio circuits +20 or above – Loudspeaker signal
         d. Video circuits: 1 volt
         e. Computer data circuits: 1 volt
         f. Direct current power circuits: 1 – 24 volts
      2. Cable pulls shall be conducted within the following requirements:
         a. Manufacturer’s guidelines for pulling tension and bend radii.
         b. Circuit separation.
         c. NEC conduit fill standards. The Contractor shall notify Engineer prior to cable installation when the conduits are found to be undersized.
         d. Any cable found to be faulty due to poor cable pull practices shall be removed and replaced at no additional cost to Owner.
      3. Cable splicing shall not be considered a common installation practice. If necessary, splice cables only in junction boxes or racks. Shielded cables shall not be spliced; instead each end shall be terminated with an appropriate connector to maintain shield continuity. Any cable found to be faulty due to splicing shall be removed and replaced at no additional cost to Owner.
      4. The Contractor shall dress all cables at both ends with:
         a. Black heat shrink where jacketing has been stripped away to expose the individual conductors
         b. Clear heat shrink around the exposed shield conductor (Coax excluded)
         c. Printed, adhesive labels with clear heat shrink over each label
      5. Contractor shall make all terminations with rosin-core solder, crimp/compression type connectors or captive screw type mechanical connections. For captive screw type mechanical connection, use spade type or ferrule type crimp connections. Bare wire terminations are not acceptable.
   C. Equipment:
      1. Equipment shall be installed as indicated and specified, and in accordance with the manufacturer’s recommendations, except where local codes or regulations take precedence.
      2. Place equipment labels or other identification where the label or identification can be easily seen and read without difficulty.
      3. Equipment shall be installed level, plumb, parallel, and perpendicular to building structures and to other building systems and components, except where otherwise indicated.
      4. Equipment shall be securely fastened. Select fasteners and supports so that the load applied to any one fastener maintains a minimum load factor of five.
5. Equipment locations: Prior to installation of Audiovisual equipment, Contractor shall coordinate with other trades and subsequently verify all equipment locations that mount on walls or within ceilings. This shall include but not be limited to:
   a. Structural elements such as lighting devices, HVAC equipment, fire protection devices, and cable tray
   b. Structural support elements for ceiling mounted devices
   c. Backing Board for wall mounted devices

6. Prior to head-end equipment installation, contractor shall verify equipment rooms are free of airborne contaminants.

7. After head-end equipment installation, contractor shall protect equipment from any future construction work that could cause damage to equipment, i.e. masonry, wood, paint, plumbing, etc.

8. Prior to furniture work, Contractor shall coordinate with other trades and subsequently verify all equipment locations that mount within furniture.

9. Contractor shall coordinate with architect as to any equipment color and finish requirements.

D. Grounding:
1. Contractor shall follow accepted engineering practices when installing the Audiovisual grounding system. The Audiovisual grounding system installation shall conform to NEC. The Contractor shall be responsible for correcting any signal grounding problems within the Audiovisual system (not Division 16 grounds) including but not limited to electromagnetic/electrostatic hums, ground loop anomalies, and distortions.

2. A grounding buss bar shall be installed in each equipment rack. The copper buss bar shall be sized to accommodate all connections plus future expansion.
   a. An insulated copper conductor properly sized shall bond the equipment rack buss bar to the dedicated ground conductor provided by Division 16.
   b. A “Star Type” grounding network shall be established within the equipment rack. All Audiovisual components shall be grounded to this buss bar. Ground all components according to the following methods:
      1) Equipment having a power cord without a grounding conductor connected to chassis: furnish and install 14 AWG grounding conductor from component’s metallic chassis to grounding buss bar within rack.
      2) Equipment having a power cord with grounding conductor connected to chassis: do not install an additional grounding conductor.
      3) Physically isolate all rack mounted equipment from racks with isolation washers.

3. Shielded audio signal cables shall have the shields terminated at one end only. The non-terminated shield conductor shall be trimmed to a length of 1/4 inch, folded back against the cable jacketing and covered with black heat shrink.

4. All ungrounded equipment, such as microphones, shall have the shielding terminated at both ends with only one end connected to ground.

5. All Video and Data shielded cables shall have the shielded conductors terminated on both ends.

E. Structural Installations
1. Structural support elements:
   a. Structural support elements are defined as those materials added to structure for the reinforcement of general construction methods to meet a designed minimum load factor of five. These include but are not limited to:
      1) Backing boards required for the support of Audiovisual equipment or cabling
      2) Strut supports hung from structural beams or concrete slab
   b. It is the Electrical Contractor’s responsibility to provide structural support elements for the Audiovisual equipment.
c. The Contractor shall provide all Audiovisual mounting and rigging equipment that fasten to the structural support elements.
d. All support elements and fastenings shall be able to support a minimum load factor of five times the total assembled weight.
e. The Contractor shall be responsible for the complete and correct installation of all the Audiovisual equipment.

2. Hard Ceiling Loudspeaker Locations:
a. Hard ceiling loudspeaker locations requiring trim rings, rough-in brackets loudspeaker back boxes shall be installed during conduit installation.
b. The Contractor shall install the trim rings, rough-in brackets and back boxes for hard ceiling locations in a timely manner, not to conflict with scheduled work of other trades. In the event that this equipment is not installed in a timely manner, the Contractor shall be responsible for all retrofit work and materials to provide a full functioning speaker assembly.
c. It is the Contractor's responsibility to coordinate installation with other trades.

3.05 TESTING

A. Performance Standards

1. Audio
   a. Electrical Requirements
      1) Frequency response: 20 Hz - 20KHz at ±1.0 dB
      2) Total harmonic distortion + noise: 20 Hz - 20KHz at ±1.0 percent dB
      3) Signal to noise ratio with crosstalk: minimum 55dB at 20 Hz – 20 KHz
   b. Acoustical Requirements
      1) Sound pressure levels shall evenly cover the audience area without audible distortions, hums, noise, rattles or buzzes.
         a) Nominal program material: 85 dB at ±2.0 dB
         b) Nominal speech material: 85 dB at ±2.0 dB
         c) Maximum sound pressure level: 100 dB at ±2.0 dB
         d) Contractor shall make final loudspeaker sound pressure level adjustments according to owner’s recommendations determined during acceptance testing.
      2) Frequency Response:
         a) Speech reinforcement: uniform response from 125 Hz – 2 KHz at ± 2 dB. Below 125Hz, roll off 6 dB/octave. Above 2 KHz, roll off 3 dB/octave.
         b) Program reinforcement: uniform response from 63Hz – 2.5 KHz ± 2 dB. Below 63 Hz, roll off appropriate to loudspeaker specification. Above 2.5 KHz, roll off 3 dB/octave.

2. Video
   a. Electrical Requirements
      1) Signal strength: minimum 70 I.R.E. with 100 percent SMPTE white reference level.
      2) Signal to noise ratio: minimum 55dB at 0 Hz - 4.2 MHz
      3) Crosstalk: minimum 45dB at 0 Hz - 4.2 MHz
      4) Frequency response: ±0.5 dB at 0 Hz - 4.2 MHz
      5) Line and field tilt: 2 percent maximum
      6) Differential gain: 3 percent maximum
      7) Differential phase: 2 degrees maximum
      8) Sync: 50 μseconds maximum
   b. Optical
      1) The projection system including projection screen, projector and mirrors shall be securely installed. No physical movement or vibration in projection system shall be acceptable.
2) Projector light levels: ±15 percent output in lumens of projector specifications
3) Projector light coverage: ±20 percent uniform light coverage within all areas of projection screen.

B. Operational Testing
1. Prior to system training and acceptance testing, the Contractor shall perform and document operational testing.
2. Contractor shall assemble the following test equipment:
   a. Ground fault indicator
   b. Digital Multi-meter
   c. Load resistors:
      1) Microphone load: 150 ohm, shielded, terminating resistors
      2) Line load: 600 ohm, shielded, terminating resistors
      3) Loudspeaker load: varies, match impedance measurements within 10 percent
   d. Sine Wave Generator:
      1) Continuously variable from 20Hz – 20kHz with level accuracy of 0.5dBu
      2) Level Range: -35 dBu to 26 dBu.
      3) Total Harmonic Distortion: 0.01 percent
   e. Pink Noise Generator
      1) Noise frequency: 20Hz – 20kHz, 1/3 octave band filtered
      2) Level Range: -35 dBu to 26 dBu.
      3) Total Harmonic Distortion: 0.01 percent
   f. Sound level meter meeting ANSI S1.4 specifications
   g. Polarity tester
   h. Impedance meter: Accuracy, 1 ohm – 8000 ohms, ±10 percent, 20Hz – 20kHz
   i. Oscilloscope: minimum of 20 MHZ bandwidth
   j. Real-time spectrum or fast fourier transform analyzer:
      1) Filters: ANSI compliant with 1/3 octave band filtering
      2) Frequency range: 20Hz to 22Khz
      3) Frequency accuracy: ± 0.5 dB, 20 Hz to 22kHz
      4) Level range: 25 dB to 140 dB
      5) Level accuracy: ± 0.1 dB
   k. Distortion analyzer: THD minimum 0.02 percent with accuracy of 5 percent of reading.
   l. Video generator: SMTPE color bar, multi-burst, and full white patterns
   m. Light meter: measurements in foot-candles and lux. Accuracy: 3 percent.
   n. Waveform monitor
   o. Vectorscope
3. Nominal test signals:
   a. Level
      1) Microphone level: -50dBu
      2) Unbalanced line level: -10dBV
      3) Balanced line level: +4dBu
   b. Frequency:
      1) Full-range frequency loudspeaker networks: 1000Hz sine wave
      2) Crossover loudspeaker networks: apply a sine wave with a frequency centered within the frequency band of the signal path under test.
4. Field Measurements:
   a. Prior to any connections being made to building power, Contractor shall use a ground fault indicator to verify the circuits provided have proper ground wiring. Notify Owner upon discovery of any faulty wiring. In no way is Contractor to perform any work on any faulty electrical wiring discovered.
b. Contractor shall produce a checklist for the testing and documentation of all Audiovisual equipment. Each device shall be verified for proper operation.

c. Contractor shall correct any defects upon discovery. Contractor shall notify and coordinate with other trades to ensure all defects (including those by other trades that affect the Audiovisual system) are corrected and put into working order.

d. Impedance testing: Measure and document impedance level of each loudspeaker cable entering equipment rack.
   1) Full-range frequency networks: measure impedance at 1000Hz.
   2) Crossover networks: measure impedance at center frequency for frequency band of loudspeaker network under test.

5. Audio System Measurements

a. The following procedures are the minimum requirements for this testing section. These procedures are guidelines only; refer to listed reference material for testing criteria. Manufacturer’s recommendations for operation and connectivity of specific test equipment shall be observed for all testing procedures. Perform all applicable procedures and document results.

b. Hum and noise testing: verify system is free of any hums, noises, buzzes, oscillations, or any other anomalies contributing to poor system operation. Correct any defects upon discovery.

c. System Gain Structure

1) The system gain structure shall be configured in such a way as to maximize dynamic range and provide a uniform clipping level across the entire audio system.

   a) References:

2) Contractor shall incorporate signal attenuation and gain devices as necessary to achieve proper system gain structure.

3) Procedure:
   a) Set signal path gains to a minimum while still passing signal.
   b) Set signal path processing equipment except bandpass filters to bypass.
   c) Set signal path volume attenuators to minimum attenuation.
   d) Connect a signal generator to the input of the signal path under test. Set the signal generator to a nominal frequency and level for the signal path under test. Set the input gain stage of the signal path under test to a nominal operating level (0 dB VU or -18 dBFS).
   e) Connect an oscilloscope to the final output of the signal path under test. Terminate the output with a load resistor appropriate for the signal path under test.
   f) Adjust the signal generator level to a maximum level just below clipping as measured on the oscilloscope.
   g) Set all gain stages in the signal path to a maximum level just below clipping as measured on the oscilloscope.
   h) Perform this procedure for all signal paths in the audio system.

4) Documentation:
   a) Document the final level of the signal path under test as measured on the oscilloscope for the signal path’s final settings.
b) Document the signal generator’s output level.

d. Amplifier Gain Structure

1) The amplifier gain structure shall be configured in such a way as to provide full amplifier gain at a maximum system input signal level just before clipping.

a) References:
   ii. John Murray, Sound System Gain Structure (ProSonic Solutions, Woodland Park, CO).

2) Procedure:
   a) Set signal path processing equipment except bandpass filters to bypass.
   b) Set signal path volume attenuators to minimum attenuation.
   c) Set the amplifier input attenuator of signal path under test to maximum attenuation.
   d) Connect a pink noise generator to the input of the signal path under test. Set the signal generator to a maximum system signal level just before clipping for the signal path under test.
   e) Terminate the loudspeaker network to the amplifier output of the signal path under test.
   f) Position a sound pressure level meter measurement microphone on-axis with the loudspeaker under test.
   g) Adjust the amplifier input attenuation of the loudspeaker network under test until one of the following conditions is reached:
      i. Amplifier maximum output level: the point at which the amplifier output signal begins to clip. Increase the amplifier input attenuation to achieve an output level just below signal clipping.
      ii. Loudspeaker maximum sound pressure level: the point at which further decrease of input attenuation has negligible effect upon the loudspeaker’s sound pressure levels. Increase the amplifier input attenuation to achieve the loudspeaker’s maximum sound pressure level.
      iii. Acoustic maximum sound pressure level: the point at which the loudspeaker sound pressure level measures the specified maximum sound pressure level as defined in the performance standards.

3) Documentation:
   a) Document the amplifier input attenuation settings for the signal path under test.
   b) Document the sound pressure level of the loudspeaker under test.

e. Signal to Noise

1) The signal to noise testing shall be conducted to determine the amount of noise present in the audio system referenced to a nominal operating input signal.

a) References:
2) Procedure:
   a) Set signal path processing equipment except bandpass filters to bypass.
   b) Set signal path volume attenuators to minimum attenuation.
   c) Connect a voltmeter to the output of the signal path under test. Terminate the output with a load resistor appropriate for the signal path under test.
   d) Connect a signal generator to the input of the signal path under test. Set the signal generator to a nominal frequency and level for the signal path under test.
   e) Replace signal generator with load resistor appropriate for signal path under test.

3) Documentation:
   a) Document the level as measured on the voltmeter with the signal generator connected to the input of the signal path under test.
   b) Document the level as measured on the voltmeter with a load resistor connected to input of the signal path under test.

f. Frequency Response
1) The frequency response testing shall be conducted to determine the bandwidth of the audio system.
   a) References:

2) Procedure:
   a) Set signal path processing equipment except bandpass filters to bypass.
   b) Set signal path volume attenuators to minimum attenuation.
   c) Connect a signal generator to the input of the signal path under test. Set the signal generator to a nominal frequency and level for the signal path under test.
   d) Connect a voltmeter to the output of the signal path under test. Terminate the output with a load resistor appropriate for the signal path under test. Calibrate the voltmeter to 0 volts.
   e) Sweep the signal generator frequency from 20Hz to 20kHz.
   f) Perform this procedure for all signal paths in the audio system.

3) Documentation:
   a) Document all frequencies that deviate from the performance standards.

g. Total Harmonic Distortion + Noise
1) The total harmonic distortion testing shall be conducted to determine the linearity of the audio system.
   a) References:
2) Procedure:
   a) Set signal path processing equipment except bandpass filters to bypass.
   b) Set signal path volume attenuators to minimum attenuation.
   c) Connect an oscilloscope to the output of the signal path under test. Terminate the output with a load resistor appropriate for signal path under test.
   d) Connect a signal generator to the input of the signal path under test. Set the signal generator to a nominal frequency for the signal path under test. Set the signal generator to a maximum level just before clipping for the signal path under test as measured on the oscilloscope.
   e) Remove the oscilloscope and connect a distortion analyzer to the output of the signal path under test.
   f) Perform this procedure for all signal paths in the audio system.

3) Documentation:
   a) Document the distortion readings as measured on the distortion analyzer for each signal path.

6. Acoustic Measurements
   a. The following procedures are the minimum requirements for this testing section. These procedures are guidelines only; refer to listed reference material for testing criteria. Manufacturer’s recommendations for operation and connectivity of specific test equipment shall be observed for all testing procedures. Perform all applicable procedures and document results.
   b. Perform testing procedures as applicable for the audio system under test.
   c. Hum and noise testing: verify the system is free of any hums, noises, buzzes, oscillations, or any other anomalies contributing to poor system operation. Correct any defects upon discovery. Contractor shall notify and coordinate with other trades to suppress any structural vibrations and noises cause by audio system.
   d. Polarity
      1) Polarity testing shall be conducted to determine the phase discrepancies within the sound system cabling.
         a) References:
      2) Procedure:
         a) Set signal path processing equipment except bandpass filters to bypass.
         b) Set signal path volume attenuators to minimum attenuation.
         c) Connect the polarity test equipment to the signal path input under test.
         d) Measure polarity on-axis to the loudspeaker under test.
         e) Correct any deficiencies upon discovery.
         f) Perform this procedure for all signal paths in audio system.
   e. Delay
1) Delay setting shall be configured to compensate for the differing arrival times of the initial sound sources versus the audio system.
   a) References:
         (Focal Press, Boston, 2002).
         (Focal Press, Boston, 1997).

2) Procedure:
   a) Set signal path processing equipment except bandpass to bypass.
   b) Set signal path volume attenuators to minimum attenuation.
   c) Set the loudspeaker delay times as follows:
      i. Speech reinforcement systems: set the delay to achieve loudspeaker arrival time consistence with the speech source arrival time.
      ii. Performance reinforcement systems: set the delay to achieve loudspeaker arrival time consistence with performance source arrival time.
      iii. Video reinforcement systems: set the delay to achieve loudspeaker arrival time consistence with the synchronization of video imagery at a listening position approximate to the center of the viewing area.

3) Documentation:
   a) Document the delay settings for all loudspeaker networks.

f. Loudspeaker Frequency Response
1) The frequency response of the loudspeakers shall be configured utilizing the audio system equalizers to provide an acoustic frequency response as defined within the Performance Standards section.
   a) References:
         (Focal Press, Boston, 2002).
      ii. John Murray, Sound System Equalization (ProSonic Solutions, Woodland Park, CO).

2) Procedure:
   a) Set signal path processing equipment except bandpass filters and system equalization to bypass.
   b) Set signal path volume attenuators to minimum attenuation.
   c) Connect a pink noise generator to the input of the signal path under test. Set the pink noise generator to a nominal level for signal path under test.
   d) Position the measurement microphone at an optimal testing position for loudspeaker under test.
   e) Utilize a real-time spectrum or fast fourier transform analyzer to measure the frequency response of the loudspeaker under test.
   f) Frequency Response Settings:
      i. Loudspeaker bandpass frequencies: set the bandpass filters to achieve frequency response as specified in the performance standards.
ii. Loudspeaker equalization: set equalization to achieve frequency response as specified in the performance standards.

g) Perform this procedure for all loudspeaker networks in audio system.

3) Documentation:
   a) Document the frequency response for all loudspeaker networks.

Microphone Frequency Response

1) The frequency response of the microphones shall be configured utilizing audio system equalizers to provide an acoustic frequency response as defined within the Performance Standards section.

   a) References:
      ii. John Murray, Sound System Equalization (ProSonic Solutions, Woodland Park, CO).

2) Procedure:
   a) Set signal path processing equipment except bandpass filters and system equalization to bypass.
   b) Set signal path volume attenuators to minimum attenuation.
   c) Connect a pink noise generator to the microphone input of the signal path under test. Set the pink noise generator to a nominal level for signal path under test.
   d) Position the measurement microphone at an optimal testing position for loudspeaker under test.
   e) Utilize a real-time spectrum or fast fourier transform analyzer to measure the frequency response of the loudspeaker under test.
   f) Frequency response settings:
      i. Microphone bandpass frequencies: set the bandpass filters to achieve frequency response as specified in the performance standards.
      ii. Microphone equalization: set equalization to achieve frequency response as specified in the performance standards.
   g) Perform this procedure for all microphone signal paths in audio system.

3) Documentation:
   a) Document the frequency response for all loudspeaker networks under test.

Feedback

1) The audio system shall be configured utilizing the audio system equalizers to provide the most gain before feedback.

   a) References:

2) Procedure:
   a) Set signal path processing equipment except bandpass filters and system equalization to bypass.
b) Set signal path volume attenuators to maximum attenuation.
c) Connect a pink noise generator to a system input. Set the pink noise generator to a nominal level for signal path under test.
d) Position the system microphone at a typical operator location.
e) Utilizing a microphone signal splitter, connect the system microphone under test to both a frequency analyzer and the microphone input of the signal path under test.
f) Utilize a real-time spectrum or fast fourier transform analyzer to measure the frequency response of the system microphone under test.
g) Adjust signal path volume attenuators to increase the loudspeaker sound pressure levels until the audio system reaches feedback.
h) Measure the feedback frequency.
i) Mute the audio system.
j) Frequency response settings:
i. Set the system equalization to eliminate the feedback frequency.
ii. Perform this procedure for the microphone signal path under test until multiple frequencies feedback simultaneously.
k) Perform this procedure for all microphone signal paths in the audio system.

i. Loudspeaker Coverage
1) The audio system shall be configured to provide uniform sound pressure levels within the audience areas.
   a) References:

2) Procedure:
   a) Connect a pink noise generator to a system input. Set the pink noise generator to a nominal level for the signal path under test.
   b) Utilize a sound pressure level meter to measure the uniformity of the loudspeaker coverage of the audience areas at listening heights.
   c) Correct any deficiencies in the loudspeaker coverage that deviate from that specified in the performance standards.

3) Documentation:
   a) Document deviations from that specified in the performance standards.

j. Reverberation
1) Measure the reverberation response of the room under test.
   a) References:

2) Procedure:
   a) Set signal path volume attenuators to minimum attenuation.
   b) Connect a pink noise generator to a system input. Set the pink noise generator to a nominal level for signal path under test.
c) Position the measurement microphone within the center of the audience area.
d) Energize system loudspeakers to the nominal sound pressure level as specified in the performance standards.
e) Remove all signals from the loudspeakers.
f) Utilize a real-time spectrum or fast fourier transform analyzer to measure the required time for all frequencies to fall below the ambient noise level.

3) Documentation:
a) Document the reverberation time.
b) Document the ambient noise level.

7. Video System Measurements
a. The following procedures are the minimum requirements for this testing section. These procedures are guidelines only; refer to listed reference material for testing criteria. Manufacturer’s recommendations for operation and connectivity of specific test equipment shall be observed for all testing procedures. Perform all applicable procedures and document results.
b. Test all video signal paths with field connection points, field cabling and video equipment in place.
   1) Multi-conductor cabling:
      a) Test all the conductors in the same manner as a single composite conductor.
      b) Document the worst performing conductor of the multi-conductor cable. Performance of the remaining conductors shall be assumed to exceed performance of documented conductor.
   c. Noise and distortion testing: During the following procedures, verify system is free of any visual noises, oscillations, ground loop distortion or any other anomalies contributing to poor system operation. Correct any defects upon discovery.
   d. Insertion Gain
      1) The insertion gain test shall be performed to verify the amplitude continuity of the video signal path.
         a) References:
      2) Procedure:
         a) Connect a video generator to the input of the signal path under test.
         b) Apply the “SMPTE color bar” test pattern.
         c) Connect a waveform monitor to the output of the signal path under test.
         d) Perform this procedure for all signal paths in video system.
      3) Documentation:
         a) Document the following as measured of the waveform monitor:
            i. White level.
            ii. Black levels.
            iii. Blanking levels.
            iv. Sync levels.
            v. Sync pulse.
   e. Frequency Response
      1) The frequency response test shall be performed to verify the uniform amplitude response as a function of frequency.
         a) References:

2) Procedure:
   a) Connect a video generator to the input of the signal path under test.
   b) Apply the “multi-burst” test pattern.
   c) Connect a waveform monitor to the output of the signal path under test.
   d) Perform this procedure for all signal paths in the video system.

3) Documentation:
   a) Document the amplitude level of each frequency burst packet.

f. Optical
   1) The light measurements shall be taken to verify the projector light output for uniformity, brightness and contrast.
   2) Procedure:
      a) Connect a video generator to the input of the signal path under test.
      b) Apply the “full white” test pattern.
      c) Utilizing a light meter, measure light output of projector under test.
      d) Perform this procedure for all projectors in the video system.
   
3) Documentation:
      a) Document the ambient light levels at center of projection screen.
      b) Document the projector light levels at center of projection screen.
      c) Document the projector light levels at corners of projection screen.

C. Acceptance Testing
1. System acceptance testing shall not be conducted until all final “as-built” drawings, manuals and operational testing have been completed and the documentation has been submitted for Engineer’s review.
2. Acceptance testing shall be conducted with Contractor, Engineer, and Owner in attendance.
3. Contractor shall demonstrate that all components of the Audiovisual Systems are in proper working order and are in accordance with specifications.
4. At time of acceptance testing, all items found to be outside of specification requirements; Owner requirements, code requirements or general installation practices shall be added as new items to the final Punch List. All items found outside of specification requirements shall be put into working order prior to final acceptance of system.
5. The Contractor shall assemble an inventory of installed equipment. This inventory shall be compiled at time of acceptance testing and compared to equipment listed in contractual documents.
6. Acceptance testing may be suspended by Engineer if Audiovisual Systems are not complete and operable, equipment failure occurs, or installation is not in accordance with specifications. Contractor shall be responsible for any cost incurred by Engineer for additional site visits required to complete acceptance testing.

END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY
A. This Section defines the Audiovisual System requirements for Audiovisual Systems within Architectural Spaces.

1.02 RELATED SECTIONS
A. The requirements of Division 27 Specification Section Audiovisual General Requirements shall serve as the basis for the requirements of this Section, and are incorporated by reference into this Section.

1.03 SYSTEM DESCRIPTION
A. Audiovisual System in the Meeting Room(s): The functionality of the Audiovisual System within this space is to include but not be limited to the reinforcement of the presenter’s spoken word and the reinforcement of audio / video program material. The Audiovisual System within this space shall include but not be limited to the following system(s):

1. The Video System(s) shall provide reinforcement and distribution of live and program source material to audience members within this space. This system shall include but not be limited to the following:
   a. Video Display System: The Video Display System shall include but not be limited to a wall mounted flat panel display, video processing equipment capable of processing multiple inputs / outputs of differing formats, and source equipment.
   b. Video Projection System: The Video Projection System shall include but not be limited to a permanently mounted projector, video processing equipment capable of processing multiple inputs / outputs of differing formats, and source equipment.

2. The Audio System(s) shall provide reinforcement and distribution of live and program source material to audience members within this space. This system shall include but not be limited to the following:
   a. Sound Reinforcement System: The Sound Reinforcement System shall include but not be limited to overhead and wall loudspeakers spaced evenly throughout audience area to provide uniform coverage, audio processing equipment capable of processing multiple inputs / outputs of differing signal levels, microphone(s) and source equipment. This system shall have separate loudspeaker networks each capable of individual equalization and level control.
   b. Assistive Listening System: The Assistive Listening System shall provide sound reinforcement and distribution of live and program source equipment to individual listeners via an RF transmission to personal listening devices. This system shall include but not be limited to transmitters, receivers, antennas and headphones.

3. Room Combining System: The Room Combining System shall provide combining / separation of the Audiovisual System across multiple rooms. This system shall consist of but not be limited to special equipment / functionality programmed or configured within the Audio, Video and Control Systems to provide a full functional and operating system ready for Owners use.

4. The Control System shall provide a seamless control process to unify the Audiovisual System. This system shall consist of but not limited to a programmable control processor capable of multiple control protocols and a touch sensitive type control interface panel. The Control System shall provide full operation of the Audiovisual System.
a. The Contractor shall coordinate with the Owner and the Engineer for the Control System operation and functionality requirements. The Contractor shall schedule a minimum of (2) Two Control System design meetings in which the Owner and/or Engineer shall be in attendance. These meetings shall establish the basis of the Control System programming requirements. The Control System design meetings shall be scheduled in a time manner as to not delay the completion of the Audiovisual System. Items to coordinate shall include but not be limited to:

1) Control interface panel appearance
2) Control interface panel operation and functionality
3) Control System synchronized operations of multiple devices including but not limited to:

a) Video display operation:
   i. Upon power-on:
   ii. The video display shall power-on
   iii. The audio / video switcher shall default to the display’s “first position” preset (coordinate with Owner to determine “first position” default requirements)
   iv. Upon power-off:
   v. The display shall power-off
   vi. The source audio associated with the display shall be remove from the Sound Reinforcement System unless otherwise noted or directed by Owner
   vii. The associated source equipment shall stop/pause (as applicable)

b) Projector operation:
   i. Upon power-on:
   ii. The projector shall power-on
   iii. The audio / video switcher shall default to the projector’s “first position” preset (coordinate with Owner to determine “first position” default requirements)
   iv. Upon power-off:
   v. The projector shall power-off
   vi. The source audio associated with the projector shall be remove from the Sound Reinforcement System unless otherwise noted or directed by Owner
   vii. The associated source equipment shall stop/pause (as applicable)
   viii. Upon video mute:
   ix. The projector shall remain on while removing light output
   x. The source audio associated with the projector shall be remove from the Sound Reinforcement System unless otherwise noted or directed by Owner
   xi. The associated source equipment shall stop/pause (as applicable)

c) Source equipment operation
   i. Upon source selection:
   ii. The A/V switcher shall route the selected source signal to the appropriate reinforcement equipment.
iii. The projector shall select the appropriate input and the image adjustment feature shall sync the projector to the appropriate input resolution.

iv. The Sound Reinforcement System shall route selected audio signal to appropriate reinforcement equipment.

v. The control features of the selected source shall become available on touch panel. Control feature shall include but not be limited to play, stop, pause, rewind, fast forward, function selection, channel selection and menu navigation.

4) Network control features:
   a) The control system shall be available over the network via a web server. The web based control page shall have all the same control features as that available at the physical control interface.
   b) The control system shall be managed via the network utilizing a newly provided and configured management software system.

5) Event scheduling features:
   a) The control system shall provide event scheduling for the audiovisual system. Coordinate operation and event times with owner.
   b) Event scheduling shall include but not be limited to:
      i. Audiovisual System power-on
      ii. Audiovisual System power-off

b. The Contractor shall demonstrate the Control System functionality to the Owner prior to acceptance testing for evaluation. Any modifications required by the Owner shall be incorporated into the Control System prior to Acceptance Testing.

5. The Transmission System shall be a traditional cable based system. This system shall consist of but not be limited to coax cable, shielded twisted pair cable, unshielded twisted pair and interface plates. Cable shall be installed and terminated to the manufacturer’s recommendations.

6. Racking System
   a. Floor Standing Rack: A floor standing rack shall be provided to house the majority of the audiovisual equipment. The floor standing rack shall be a pivoting type rack with a lockable front door. The Contractor shall provide non-conductive conduit bushing to isolate rack from conduit. The Contractor shall provide a power distribution and thermal dissipation system within the rack.

B. Audiovisual System in the Computer Lab: The functionality of the Audiovisual System within this space is to include but not be limited to the reinforcement of the presenter’s spoken word and the reinforcement of audio / video program material. The Audiovisual System within this space shall include but not be limited to the following system(s):

1. The Video System(s) shall provide reinforcement and distribution of live and program source material to audience members within this space. This system shall include but not be limited to the following:
   a. Video Projection System: The Video Projection System shall include but not be limited to a permanently mounted projector, video processing equipment capable of processing multiple inputs / outputs of differing formats, and source equipment.

2. The Audio System(s) shall provide reinforcement and distribution of live and program source material to audience members within this space. This system shall include but not be limited to the following:
   a. Sound Reinforcement System: The Sound Reinforcement System shall include but not be limited to overhead and wall loudspeakers spaced
evenly throughout audience area to provide uniform coverage, audio processing equipment capable of processing multiple inputs / outputs of differing signal levels, microphone(s) and source equipment. This system shall have separate loudspeaker networks each capable of individual equalization and level control.

b. Assistive Listening System: The Assistive Listening System shall provide sound reinforcement and distribution of live and program source equipment to individual listeners via an RF transmission to personal listening devices. This system shall include but not be limited to transmitters, receivers, antennas and headphones.

3. The Control System shall provide a seamless control process to unify the Audiovisual System. This system shall consist of but not limited to a programmable control processor capable of multiple control protocols and a touch sensitive type control interface panel. The Control System shall provide full operation of the Audiovisual System.

a. The Contractor shall coordinate with the Owner and the Engineer for the Control System operation and functionality requirements. The Contractor shall schedule a minimum of (2) Two Control System design meetings in which the Owner and/or Engineer shall be in attendance. These meetings shall establish the basis of the Control System programming requirements. The Control System design meetings shall be scheduled in a time manner as to not delay the completion of the Audiovisual System. Items to coordinate shall include but not be limited to:

1) Control interface panel appearance
2) Control interface panel operation and functionality
3) Control System synchronized operations of multiple devices including but not limited to:
   a) Projector operation:
      i. Upon power-on:
      ii. The projector shall power-on
      iii. The audio / video switcher shall default to the projector’s “first position” preset (coordinate with Owner to determine “first position” default requirements)
      iv. Upon power-off:
      v. The projector shall power-off
      vi. The source audio associated with the projector shall be remove from the Sound Reinforcement System unless otherwise noted or directed by Owner
      vii. The associated source equipment shall stop/ pause (as applicable)
      viii. Upon video mute:
      ix. The projector shall remain on while removing light output
      x. The source audio associated with the projector shall be remove from the Sound Reinforcement System unless otherwise noted or directed by Owner
      xi. The associated source equipment shall stop/ pause (as applicable)

b) Source equipment operation
   i. Upon source selection:
   ii. The A/V switcher shall route the selected source signal to the appropriate reinforcement equipment.
iii. The projector shall select the appropriate input and the image adjustment feature shall sync the projector to the appropriate input resolution.

iv. The Sound Reinforcement System shall route selected audio signal to appropriate reinforcement equipment.

v. The control features of the selected source shall become available on touch panel. Control feature shall include but not be limited to play, stop, pause, rewind, fast forward, function selection, channel selection and menu navigation.

4) Network control features:

a) The control system shall be available over the network via a web server. The web based control page shall have all the same control features as that available at the physical control interface.

b) The control system shall be managed via the network utilizing a newly provided and configured management software system.

c) The Contractor shall demonstrate the Control System functionality to the Owner prior to acceptance testing for evaluation. Any modifications required by the Owner shall be incorporated into the Control System prior to Acceptance Testing.

4. The Transmission System shall be a traditional cable based system. This system shall consist of but not be limited to coax cable, shielded twisted pair cable, unshielded twisted pair and interface plates. Cable shall be installed and terminated to the manufacturer's recommendations.

5. Racking System

a. Floor Standing Rack: A floor standing rack shall be provided to house the majority of the audiovisual equipment. The floor standing rack shall be a pivoting type rack with a lockable front door. The Contractor shall provide non-conductive conduit bushing to isolate rack from conduit. The Contractor shall provide a power distribution and thermal dissipation system within the rack.

C. Audiovisual System in the Events/Reception: The functionality of the Audiovisual System within this space is to include but not be limited to the reinforcement of audio / video program material. The Audiovisual System within this space shall include but not be limited to the following system(s):

1. The Video System(s) shall provide reinforcement and distribution of live and program source material to audience members within this space. This system shall include but not be limited to the following:

   a. Video Display System: The Video Display System shall include but not be limited to a wall mounted flat panel display, video processing equipment capable of processing multiple inputs / outputs of differing formats, and source equipment.

2. The Audio System(s) shall provide reinforcement and distribution of live and program source material to audience members within this space. This system shall include but not be limited to the following:

   a. Sound Reinforcement System: The Sound Reinforcement System shall include but not be limited to overhead and wall loudspeakers spaced evenly throughout audience area to provide uniform coverage, audio processing equipment capable of processing multiple inputs / outputs of differing signal levels, microphone(s) and source equipment. This system shall have separate loudspeaker networks each capable of individual equalization and level control.
3. Room Combining System: The Room Combining System shall provide combining / separation of the Audiovisual System from Meeting Room 170B. This system shall consist of but not be limited to special equipment / functionality programmed or configured within the Audio, Video and Control Systems to provide a full functional and operating system ready for Owners use.

4. The Transmission System shall be a traditional cable based system. This system shall consist of but not be limited to coax cable, shielded twisted pair cable, unshielded twisted pair and interface plates. Cable shall be installed and terminated to the manufacturer's recommendations.

5. Racking System
   a. Furniture Rack: Furniture with an equipment rack shall be provided to house the rack mounted equipment. Furniture shall provide shelving for equipment and a possible work area for laptops or other items. Connection points into the Audiovisual System shall be provided for auxiliary equipment. Furniture shall be equipped with lockable doors.

PART 2 - MATERIALS

2.01 GENERAL
   A. Manufacturer: Unless otherwise indicated, equipment in this Section shall be the standard products of a manufacturer regularly engaged in the manufacture of such products. All components used in the system shall be commercial designs that comply with the Specifications. Each major component of equipment shall identify the manufacturer’s name, model and serial number. Items of the same classification shall be identical. This includes equipment, modules, parts, and components. The Engineer retains the right to reject products which reflect, in the Engineer’s opinion, sub-standard design practices, manufacturing procedures, support services, or warranty policies.

   B. Part Numbers: Refer to the equipment schedule at the end of this Section for specific part numbers. Part numbers listed in the equipment schedule define the performance specifications for the parts and shall be per the most recent manufacturer’s data sheet available at the time of bid. If no part number is provided, then any part meeting the requirements specified is acceptable.

   C. Provide materials in quantities as required to provide a fully functional and operational Audiovisual System ready for Owner’s use.

   D. Owner Provided Contractor Installed: Refer to the equipment schedule at the end of this Section for procurement requirements. Equipment identified with an “OFCI” shall be provided by Owner for the Contractor to install.

2.02 EQUIPMENT SPECIFICATION
   A. This equipment shall as a minimum conform to the following specifications.

      1. Assistive Listening System
         a. The Assistive Listening System shall utilize a RF/IR Transmitter to distribute audio signal to Personal Listening Devices.
         b. The Transmitter shall be frequency agile and rack mountable.
         c. The Personal Listening Device shall have channel selection, volume control and be battery powered.

      2. Audio Power Amplifier
         a. The audio power amplifier shall provide balanced inputs and voltage transformer outputs.
         b. The audio power amplifier shall have attenuation pads to provide level control.
         c. The audio power amplifiers shall be rack mountable.

      3. Audiovisual Matrix Switcher
         a. The audiovisual matrix switcher shall provide routing of multiple A/V inputs to multiple outputs.
b. The audiovisual switcher shall provide an interface to a control system utilizing data communication.

4. Control Interface
   a. The control interface shall have static hard wired buttons.
   b. The control interface shall be software configurable to accommodate a variety of manufacturers' equipment.

5. Control Interface
   a. The control interface shall be a software programmable touch screen.
   b. The control interface shall be custom programmed by the Contractor to provide a user friendly control interface for the control of the Audiovisual System. Contractor shall coordinate with Owner to determine Control System requirements.
   c. The control interface shall be capable of video and computer image reproduction.
   d. The control interface shall be incorporating the Annotative System the touch screen functionality.

6. Control Processor
   a. The control processor shall be software programmable.
   b. The control processor shall be custom programmed by the Contractor to control all aspect of the Audiovisual System. Contractor shall coordinate with Owner to determine control system requirements.
   c. The control processor shall utilize various communication protocols to control the Audiovisual System components.
   d. The control processor shall provide a web interface for remote system access and control.
   e. The control processor shall be rack mountable.

7. Digital Signal Processor
   a. The digital signal processor shall process multiple input audio signals of both microphone and line level formats.
   b. The digital signal processor shall be capable of routing, mixing, equalization, filtering, and signal level control.
   c. The digital signal processor shall provide automatic mixing of audio signals with suppression of audio echo and noise.
   d. The digital signal processor shall provide an interface to a control system utilizing data communication.
   e. The digital signal processor shall be rack mountable.

8. DVD/VCR Player
   a. The DVD/VCR player shall a combine unit.
   b. The DVD/VCR player shall provide an interface to a control system utilizing infrared communication.
   c. The DVD/VCR player shall be rack mountable.

9. Floor Standing Rack
   a. The floor standing rack shall have a back can that mounts against a structural wall.
   b. The floor standing rack shall have a pivoting rack enclosure for access to rear of rack.

10. Interface Plate
    a. The interface plates unless noted otherwise shall be made of 1/8 inch brushed anodized aluminum with beveled edges, with 1/8 inch high enamel filled lettering.
    b. Coordinated finish requirements with Architect / Owner prior to procurement.

11. Loudspeaker
    a. Ceiling Loudspeaker:
       1) The loudspeaker shall be a passive transducer with a voltage transformer with variable tap selection.
       2) The loudspeaker shall be a ceiling mounted type loudspeaker with appropriate tile bridge, back box and grille.
12. Projector
   a. The projector shall have the capability to reproduce multiple A/V inputs of varying formats.
   b. The projector shall provide image size adjustment and image focusing.
   c. The projector shall provide an interface to a control system utilizing data communication.
   d. The projector shall provide image inversion for ceiling mounting.

13. Projection Screens (Manual)
   a. The projection screen shall be a tab tension type screen.

14. Rack Accessories
   a. Rack accessories shall be made of 11 gauge aluminum and finished in black powder coat.

15. Video Codec (Mobile)
   a. The video codec shall transmit audio / video signal via Ethernet to receiving unit at remote end.
   b. The video codec shall be compatible with most major video codec manufacturers.
   c. The audiovisual switcher shall provide an interface to a control system utilizing data communication.

16. Video Display
   a. The video display shall have the capability to reproduce multiple A/V inputs of varying formats.
   b. The video display shall be an active matrix LCD type display.
   c. The video display shall incorporate speakers for audio reproduction.
   d. The video display shall provide an interface to a control system utilizing data communication.
   e. The video display shall be wall mounted.
   f. The monitor shall incorporate speakers for audio reproduction.

17. 2.03 WIRE AND CABLE

   A. This equipment shall as a minimum conform to the following specifications. Cable conductor and gauge requirements may vary depending on device requirements. Contractor to determine and utilize cables with proper conductor and gauge requirements to provide optimum operation of system devices. Use Plenum equivalent cable as required.
   1. Communication Cable: This cable shall conform to Division 27 Specification Section - Communication Horizontal Cabling.
   2. Composite Video: This cable distances less than 100 feet shall be a Shielded/Coaxial one 20 AWG solid conductor, 75 ohm.
   3. Composite Video: This cable distances more than 100 feet shall be a Shielded/Coaxial one 18 AWG solid conductor, 75 ohm.
   4. Contact Closure: This cable shall be an Unshielded Twisted Non-Pair, (2) 20 AWG stranded conductor.
   5. Control System Data: This cable shall be a Shielded Twisted Pair, (2) 18 AWG stranded conductor and a Shielded Twisted Pair, (2) 18 AWG stranded conductor.
   6. Fiber: This cable shall be a Multi Mode conductor.
   7. Infrared: This cable shall be a Shielded Twisted Pair, (2) 22 AWG stranded conductor.
   8. Line Audio: This cable shall be a Shielded/Twisted/Pair, two 22 AWG stranded conductor.
   9. Loudspeaker Audio: This cable shall be an Unshielded/Twisted/Pair, two 16 AWG stranded conductor.
   10. Microphone Audio: This cable shall be a Shielded/Twisted/Pair, two 22 AWG stranded conductor.
   11. Power supply: This cable shall be a Shielded Twisted Pair, Unshielded Twisted Non-Pair, (2) 18 AWG stranded conductor.
12. QuickMedia balanced video with power: This cable shall be a Siamese type cable with: (1) jacketed cable with a Shielded Twisted Non-Pair, (8) 22 AWG stranded conductor and (1) jacketed cable with an Unshielded Twisted Non-Pair, (4) 18 AWG stranded conductor.

13. Radio Frequency: This cable shall be a Shielded Coaxial, (1) 20 AWG solid conductor, 50 ohm.

14. RGBHV Video: This cable shall be a Shielded/ (5 individual coaxial conductors), one 26 AWG stranded conductor, 75 ohm.

15. RS-232 Data: This cable shall be a Shielded/Twisted/Pair, two 24 AWG stranded conductor.

16. RS-422 Data: This cable shall be a Shielded Twisted Pair, (4) 24 AWG stranded conductor.

17. RS-485 Data: This cable shall be a Shielded/Twisted/Pair, four 24 AWG stranded conductor.

2.04 MANUFACTURER SUPPORT CONTRACT(S)

A. The Contractor shall provide any manufacturer backed maintenance, warranty and/or technical support contract necessary for the Contractor to configure, operate, service, repair and/or replace any component of the Audiovisual System. The contract shall be valid for the duration of the warranty period. The Contractor shall purchase the contract in the Owner’s name and provide documentation and renewal information to the Owner at acceptance testing.

PART 3 - EXECUTION

3.01 REFERENCES

A. The Contractor shall closely coordinate with the Owner to ensure that Owner provided equipment is procured, configured (as necessary), and installed (as necessary) with ample lead time prior to the Contractor’s use of the equipment.

B. Refer to Division 27 Specification Section Audiovisual General Requirements for execution requirements.

END OF SECTION
SECTION 27 60 00
SECURITY GENERAL REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY
A. This Section provides supplemental information to the Division 27 Specification Section Basic Requirements.
B. Provide all labor, materials, equipment, tools and services required for the installation of the Security Systems.

1.02 RELATED SECTIONS
A. Division 27 Specification Section Common Work - Sleeves, Penetrations and Firestopping. Provide sleeves, penetrations, and firestopping as required to support the work of this Section.
B. Division 27 Specification Section Common Work – Hangers and Supports. Provide hangers and supports as required to support the work of this Section.

1.03 SUBMITTALS
A. Provide the following per the criteria set forth for Submittals in Division 27 Specification Section Basic Requirements:
   1. Product Data
   2. Shop Drawings

1.04 RECORD DOCUMENTS
A. Provide Record Documents per the criteria set forth for Record Documents in Division 27 Specification Section Basic Requirements.

1.05 OPERATION AND MAINTENANCE MANUALS
A. Provide Operation and Maintenance Manuals per the criteria set forth for Operation and Maintenance Manuals in Division 27 Specification Section Basic Requirements.

PART 2 - MATERIALS

2.01 THIS SECTION NOT USED

PART 3 - EXECUTION

3.01 GENERAL
A. Work shall comply with the Governing Requirements as defined in Division 27 Specification Section Basic Requirements. Governing Requirements of particular relevance to this Section include, but are not limited to:
   1. IEEE C62.41: Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits
   2. UL 1449: Transient Voltage Surge Suppressors

3.02 SOFTWARE IMPLEMENTATION
A. The Contractor shall provide all software implementation as required to provide a fully functional and operating system ready for the Owner’s use. Software implementation shall include but not be limited to programming, configuration, modification, integration of...
other systems, data entry and installation. Existing Security System databases (i.e. card holder databases, biometric templates and/or log files) shall be incorporated into new/expansion systems, as required.

3.03 HARDWARE CONFIGURATION

A. The Contractor shall provide all hardware configurations as required to provide a fully functional and operating system ready for the Owner’s use. Hardware configuration shall include but not be limited to firmware configuration, data communication, system settings, power distribution and installation. Existing Security Systems shall be incorporated into new/expansion systems, as required.

3.04 INSTALLATION

A. Pathways: Prior to the installation of Security Systems cabling, Contractor shall verify conduit sizing and quantity for correctness. Deviations from the design documents shall be documented and Contractor shall contact Engineer with notification of deviation.

B. Cabling:
   1. Security Systems cabling that is not network-based (i.e. Category 5E, 6, etc.) shall maintain separation from other system cabling and shall route within dedicated Security System pathways.
   2. Cable pulls shall be conducted within the following requirements:
      a. Manufacturer’s guidelines for pulling tension and bend radii.
      b. NEC conduit fill standards. Contractor shall notify Engineer prior to cable installation when conduits are found to be undersized.
      c. Any cable found to be faulty do to poor cable installation practices shall be removed and replace at no additional cost to Owner.
   3. Cable splicing shall not be considered a common installation practice. If necessary, splice cables only in junction boxes or racks. Shielded cables shall not be spliced; instead each end shall be terminated with an appropriate connector to maintain shield continuity. Any cable found to be faulty due to splicing shall be removed and replaced at no additional cost to Owner.
   4. The Contractor shall dress all cables at both ends with:
      a. Black heat shrink where jacketing has been stripped away to expose individual conductors
      b. Clear heat shrink where shields have been exposed (Coax excluded)
      c. Printed, adhesive labels with clear heat shrink over each label
   5. Contractor shall make all terminations with rosin-core solder, crimp/compression type connectors or captive screw type mechanical connections. For captive screw type mechanical connection, use spade type or ferrules type crimp terminations. Bare wire terminations are not acceptable.

C. Equipment:
   1. Equipment shall be installed as indicated and specified, and in accordance with the manufacture’s recommendations, except where local codes or regulations take precedence.
   2. Place equipment labels or other identification where the label or identification can be easily seen and read without difficulty.
   3. Equipment shall be installed level, plumb, parallel, and perpendicular to building structures and to other building systems and components, except where otherwise indicated.
   4. Equipment shall be securely fastened. Select fasteners and supports so that the load applied to any one fastener maintains a minimum load factor of five.
   5. Equipment locations: Prior to installation of Security System equipment, Contractor shall coordinate with other trades and subsequently verify all equipment locations that mount on walls or within ceilings. This shall include but not be limited to:
      a. Structural elements such as lighting devices, HVAC equipment, fire protection devices, and cable tray
      b. Structural support elements for ceiling mounted devices
c. Backing Board for wall mounted devices

6. Prior to head-end equipment installation, contractor shall verify equipment rooms are and will remain free of airborne contaminants.

7. After head-end equipment installation, contractor shall protect equipment from any future construction work that could cause damage to equipment, i.e. masonry, wood, paint, plumbing, etc.

8. Prior to furniture work, Contractor shall coordinate with other trades and subsequently verify all equipment locations that mount within furniture.

9. Contractor shall coordinate with architect as to any equipment color and finish requirements.

10. Any equipment exposed to tampering or indicated as tamper or vandal proof shall be installed with tamper/vandal proof enclosures and secured using pin-head Torx fasteners suitable for the material and load requirements.

D. Grounding and Surge Protection:

1. The Contractor shall follow accepted engineering practices when installing the Security Systems grounding system. The security grounding system installation shall conform to NEC standards. The contractor shall be responsible for correcting any grounding problems within the Security System including but not limited to electromagnetic/electrostatic interference, ground loops anomalies, and distortions.

2. All devices installed to the exterior of structure shall be protected from surge voltages with surge suppression devices. Install surge suppression devices in strict accordance with the manufacturer requirements.

3. All solenoid or coil driven devices (i.e. door strikes, pin bolt locks, large relays, gate operators and magnetic locks) shall be installed with metal oxide varistors for surge suppression.

E. Structural Installations

1. Structural support elements are defined as those materials added to structure for the reinforcement of general construction methods to meet a designed minimum load factor of five. These include but are not limited to:
   a. Backing boards required for the support of Security System equipment and cabling
   b. Strut supports hung from structural beams or concrete slab

2. It is the Electrical Contractor’s responsibility to provide structural support elements for the Security Systems equipment.

3. The Contractor is to provide all Security Systems mounting and rigging equipment that fasten to the structural support elements.

4. All support elements and fastenings shall be able to support a minimum load factor of five times the total assembled weight of the Security System equipment.

5. The Contractor shall be responsible for the complete and correct installation of all Security Systems equipment.

3.05 TESTING

A. Operational Testing

1. Prior to system training and acceptance testing, the Contractor shall perform and document operational testing.
   a. Access Control System
      1) Contractor shall assemble the following test equipment:
         a) Ground fault indicator
         b) Digital Multi-meter
      2) Prior to any connections being made to building power, Contractor shall use a ground fault indicator to verify the circuits are properly grounded wiring. If grounding is found to be faulty, the contractor shall notify the electrical contractor. Connections shall not be made to building power until proper grounding is demonstrated.
3) The Contractor shall produce a checklist for testing and documentation of all Access Control System equipment. Each device shall be verified for proper operation at the monitoring stations and the door locations. Devices under test shall consist of, but not be limited to card readers, locking mechanisms, door position switches, request to exit devices, auto operators, handicap paddles, crash bars with switches, and overhead door operators.

4) The Contractor shall correct any defective device upon discovery. The Contractor shall notify and coordinate with other trades as necessary to ensure faulty devices are put into working order.

5) The Contractor shall test and document all “end of line resistance” values in all states of operation, where applicable. Correct any defect upon discovery.

6) The Contractor shall test and document all data transmissions for proper operation. Correct any defect upon discovery.

7) The Contractor shall conduct operational testing, in accordance with manufacturer approved test recommendations.

B. Acceptance Testing

1. System acceptance testing shall not be conducted until all final “as-built” drawings, manuals and operational testing have been completed and the documentation has been submitted for Engineer’s review.

2. Acceptance testing shall be conducted with Contractor, Engineer, and Owner in attendance.

3. Contractor shall demonstrate that all components of the Security System are in proper working order and are in accordance with specifications.

4. At time of acceptance testing, all items found to be outside of specification requirements; Owner requirements, code requirements or general installation practices shall be added as new items to the final Punch List. All items found outside of specification requirements shall be put into working order prior to final acceptance of system.

5. The Contractor shall assemble an inventory of installed equipment. This inventory shall be compiled at time of acceptance testing and compared to equipment listed in contractual documents.

6. Acceptance testing may be suspended by Engineer if Security System are not complete and operable, equipment failure occurs, or installation is not in accordance with specifications. Contractor shall be responsible for any cost incurred by Engineer for additional site visits required to complete acceptance testing.

END OF SECTION
SECTION 27 62 00
ACCESS CONTROL SYSTEM

PART 1 - GENERAL

1.01 SUMMARY
A. This Section defines the Security System requirement for the Access Control System.

1.02 RELATED SECTIONS
A. The requirements of Division 27 Specification Section Security - General Requirements shall serve as the basis for the requirements of this Section, and are incorporated by reference into this Section.

1.03 SYSTEM DESCRIPTION
A. The primary function of the Access Control System is to secure / monitor selected building entry locations from unauthorized entry. The Access Control System shall include but limited to a database application(s), access control processing equipment, verification devices, a monitoring station(s), and door hardware equipment.

1. The Access Control System Database resides within the Stadium building. The Database software shall be upgraded and reconfigured as required to incorporate the addition of the new Access Control System onto the existing Access Control Network. The Contractor shall provide all necessary software upgrades to provide a fully functional and operating system ready for the Owner's use. The Database configurations shall be implemented by the Owner. The Contractor shall assist the Database configuration, which shall include but not limited to: programming, troubleshooting, testing and verification of system operation.

2. The Contractor shall provide communication via the Owner provided Data Network System to incorporate this Access Control System onto the existing Access Control Network. The Contractor shall coordinate with the Owner to ensure all Data Network System requirements have been provided, this is to include but not limited to patch panel configuration, switch/ router allocation, IP addressing and network security. The Contractor shall provide all communication devices that reside outside of the Owner provided Data Network System, this is to include but not limited to switches / routers, protocol converters and patch cabling.

3. The Access Control System shall include but not be limited to: network modules utilizing standard Ethernet cabling, processor modules, input / output modules, cards readers, power supplies and any necessary cabling to provide a fully functional and operating system ready for the Owner’s uses. The Access Control System shall operate within the parameters set forth below:
   a. The network communication between the Access Control System panels and the main Database shall be provided via the Owner’s Data Network System. The Security Contractor shall coordinate with the Owner and the Communications Contractor to ensure the Data Network System is configured to support the Access Control System.
      1) Structured Cabling: Structured cabling required for the direct operation of the Access Control System shall be provided by the Communication Contractor. Structured cabling shall include but not limited to fiber optic and copper cabling.
      2) Data Communications Equipment: Data communications equipment required for the direct operation of the Access Control System shall be provided by the Owner. Data communication equipment shall include but not limited to repeaters, switches and routers.
3) Data Termination Equipment: Data termination equipment required for the direct operation of the Access Control System shall be provided by the Contractor. Data termination equipment shall include but not limited to computers, network interface cards, network modules and/or serial servers.
   a) Network termination equipment that the Access Control System Database application(s) is to be installed upon shall be provided by the Owner. This shall include but not limited to computers and data servers.

b. The Access Control System shall be capable of stand alone operation in the event that communication is interrupted between the local system and the Network Database.

c. The Access Control System shall have battery back-up power for continued operation of entire system in the event of a power outage. This shall include but not limited to the Access Control System panels and lock power supplies.

d. The Contractor shall provide connectivity to all door hardware, as applicable, to ensure the Access Control System operates within the parameters set forth herein. The Contractor shall provide door hardware as specified in the Product section herein. All other door hardware shall be provided by others. The Security Contractor shall coordinate with Door Hardware Contractor to ensure all door hardware operates as indicated in Construction Documents.

e. The Access Control System shall provide monitoring for secure state of specified doors.

f. The Access Control System shall provide operation for doors consistent with the following:
   1) Secured side access:
      a) The door shall remain locked to unauthorized personal at all times expect during times of building operation. Coordinate building operation schedule with Owner.
      b) Authorized personnel shall present identification card to card reader unit, upon database verification, access shall be granted. The automatic door opener feature, if applicable, shall be available only after personnel are granted access. The door shall remain unsecured for 7 seconds before returning to a secure state.
      c) The door shall maintain a Fail Secure state in the event of a power outage.

   2) Unsecured side access:
      a) The door shall provide free egress from building at all times.
      b) Egress shall be provided by means of a mechanical release located within the door hardware (non-magnetic locks) or an electromechanical switch located within door handle, exit device or door frame (magnetic locks).
      c) The automatic door opener feature, if applicable, shall be available at all times.

g. The Access Control System shall provide capability for a “Lock Down” situation. The Owner’s “Lock Down” procedural standards shall set the precedence to which the Access Control System shall be programmed and / or configured. The system shall provide but not be limited to panic button(s) to initiate the “Lock Down” operations, release all door hold open hardware and secure all controlled doors (i.e. disable schedule events).

h. The Access Control System panels and/or lock power supplies shall interface with the fire detection control equipment. The Contractor shall coordinate the functionality of the Access Control System during the
activation of the fire alarm with Authorities Having Jurisdiction and the Owner.

i. The Access Control System shall interface with the elevator control equipment providing individual floor access based on database verification. The card reader device shall be located within the elevator cab. In the event of fire and/or power outages, the elevator shall operate without restrictions from the Access Control System. The Contractor shall coordinate with Owner for operation requirements.

j. The Access Control System shall incorporate functionality of door hold open equipment. The door hold open equipment shall be provided by others. The Contractor shall coordinate with Fire Alarm Contractor Owner for operation requirements.

PART 2 - MATERIALS

2.01 GENERAL

A. Manufacturer: Unless otherwise indicated, equipment in this Section shall be the standard products of a manufacturer regularly engaged in the manufacture of such products. All components used in the system shall be commercial designs that comply with the Specifications. Each major component of equipment shall identify the manufacturer’s name, model and serial number. Items of the same classification shall be identical. This includes equipment, modules, parts, and components. The Engineer retains the right to reject products which reflect, in the Engineer’s opinion, sub-standard design practices, manufacturing procedures, support services, or warranty policies.

1. Unless otherwise indicated, the equipment by the following manufacturers shall not be substituted. The Contractor shall provide the most current model and/or version of product available by listed manufacturer at time of procurement:

   a. Software House

B. Part Numbers: Refer to the equipment schedule at the end of this Section for specific part numbers. Part numbers listed in the equipment schedule define the performance specifications for the parts and shall be per the most recent manufacturer’s cut/data specification sheets available at the time of bid. If no part number is provided, then any part meeting the requirements specified is acceptable.

C. Provide materials in quantities as required to provide a fully functional and operational Access Control System.

D. Owner Provided Contractor Installed: Refer to the equipment schedule at the end of this Section for procurement requirements. Equipment identified with an “OFCI” shall be provided by Owner for the Contractor to install.

2.02 EQUIPMENT SPECIFICATION

A. This equipment shall as a minimum conform to the following specifications:

1. Access Control Processing Equipment
   a. The access control processing equipment shall provide capacity for current door requirements as referenced in drawings with the ability to expand for future Access Control needs.
   b. The processing equipment shall have a dedicated power supply with battery charger. In the event of power outage, the system shall have a minimum of 7 Amp hours of battery back-up power.
   c. Contractor to verify power requirements of processing equipment prior to installation.

2. Auxiliary Relay
   a. The relay shall be of a blade type construction with a double pole, double throw contact configuration.
   b. The coil and contact ratings shall exceed the inline current and voltage requirement of the relay controlled devices.

3. Card Reader
a. The card reader shall be a magnetic swipe type card reader.
b. The card reader shall have battery back up power in the event of power outages.
c. All exterior card readers shall have surge protectors to protect against lightening.

4. Interface Plate
a. The Interface plates shall be made of 1/8 inch brushed anodized aluminum with beveled edges, finished in black with 1/8 inch height, white enamel filled lettering.

5. Lock Power Supply
a. The power supply shall be a dedicated, voltage selectable power supply with battery charger. In the event of power outage, the system shall have a minimum of 7 Amp hours of battery back-up power.
b. Contractor to verify power requirements of processing equipment prior to installation.

6. Management / Monitoring Station
a. Software
1) The Contractor shall provide software (and licenses if applicable) to support one Management Station.
2) The software shall be of the same manufacturer as the Access Control System.
3) The software shall provide the ability to manage card holder information.
4) The software shall provide the ability to manage door operation.
5) The software shall provide real-time monitoring of select doors.
6) The software shall provide floor plan maps with icons that will alert operators where the system has detected a breach in security.

b. Computer
1) The Contractor shall provide the computer onto which the management software shall be installed. The Contractor shall provide installation and configuration of software for operation of one Monitoring Station ready for Owner’s use.
2) The computer shall exceed the minimal requirements of the monitoring software as specified by manufacturer.
3) The computer monitor shall mount to the security console.

c. Security Console
1) The Contractor shall provide the security console and all ancillary equipment required for a fully functioning monitoring station ready for Owner’s use.
2) The security console shall have two swivel computer mounts that are located under the desk top of the console.
3) The security console shall provide two articulating LCD mounts located on the desktop of the console.
4) The Contractor shall coordinate with the Owner for configuration of security console mounted equipment.
5) The Contractor shall coordinate with the Architect for finish requirements.

7. Rack Accessories
a. Rack accessories shall be made of 11 gauge aluminum and finished in black powder coat.

2.03 WIRE AND CABLE

A. This equipment shall as a minimum conform to the following specifications. Cable gauge and conductor quantity requirements may vary depending on device requirements. Contractor to determine and utilize cable with proper conductor and gauge requirements to provide proper operation. Use Plenum equivalent cable as required.
1. Card Reader: This cable shall be a Shielded Twisted Pair, (6) 18 AWG stranded conductors.
2. Card Reader: This cable shall be an Unshielded/Twisted/Pair (Category 5e), eight 24 AWG solid conductors.
3. Card Reader: This cable shall be a Shielded/Twisted/Pair, (6) 24 AWG stranded conductors.
4. Card Reader: This cable shall be a Shielded Twisted Pair, (8) 20 AWG stranded conductors.
5. Communications System: This cable shall conform to Division 27 Specification Section - Communication Horizontal Cabling.
6. Contact Closure: This cable shall be a Shielded Twisted Pair, (2) 20 AWG stranded conductor.
7. Lock Power: This cable shall be an Unshielded Twisted Non-Pair, (2) 16 AWG stranded conductors.
8. Network Patch Cords: This cable will be provided by the Owner. Coordinate with the Owner and obtain patch cords prior to system installation.
9. Power Supply: This cable shall be an Unshielded Twisted Non-Pair, (2) 18 AWG stranded conductors.
10. RS-485 Data: This cable shall be a Shielded Twisted Pair, (4) 22 AWG stranded conductors.

PART 3 - EXECUTION

3.01 GENERAL

A. The Contractor shall closely coordinate with the Owner to ensure that Owner provided equipment is procured, configured (as necessary), and installed (as necessary) with ample lead time prior to the Contractor's use of the equipment.

B. The Contractor shall closely coordinate with the Authority Having Jurisdiction to ensure that all local codes and building requirements are met. Contractor shall provide all documentation required to pass Certificate of Occupancy.

C. Refer to Division 27 Specification Section - Security General Requirements for execution requirements.
SECTION 28 31 00
FIRE ALARM AND DETECTION SYSTEMS

PART 1 - GENERAL

1.01 REFERENCE

A. Related Sections:
1. Division 21 – Fire Protection
2. Division 23 – Controls
3. Division 26 – Electrical
4. Division 21 - Conveying Systems
5. Division 27 - Telecommunications

B. References:
1. International Building Code
2. International Fire Code
3. National Electrical Code
4. NFPA
5. American National Standards Institute (ANSI)
6. Design Engineer and Contractor shall use the UCB Standard Symbols
7. ADA Guidelines

1.02 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firm regularly engages in the manufacture of fire alarm systems of types, sizes, and electrical characteristics compatible with the current campus systems, and whose products have been in satisfactory use in similar service for not less than five (5) years.

B. Installer's Qualifications: Firm with at least five (5) years of successful fire alarm systems installation experience. Installers shall have at least two (2) years documented fire alarm installation experience and a minimum of a NICET II certification for Fire Alarm Systems.

C. Codes and Standards:
1. Each and every item of the fire alarm system shall be new and listed as the product of a fire alarm system manufacturer under the appropriate category by Underwriters Laboratory, Inc. (UL) and shall bear the UL label on all devices.
2. The complete installation shall conform to the applicable sections of NFPA, especially NFPA 72 and the National Electrical Code.

1.03 SUMMARY

A. Proprietary Supervising Station: Class B-IDC, Class 4-SLC, Class B-NAC.

B. Hardwire zones shall only be used with UCB permission and only for small systems.
C. The fire alarm system and devices shall comply with ADA and UL requirements.

D. At a minimum, provide manual pull stations at each building exit, adjacent to the FACP, and any stage manager consoles.

E. Where feasible, smoke detectors are to be provided as required by code and in electric and telecommunication/data rooms.

F. The use of duct detectors shall be minimized where feasible, area detectors shall be used to accomplish the objective.

G. Smoke detectors located in open areas should be used rather than duct-type detectors for the operation of any automatic smoke control system.

H. Stage Manager's Console:
   1. A "Stage Manager's Console" shall be installed in those areas open to the public for performances or special events where special effects could be used. Areas where special effects are used shall provide a means to disable detection during performances. All switches are to be identified and activate a system trouble upon activation of any switch.
   2. Any initiating devices that are disabled from the Stage Manager's Console shall cause a trouble at the FACP and activate a trouble lamp at the stage Manager's Console.
   3. A pull station shall be located near the Stage Manager's Console.

I. Pre-Action systems shall operate in accordance with Section 210500.

J. Outside bell and strobe appliances shall track the main water flow device.

K. Elevators:
   1. Shunt trip shall be activated only from the FACP, not contacts on heat detectors.
   2. Where heat detectors perform elevator recall and shunt trip, smoke and heat detectors shall share the same time counter to activate the shunt trip. However, heat detector activation is required for shunt trip.
   3. Where required, the vent for the elevator shaft shall have a pneumatic damper where possible. Where allowed by code, the damper shall be normally closed (energize open). The damper shall have a manual control located adjacent to the FACP and be keyed to the University Standard. The damper activation shall be 24VDC powered from the fire alarm system.
   4. The 120VAC power to the elevator shunt trip shall be supervised.

L. A remote annunciator shall be required where the FACP is not readily accessible for Fire Department response in a building. At a minimum, annunciators shall have a control panel fully duplicating the functions of the FACP front panel.

M. The Contractor shall install a remote reset station (provided by the Owner) adjacent to the fire alarm control panel and include the following:
   1. Common alarm and common trouble lamps.
   2. A single pole double throw remote silence switch. Upon activation, this switch will silence all notification appliances in the building. This switch shall be supervised by the FACP and keyed to the University Standard.
3. A single pole spring loaded remote reset switch that is supervised by the FACP and keyed to the University Standard.

N. Door holders shall be non-supervised and release upon AC power loss.

O. Fan shutdown shall be hardwired through the fire alarm system.

1.04 MASS NOTIFICATION SYSTEM

A. In General, campus buildings shall be provided with Mass Notification Systems (MNS). Small buildings may not require MNS; examples include very small buildings such as pump houses, lawn equipment storage areas, single family houses on the Hill and similar places. The design team shall coordinate with the campus AHJ and determine whether the building under design needs to be provided with MNS. Only for buildings where it is determined and agreed that MNS is required and that it is combined with the fire detection and alarm system, all applicable paragraphs in this section that refer to MNS shall apply. For buildings where it is determined and agreed that MNS is not required, none of the paragraphs that refer to MNS shall apply. Where the MNS is independent of the fire detection and alarm system, please refer to applicable codes and standards, instead of using this section.

B. New Buildings MNS:

1. All new buildings where a fire alarm control panel is required are to be provided with a combination Fire Alarm/Mass Notification System.

2. Speakers, instead of horns, are to be used.

3. The system is to be installed in full compliance with the adopted edition of the National Fire Protection Association (NFPA) pamphlet No. 72, National Fire Alarm Code.

4. The system is to be designed and installed such that announcements can be made for other emergencies on campus. The new or modified fire alarm control panel shall be capable of receiving audio inputs for announcements over the systems speakers. The panel shall be configured and programmed so that these inputs are a higher priority than a fire alarm (i.e., the audio inputs will override a current or pending fire alarm announcement).

5. The system is to be designed and installed such that campus emergency announcements can be made using a microphone at the fire alarm control panel and using microphones from two (2) remote campus buildings, e.g., possibly University of Colorado Police Department (CUPD) and the Service Center.

6. The combination systems need to be tested and maintained by CU personnel in accordance with the testing and maintenance procedures and frequencies required by NFPA-72. If in-house maintenance and testing expertise are not available, outside agencies need to be hired to ensure compliance with testing and maintenance requirements.

7. Currently, CU Dispatch can use a dial-in system to access the public address system of several campus buildings. As an intermediate measure, all new systems should have this feature, allowing CUPD Dispatch to communicate with the occupants via a dial-in connection. However, in the long term, the objective is to provide CUPD Dispatch with a control panel which would allow the CUPD Dispatch to readily select any number of buildings (that have a Public Address System) for announcements. The details of this long-term plan will be established by an outside consultant.

8. Speakers shall be provided in compliance with the Emergency Voice/Alarm Communications System from NFPA 72.
9. For emergency voice/alarm communications systems, contractor shall perform intelligibility testing for the building. All large and/or complicated spaces and a random sample of remaining areas shall be tested. Testing shall be performed in accordance with Annex B, Clause B1, of IEC 60849. The system is to exceed the equivalent of a common intelligibility scale (CIS) score of 0.70. Alternatively, the use of subject-based tests methods as described in ANSI S3.2, Method for Measuring the Intelligibility of Speech Over Communication Systems, may be used if pre-approved by the University and detail testing procedures are provided.

10. Interior emergency voice/alarm systems shall have speakers installed in accordance with NFPA 72. Speakers are to be provided with integral strobe visual alarm where appropriate. Mounting of all devices shall comply with ADA requirements. Speakers shall be designed and installed to provide voice intelligibility throughout all areas of the building. Areas where voice intelligibility cannot be provided due to high ambient noise levels (e.g., mechanical spaces) shall be separately evaluated by the Engineer to determine appropriate design requirements. Engineers are encouraged to use an acoustical program (e.g., EASE from Renkus-Heinz or Modeler from Bose) to determine speaker layout for large and/or complicated spaces. Provide Wheelock E70/E90 or ET70/ET90 series speakers or as approved by the University.

C. Existing Buildings MNS:

The Fire Alarm System construction activities in existing buildings fall under three (3) categories as explained below.

1. Fire Alarm System Replacements:

The new system is to comply with the requirements for new buildings (see Section #3 above).

2. Fire Alarm Major Upgrades:

If feasible, the upgraded system is to comply with the requirements for new buildings (see Section #3 above). Feasibility is to be determined by the project administrator and FLS. As a minimum, all new Fire Alarm Control Panels (FACP) and devices added are required to be compatible with a combination Fire Alarm/Public Address System so that the system is more readily convertible to a Combination System during future upgrades.

3. Fire Alarm System Minor Upgrades:

Compliance with new building requirements, listed under Item I above, is not required. If feasible, all new panels and devices added are to be compatible with a combination Fire Alarm/Public Address System so that the system will be readily convertible to a Combination System during future upgrades.

1.05 SUBMITTALS

A. Shop Drawings must be submitted within 30 days after award of contract and shall include the following:

1. Locations of alarm initiating and notification appliances.
2. Alarm control equipment.
3. Annunciation.
4. One-line diagram for the complete system including device addresses and room numbers.
5. Power connections.
7. Network connections.
8. Voltage drop calculations.
9. Manufacturer's model numbers, and listing information for equipment, devices and material.
10. The interface of fire control functions and sequence of operations.
11. UCB wiring installation guide.
12. Graphic Command Center (GCC) graphic screens.

B. Operations and Maintenance Manuals (O&M's) shall be submitted within 30 days of the final accepted fire alarm test and shall contain:

1. Four (4) sets of complete as-built drawings the same size as the original drawings and two (2) CAD disks containing all items of "A" above corrected to include all shop drawing comments and reflect actual space installation. The CAD drawings shall be based on campus CAD standards available from the Facilities Management CAD office.
2. Complete schematic and interconnection wiring diagrams, internal and external, including junction box wiring with all terminal strip and wire numbers.
3. Parts list including complete parts price list and recommended spare parts list.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store fire alarm equipment in a clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

B. Do not install damaged equipment or components; replace with new.

PART 2 - PRODUCTS

2.01 MANUFACTURER

A. All fire alarm equipment shall be supplied by one representative. All equipment and wiring configurations shall be reviewed and approved by the AHJ and the Owner. Equipment shall be by:

1. Simplex

B. All fire alarm equipment shall be compatible with the campus fire alarm systems and networks.

C. The manufacturer's representative and service agency supplying the equipment must have factory authorized 24-hour on-call service departments and complete stock of spare parts. Agencies must be located within a 50 mile radius of the Campus. Response time must be guaranteed within 24 hours of notification.
2.02 FIRE ALARM CONTROL PANEL

A. All power and back-up power shall comply with NFPA 72 and NEC.

B. The FACP shall have the following functions:
   1. City disconnect.
   2. Pre-Action system bypass.
   3. Other suppression systems bypass.
   4. Elevator bypass.
   5. Door holder bypass.
   7. Voice capability where required by the AHJ; also see Section 1.04, Mass Notification System.

C. The control panel shall provide the following:
   1. Display software revision level.
   2. Battery voltage monitor for supervision of low voltage of the back-up battery.
   3. Display historic logs.
   4. Display card status.
   5. Point list.

D. The control panel shall have a hinged front and lock that is keyed to the University Standards.

2.03 ADDRESSABLE COMMUNICATION

A. The Fire Alarm System shall provide communication with individual initiating and control devices, annunciated at the FACP.

B. All addressable devices shall have the capability of being individually disabled and enabled by the FACP.

C. Fire Alarm Systems that require factory reprogramming to add or delete devices are not acceptable.

D. The use of jumpers to set the address shall not be acceptable.

E. Device identification that rely on electrical position along the communication lines and do not use unique addresses shall not be acceptable.

2.04 FIRE SYSTEM DEVICES

A. Manual Pull Stations:
   1. Manual, non-coded, single action flush or surface mounted as specified.
   2. An indication of operation shall be visible until the device has been manually reset.
   3. Problem areas such as spaces for theatrical, sporting, or similar events, etc., shall utilize dual action break glass type pull station. In dormitories, and other
areas susceptible to nuisance alarms, provide a clear shielded enclosure with a battery operated sounder.

B. Heat Sensors:
   1. All heat sensors shall be of the addressable type unless environmental conditions prohibit their use. If non-restorable detectors are used, an addressable module shall be located in an area not subject to the adverse environment.
   2. Rate of rise detectors will be used with UCB permission only. Fire alarm reset shall be required to restore a rate of rise detector to normal.

C. Smoke Detectors:
   1. Smoke detectors shall be analog and capable of alarm verification.
   2. Smoke detectors shall have environmental compensation and provide a trouble at the FACP when the sensor's value reaches a predetermined value.
   3. Smoke detector/control unit shall be arranged so that the detector causes a signal at the control unit when its sensitivity is outside its listed range.

D. Duct detectors shall have duct sampling tubes, remote indicator and test switch. Units shall be able to reset at the FACP.

E. Horns used in sensitive animal research areas shall be Silentone MKII or AHJ approved equal.

F. All signaling devices shall be Simplex or Wheelock.

PART 3 - EXECUTION

3.01 IDENTIFICATION
   A. All new and reused junction boxes shall be painted red and labeled "Fire Alarm".
   B. All conductors shall be numbered and their numbers shall correspond to the terminal block numbering they are connected to.
   C. Device Labeling:
      1. All initiating and notification devices shall be labeled with the appropriate circuit number(s).
      2. Labels shall be 3/8" high lettering, black on clear background.

3.02 INSTALLATION OF BASIC WIRING SYSTEMS
   A. All cable and wiring shall be installed in conduit by a Colorado licensed electrician and in compliance with Division 26.
   B. All wiring shall be in conduit.
   C. Provide basic wiring materials that comply with Division 26.
1. Use only copper conductors.
2. Provide conductors which are UL Listed for installation and location, and approved for fire alarm use.
3. Wire color and size shall be per the University Standards, see attachment "Installation Guidelines". If inconsistent with the existing building fire alarm wiring, the Contractor shall match the existing wire colors and note it on the as-built drawings.

D. Install wire and cables in accordance with the manufacturer's requirements and in compliance to NEC.

E. All junction boxes 8"x8" or larger shall be provided with numbered terminal strips with all wires numbered and landed on corresponding terminals. One conductor per terminal.

F. Only one extension ring is allowed on a 4"x4" box.

G. Provide a 3/4" conduit from the FACP to the building main telephone room for the campus fire alarm network connection. Run four (4) multimode fiber strands or four (4) copper conductors between the FACP and the fire alarm network. Verify the connection type with UCB personnel prior to installation.

H. All riser conduits shall be a minimum 1" to 8"x8" minimum junction boxes.

I. Contractor shall not pull wire through existing raceways with live circuits without prior CU approval.

3.03 INSTALLATION OF FIRE ALARM SYSTEMS

A. All outside bells, horns, and strobes shall be installed a minimum of 10'0" above finished grade.

B. All outside audible appliances shall have an audible level no less than 90db at 10-feet.

C. All conduit and boxes within 6'0" of tamper and water flow switches shall be watertight.

D. All remote test switches shall be located in common areas at a height of 7'0" above finished floor.

3.04 FIRE ALARM NETWORK

A. Graphic Command Center:
   1. All additions and/or changes to the fire alarm system shall be updated at the supervising station and all appropriate (as determined by Facilities Operations Fire Systems Group) graphic command centers to include graphic screens.
   2. All new or updated FACP's shall use fiber optics to tie into the campus fire alarm network.
3.05 FIELD QUALITY CONTROL

A. Make all connections to the control equipment under UCB personnel or manufacturer's supervision.

B. Notify the University Fire Systems Group a minimum of two (2) days prior to any interruption or modification of any existing fire alarm system for scheduling of work (303-492-0791).

C. Final Acceptance Testing:

1. Before the final test, the Contractor shall perform a complete system check with the manufacturer's representative present. This test shall be completed without the involvement of the Owner. The test of the fire alarm system, initiating devices, notification appliances, and all functions of the FACP shall comply with NFPA 72. This "preliminary" test shall be documented as to what was tested and the test procedures used. This test documentation, NFPA 72 Record of Completion, and the attached Fire Alarm Application for Final Acceptance Test shall be submitted to the Owner prior to scheduling a final test.

2. As a final test, the Contractor and a manufacturer’s representative shall demonstrate to the design engineer and the Owner's representative that the system is in full operation status. This demonstration shall include testing 100% of the devices and/or the systems as directed by the design engineer and witnessed by the Owner's representative. The Contractor shall furnish all test equipment necessary to complete the testing. In cases where a system was remodeled or added to, all new devices shall be 100% tested and a representative quantity of existing devices, as determined by the Owner's representative, shall be re-tested to ensure proper operation of the system.

3.06 WARRANTY

A. The Contractor shall guarantee all equipment and wiring free from inherent mechanical and electrical defects for a period of one (1) year from the date of acceptance as set forth in the General Conditions.

3.07 OPERATING AND MAINTENANCE INSTRUCTION

A. Conduct instruction to the Owner's representative on all normal maintenance and trouble shooting procedures down to circuit board level of equipment include in contract (minimum of eight (8) hours per new system, one (1) to four (4) hours as required for remodeled systems).

B. For major projects, when needed by the Fire Systems Group, provide one (1) week, minimum forty (40) hours, of factory training (component and programming) for University technicians. Training may be either at the factory or in the Denver/Boulder area. Training shall include transportation, lodging, and one (1) meal a day for one (1) technician.

C. Failure to comply with all contractual obligations resulting in costs incurred by the University shall result in those costs being transferred to the appropriate contractor for payment.
D. Contractor shall be financially responsible for all fees to the University by the Boulder Fire Department, and all lost research due to false alarms.

3.08 FIRE WATCH AND SHUTDOWN REQUIREMENTS

A. Fire Alarm Shutdown:

1. Except for replacement of control equipment, at no time during construction should the entire fire alarm system be disabled where the notification devices are not functioning.

2. If the fire alarm system is out of service, fire watches shall be posted in accordance with UCB procedures. See requirements at http://fm.colorado.edu/firesafety/constructionpolicies.html

3.09 PAINTING AND PATCHING

A. Contractor shall paint exposed conduit to match adjacent surfaces. All surfaces or finishes damaged as a result of work shall be properly patched, painted, and/or repaired by trained craftsmen of the trade involved.

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 1 Specification Sections, apply to this Section.

1.02 SUMMARY
A. This Section includes the following:
   1. Protecting existing trees, shrubs, groundcovers, plants, and grass to remain.
   2. Removing existing trees, shrubs, groundcovers, plants, and grass.
   3. Clearing and grubbing.
B. Related Sections include the following:
   1. Division 1 Section “LEED Requirements” for additional LEED requirements.
   2. Division 1 Section “Temporary Facilities and Controls” for temporary utilities, temporary construction and support facilities, temporary security and protection facilities, and temporary erosion and sedimentation control procedures.
   3. Division 1 Section “Execution Requirements” for verifying utility locations and for recording field measurements.
   4. Division 1 Section “Selective Demolition” for partial demolition of buildings or structures undergoing alterations.
   5. Division 2 Section “Building Demolition” for demolition of buildings, structures, and site improvements.
   6. Division 2 Section “Earthwork” for soil materials, excavating, backfilling, and site grading.
   7. Division 2 Section “Lawns and Grasses and Exterior Plants” for finish grading including preparing and placing planting soil mixes and testing of topsoil material.
   8. Division 2 Section “Erosion Control and Water Pollution Control”.
   9. Division 2 Section “Topsoil Stripping Storing & Replacement”.

1.03 DEFINITIONS
A. Topsoil: Natural or cultivated surface-soil layer containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches in diameter; and free of subsoil and weeds, roots, toxic materials, or other non-soil materials.

B. Tree Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and defined by the drip line of individual trees or the perimeter drip line of groups of trees, unless otherwise indicated.
1.04 MATERIAL OWNERSHIP
A. Except for stripped topsoil or other materials indicated to remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.05 SUBMITTALS
A. Photographs or videotape, sufficiently detailed, of existing conditions of trees and plantings, adjoining construction, and site improvements that might be misconstrued as damage caused by site clearing. All photographs or videotaping of the site must be authorized prior to the performance of those activities. The Contractor must have the authorized paperwork prior to bringing cameras on the Owner's property. The unauthorized possession and use of camera and recording devices is strictly prohibited.
B. Record drawings, according to Division 1 Section "Project Record Documents," identifying and accurately locating capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.06 QUALITY ASSURANCE
A. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.07 PROJECT CONDITIONS
A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
   2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
B. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.
C. Utility Locator Service: Notify Owner's Representative for area where Project is located before site clearing. Note: Lockheed has conducted an underground utility investigation. All underground utility markings will be refreshed prior to commencement of construction activities.
D. Do not commence site clearing operations until temporary erosion and sedimentation control measures are in place.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION
3.01 PREPARATION
A. Protect and maintain benchmarks and survey control points from disturbance during construction.
B. Locate and clearly flag trees and vegetation to remain or to be relocated.
C. Protect existing site improvements to remain from damage during construction.
1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.02 TREE PROTECTION

A. Erect and maintain temporary fencing around tree protection zones before starting site clearing. Remove fence when construction is complete.
   1. Do not store construction materials, debris, or excavated material within fenced area.
   2. Do not permit vehicles, equipment, or foot traffic within fenced area.
   3. Maintain fenced area free of weeds and trash.

B. Do not excavate within tree protection zones, unless otherwise indicated.

C. Where excavation for new construction is required within tree protection zones, hand clear and excavate to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.
   1. Cover exposed roots with burlap and water regularly.
   2. Temporarily support and protect roots from damage until they are permanently redirected and covered with soil.
   3. Coat cut faces of roots more than 1-1/2 inches in diameter with an emulsified asphalt or other approved coating formulated for use on damaged plant tissues.
   4. Backfill with soil as soon as possible and in accordance with Drawings and Specifications. If the excavation is left open overnight, place temporary barrier (plastic fencing) around excavated hole to preclude entrance into disturbed area.

D. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in a manner approved by Engineer.
   1. Employ an arborist, licensed in jurisdiction where Project is located, to submit details of proposed repairs and to repair damage to trees and shrubs.
   2. Replace trees that cannot be repaired and restored to full-growth status, as determined by Engineer.

3.03 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction.
   1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
   2. Cut minor roots and branches of trees indicated to remain in a clean and careful manner where such roots and branches obstruct installation of new construction.
   3. Grind stumps and remove roots, obstructions, and debris extending to a depth of 18 inches below exposed subgrade.
   4. Use only hand methods for grubbing within tree protection zone.
   5. Chip removed tree branches and dispose of off-site.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
   1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.
C. Inorganic Materials within the Site: Remove all concrete and asphaltic paving and other debris materials as indicated by the Owner’s Representative. Dispose of off-site and off the OWNER’S property to a suitable disposal location.

D. Organic Material: Organic materials, other than top soil, shall be removed as directed by Owner’s Representative, Geotechnical Engineer or Civil Engineer. Material shall be disposed of off site by the CONTRACTOR, unless otherwise authorized by the OWNER.

E. Top Soil: All Topsoil (6 inches minimum) shall be stripped from the ground surface upon which fill is to be placed or excavation is to occur and stockpiled. Stripping of top soil shall be performed after removal of organic materials. Obtain approval from the Owner’s Representative.

3.04 DISPOSAL

A. Disposal: Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner’s property.

1. Separate recyclable materials produced during site clearing from other non-recyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities.

END OF SECTION
SECTION 31 30 00

EARTHWORK

PART 1 - GENERAL

1.01 SCOPE

A. Provide materials and workmanship necessary to perform all items of site preparation and earthwork required for the Work, complete, in accordance with the Drawings, other project documents, and the following.

1.02 GENERAL

A. Work Included:
   1. Establishment of additional baselines and benchmarks required for the Work.
   2. General site grading, cut and fill.
   3. Excavation and backfill for new construction.
   4. Excavation, including rock excavation, and removal of unsuitable materials from construction site.
   5. Proofrolling.
   6. Placing of subgrade material for paved areas.
   7. Identification of new buried piping, including warning tape, tracer wire, and tracer wire test stations.
   8. All other items of site preparation and earthwork required to complete the Work.

B. Related Work Specified Elsewhere:
   1. Division 1: General Requirements of Work.
   2. Section 02 42 00: Site Drainage.
   3. Section 02 62 00: Foundation Drainage.
   4. Section 02 74 00: Hot Mix Asphalt Pavement (HMAP).

C. Work Performed by THE OWNER:
   1. Soils testing, including compaction testing by THE OWNER's Geotechnical Engineer, shall be paid for by THE OWNER.
   2. Establishment of original benchmark and baselines.
   3. Removal and Disposal of contaminated materials and hazardous waste, if encountered will be handled by an approved Field Change Authorization (FAC).
   4. Soils Exploration: Soils exploration has been conducted by CTC Geotek. Their findings and recommendations are set forth in their Job No. 282014, dated May 2, 2008. Data acquired from this soils investigation is included only for the CONTRACTOR's information. Recommendations set forth by this report were used at THE OWNER's discretion. Exploratory data presented in the soils report was collected only to develop building foundation design requirements for the Work and pavement section recommendations. Test holes were widely spaced and therefore have limited value for indicating conditions for the CONTRACTOR bidding or construction. If the CONTRACTOR does not choose to obtain additional exploratory data to more accurately portray underground conditions, he should consider all materials to be excavated as unclassified.
1.03 QUALITY ASSURANCE

A. CONTRACTOR's Qualifications: Minimum of five (5) years experience on projects of similar size and cost.

1.04 REFERENCES

A. ASTM D698 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, Using 5.5 lb (2.49 kg) Rammer and 12 inch (305 mm) Drop.
B. ASTM D1556 - Test Method for Density of Soil in Place by the Sand-Cone Method.
E. ASTM D2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

1.05 SUBMITTALS

A. Conform to Section 01 33 00, "Submittals".
B. Product Data: Provide manufacturer's descriptive literature and installation instructions.
C. Samples of offsite import fill materials shall be submitted at least one week prior to import to test for compliance with these specifications.
D. Safety plan for excavation, trenching, and shoring. Include Competent Person on-site.

1.06 MATERIAL DELIVERY, STORAGE, AND HANDLING

A. All fill material shall be placed as it is cut from the site and/or delivered from the "borrow area" and offsite granular fill source. Stock piling will not be permitted except upon written permission by THE OWNER and only then upon the terms and conditions set forth by THE OWNER.

1.07 JOB CONDITIONS

A. Site Examination: Prior to starting work, the CONTRACTOR shall visit and examine the site to become familiar with the existing site conditions. The CONTRACTOR may perform additional soils investigation at his own expense.
B. Scheduling of the Work: The CONTRACTOR shall conform to and comply with the Schedule of Construction.
C. The use of explosives is not permitted.
1.08 QUANTITIES, METHODS OF DETERMINATION FOR PAYMENT OF EARTHWORK OPERATIONS

A. Payments by Lump-Sum Method
1. All earthwork, excavation, backfill, compaction, etc. necessary to perform the work as indicated on the Drawings shall be included in the Base Bid, and shall be paid by Lump-Sum Method.
2. Lump-Sum Method (Base Bid): Earthwork contracted and paid for under this method shall be bid as all inclusive and shall include all labor, material, tools, and equipment necessary to perform all items of excavation, fill, and backfilling; complete, in accordance with the Drawings, the Specifications, Bidding Documents, and other Project Documents.

B. Payments by Unit Price
1. Additional over-excavation and/or soil stabilization, when directed by THE OWNER's Geotechnical Engineer, shall be paid on a Unit Price Basis.
2. Unit Price Method (Additional Work): Earthwork contracted and paid for on this basis shall be based on the actual quantities removed of materials in place in its natural state and quantities compacted in place. Quantity determination shall be by actual measurements performed jointly by the CONTRACTOR and Geotechnical Engineer. Quantities shall be logged daily and certified by parties performing measurements. Certified copies of quantities removed or placed shall be sent to THE OWNER daily as the Work progresses.
3. Unit Prices Required: The CONTRACTOR shall include in his proposal Unit Prices for the following items.
   a. Excavation of unsuitable soils as directed by THE OWNER's Construction Administrator and Geotechnical Engineer, including disposal on site to a location determined by THE OWNER's Construction Administrator.
   b. Excavation of material from an on site (Waterton Plant) "borrow area," transportation and compaction of fill material in its final location as necessary to replace unsuitable material. Borrow area is located within 1.5 miles of the job site.
   c. Importation of structural backfill material from an offsite "borrow area", including transportation and compaction of fill material in its final location, as necessary to replace unsuitable material.
   d. Rock excavation which is not indicated in the soils report or on the Drawings.

1.09 GUARANTEE

A. At completion of the Work and acceptance of same by THE OWNER's Geotechnical Engineer and Construction Administrator, the CONTRACTOR shall issue his written guarantee covering the work performed under this section of the Specifications.

PART 2 - PRODUCTS

2.01 SOIL MATERIALS

A. Backfill
1. Use on-site fill materials complying with CDOH requirements for Class 2 structure backfill. Fill materials shall be obtained from cut areas shown on the plans or staked in the field by the Engineer or imported to the site.
Concrete, asphalt, and other deleterious materials or debris shall not be used as fill. On-site and import materials classifying as SC, SM, SW, SP, GP, GC, and GM as defined by ASTM D2487 are acceptable.

B. Structural Backfill
1. On-site material may be used as outlined in geotech report or imported select granular soils complying with CDOT requirements for Class I structure backfill.

C. Rock (Definition)
1. Rock shall be the material indicated in the soils report as bedrock and all boulders or other detached stones, each having a volume of 1/2 cubic yard or more. Rock requires the use of special equipment (i.e. trackhoe with rock teeth, rock trencher, dozer with ripper teeth) to remove.

D. Bedding Materials, Culverts, Utility Lines, Vaults
1. “Squeegee”, clean sand; medium to coarse, sub-rounded natural river or bank sand; washed, free of silt or clay, loam, friable or soluble materials, and organic matter; graded in accordance with the following grain size distribution:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percentage Passing</th>
</tr>
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<tbody>
<tr>
<td>3/8”</td>
<td>100%</td>
</tr>
<tr>
<td>No. 4 mesh</td>
<td>60 - 90%</td>
</tr>
<tr>
<td>No. 8 mesh</td>
<td>0 - 45%</td>
</tr>
<tr>
<td>No. 16 mesh</td>
<td>0 - 25%</td>
</tr>
<tr>
<td>No. 100 mesh</td>
<td>0 - 2%</td>
</tr>
<tr>
<td>No. 200 mesh</td>
<td>0 - 2%</td>
</tr>
</tbody>
</table>

E. Granular Fill Material
1. Sand/gravel mixture shall conform to Colorado Department of Highways Class 6 aggregate base course requirements.

F. Washed Stone
1. 1/2 to 1 inch natural stone free of shale, clay, friable material, sand and debris.

2.02 ACCESSORIES

A. Detectable Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored as follows:
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.

B. Tracer Wire Test Stations:
PART 3 - EXECUTION

3.01 GENERAL

A. The CONTRACTOR shall furnish all material necessary to complete the excavation and backfill. Materials shall be subject to the approval of THE OWNER's Geotechnical Engineer.

B. Lines and Grade: The CONTRACTOR shall furnish all labor, material, tools and equipment required to establish and maintain line and grade for all areas of the Work. The CONTRACTOR shall establish and maintain benchmarks to the extent that verification of grades can be reasonably made by THE OWNER. The CONTRACTOR shall notify THE OWNER when grades are available for verification and shall assist THE OWNER with the verification.

C. Work Method: Before starting work, the CONTRACTOR shall obtain THE OWNER's Geotechnical Engineer's approval as to the method of placing and compaction.

D. Fill material shall not be placed upon frozen subgrade, nor placed, spread, or rolled while the material is frozen or thawing, nor during unfavorable weather conditions. When work is interrupted by heavy rain, snow, or frost penetration, fill operations shall not be resumed until the Geotechnical Engineer indicates that the moisture content and density of the previously placed fill are as specified.

E. The CONTRACTOR shall be responsible for any damage done to existing underground utilities shown on the Drawings or as identified on Underground Utility Maps and field markings. In areas of excavation, the CONTRACTOR shall field locate the existing underground utilities and shall validate burial depth.

F. Existing Utility Lines: Any sewer, water, gas, electric, nitrogen, telecommunications fiber and copper, or other pipe lines or conduits uncovered during the course of the Work shall be protected from damage until they have been examined by the OWNER. If THE CORPORATION deems it advisable to relocate such lines, the OWNER will pay the cost of relocation. Remove abandoned utility lines as directed by the OWNER's Construction Administrator.

G. Removal of Impounded Water: The CONTRACTOR shall maintain and keep all excavated areas free of impounded water resulting from weather and surface drainage. Slope tops of excavated areas away from the excavations. Mud and silt resulting from impounded water shall be removed from the excavations and the areas brought to grade and line by placing compacted fill as directed by the Geotechnical Engineer. All impounded water encountered in excavations shall be pumped out by the OWNER.

H. Surface Sealing: The CONTRACTOR shall seal all surfaces, by rolling, at the completion of each days work.

I. Buried Piping Identification:
   1. Provide a continuous plastic warning tape (3" minimum width) above all underground utility piping. Tape shall be located 12" below finished grade, installed directly above the buried piping and shall identify in large block letters the type of piping below grade.
   2. Provide a copper or galvanized steel tracer wire (12-gage minimum) wrapped or taped on all buried piping.
3. Provide test stations for access to tracer wires, located adjacent to each valve box or PIV, and at a maximum spacing of 300 feet.

3.02 EXCAVATION

A. Prevent excavated, stockpiled, or disturbed soil from eroding off the construction site into nearby ditches, creeks, or waterways.

B. Excavate as required for walls, footings, grade beams, pits, etc., to depths indicated on the Drawings, including overexcavation below footings and slabs when indicated on the drawings and specifications. If carried deeper than required, excavated areas shall have over-depth recompacted as specified. Bottoms of all excavations shall be level, reasonably smooth and free from loose dirt, rubbish, standing water, frozen material, etc.

C. Shoring: Provide piling, sheathing, shoring, and bracing as required to retain earth walls of excavations and trenches and to maintain retaining walls in true alignment. Comply with OSHA 29 CFR Part 1926 and Colorado Industrial Commission Regulations for Excavation and Shoring. For purposes of compliance with Part 1926, soil shall be assumed to be “Class C” unless classified otherwise by a Professional Engineer registered in the State of Colorado. A Competent Person, as defined by OSHA 1926.651, shall be provided by the CONTRACTOR on-site at all times during operations involving excavation, trenching, and shoring.

D. Excess Materials: All excess materials from excavations and grading not reused in backfilling, fill, and grading shall be removed from the site to a location specified by THE OWNER's Construction Administrator.

3.03 ROCK EXCAVATION

A. When anticipated and unanticipated rock is encountered, THE OWNER's Geotechnical Engineer and Construction Administrator shall be contacted and quantities shall be determined as specified in Paragraph 1.08. The use of explosives is not permitted.

3.04 BACKFILLING

A. Preparation

1. Areas to be backfilled, except rock excavations, shall be plowed or scarified to a minimum depth of eight (8) inches until the surface is free from ruts, hummocks, or other uneven features which would prevent uniform compaction by the equipment to be used. The areas shall then be disked or bladed until it is free from large clods. The subgrade materials shall be brought to the proper moisture content and compacted to the density as specified in Paragraph 3.4 D for the type of backfill specified, unless otherwise noted. The subgrade materials shall be worked, stabilized or removed and replaced if necessary in accordance with THE OWNER's Geotechnical Engineer's recommendations in preparation for fill.

2. Where fill will be placed on slopes of 4:1 (horizontal to vertical) or greater, the slope shall be benched prior to placement of fill. One bench shall be provided for each 3 to 5 feet of slope height. All areas of rock excavation shall be benched prior to placement of backfill and topsoil.
B. Moisture Content
1. Fill materials shall be moisture treated to within limits of optimum moisture content specified in Paragraph 3.4 D. Sufficient laboratory compaction tests shall be made to determine the optimum moisture content of the various soils encountered in borrow areas or imported to the site.
2. The Contractor may be required to add moisture to the excavation materials in the borrow area if, in the opinion of THE OWNER's Geotechnical Engineer, it is not possible to obtain uniform moisture content by adding water on the fill surface. The Contractor may be required to rake or disk the fill soils to provide uniform moisture content through the soils.
3. The application of water to embankment materials shall be made with any type of watering equipment approved by THE OWNER's Geotechnical Engineer, which will give the desired results. Water jets from the spreader shall not be directed at the embankment with such force that fill materials are washed out.
4. Should too much water be added to any part of the fill, such that the material is too wet to permit the desired compaction from being obtained, rolling and all work on that section of the fill shall be delayed until the material has been allowed to dry to the required moisture content. The Contractor will be permitted to rework wet material in an approved manner to hasten its drying.

C. Compaction of Fill Areas: Following are minimum requirements for which the CONTRACTOR is required to comply. CONTRACTOR is responsible for full compliance with contract documents, and may perform additional testing at his expense.
1. Fill materials shall be placed and mixed in evenly spread layers. After each fill layer has been placed, it shall be uniformly compacted to not less than the specified percentage of maximum density given in Paragraph 3.4 D. Fill materials shall be placed such that the thickness of loose material does not exceed eight (8) inches.
2. Compaction, as specified above, shall be obtained by the use of sheepsfoot rollers, multiple-wheel pneumatic-tired rollers, or other equipment approved by THE OWNER’s Geotechnical Engineer for soils classifying as CL or SC. Granular fill shall be compacted using vibratory equipment or other equipment approved by THE OWNER's Geotechnical Engineer. Compaction shall be accomplished while the fill material is at the specified moisture content. Compaction of each layer shall be continuous over the entire area.
3. Proofrolling: Perform, as directed by THE OWNER's Geotechnical Engineer, to determine location of unacceptable soft areas. Unacceptable areas shall be over-excavated and stabilized in accordance with Geotechnical Engineer's recommendations.
4. Backfill around all walls, retaining walls, etc., shall be installed in compliance with the provisions of Paragraph 3.4.D. Soil material shall not be shoveled against foundations into excavations by a tractor or other machinery. Backfill at walls shall be placed evenly on both sides of the wall at the same time. Provide shoring as required to maintain structural stability of the walls, etc.

D. Compaction Requirements
1. Footing and Foundations - Use Structural backfill 5 feet below and extending 5 feet beyond the edge of the footing. The bottom of the excavation shall be compacted to a 95% of Modified Proctor maximum dry
density (ASTM D698). The structural fill shall be placed in thin, loose lifts, moistened to Plus or Minus 2% of optimum moisture content, and compacted to a minimum 95% Modified Proctor maximum dry density (ASTM D698).

2. Floor Slabs - Use structural backfill 3 feet beneath the floor slab. The bottom of the excavation shall be compacted to a minimum of 100% of Standard Proctor maximum dry density (ASTM D698). The structural fill shall be placed in thin, loose lifts, moistened to ±2% of optimum moisture content, and compacted to a minimum of 100% of Standard Proctor maximum dry density (ASTM D698).

3. Slab-On-Grade (Exterior concrete slabs, sidewalks and curb and gutter) - Use backfill material - placed in thin, loose lifts, moistened to within ±2% of optimum moisture content, and compacted to a minimum of 100% of Standard Proctor maximum density (ASTM D698).

4. Pavement Areas - Use backfill material - placed in thin, loose lifts, moistened to within ±2% of optimum moisture content and compacted to a minimum of 95% of Standard Proctor maximum dry density (ASTM D698). Prior to paving, scarify the entire sub-grade to a minimum depth of eight inches, moistened to within ±2% of optimum moisture content and compacted to a minimum of 95% of Standard Proctor maximum dry density (ASTM D698). Before placing base course, the entire area shall proof rolled with a heavy pneumatic-tired vehicle. Areas which deform excessively shall be over-excavated and recompacted or stabilized using crushed rock and geotextile fabric to the satisfaction of THE OWNER’s Geotechnical Engineer and the Owner’s Representative.

5. Landscaped and Natural Terrain Areas - Use backfill material - placed in thin, loose lifts, moistened to within ±2% of optimum moisture content and compacted to a minimum of 90% of Standard Proctor maximum dry density (ASTM D698). Scarify the top 4 inches of areas to be seeded.

6. Fill Behind Walls - Use backfill material except the top 3 feet below floor slabs which shall have structural fill. The backfill shall be placed in thin loose lifts, moistened to within ±2% of optimum moisture content and compacted to a minimum of 100% of Standard Proctor maximum dry density (ASTM D698). Compaction of backfill should avoid over-stressing of the walls. A hand-operated compactor should be used for compaction within 2 feet adjacent to the wall. The Contractor should anticipate very thin lifts (2 to 4 inches) for hand compacted materials.

7. Trenches - The bottom of the excavation shall be compacted to a minimum of 95% Modified Proctor maximum density (ASTM D1557). The bedding material shall be placed in the excavation and moistened to within ±2% of optimum moisture content and compacted to a minimum of 95% Modified Proctor maximum density (ASTM D1557). Utilities shall be placed in the trench as per the Drawings and additional bedding material placed over the utilities and compacted. Backfill material shall be placed in thin loose lifts, moistened to within ±2% of optimum moisture content, and be compacted as per Section 3.05 D paragraphs 1-6. Utility caution tape shall be placed on a smooth, level, compacted surface (at the depth specified on the Drawings) and inspected by THE OWNER’s Construction Administrator prior to placement of the additional lifts of backfill.

8. Stabilized new and existing roadways. Prior to aggregate base course, scarify the entire subgrade to a minimum depth of twelve inches, moisture condition to near optimum moisture content (-1 to +3%) and compact to a
minimum of 95% maximum Modified Proctor dry density (ASTM D1557). Before placing base course, the entire area shall proof rolled with a heavy pneumatic-tired vehicle. Areas which deform excessively shall be over-excavated and recompressed to the satisfaction of THE OWNER's Geotechnical Engineer and THE OWNER. Aggregate base course shall be graded and compacted to 95% of the Modified Proctor (ASTM D1557) at near optimum moisture content (±2%).

3.05 FIELD QUALITY CONTROL

A. Field Density Tests
   1. Field density tests shall be performed in accordance with ASTM D2922 or ASTM D1556 by THE OWNER's Geotechnical Engineer.
   2. Field Density tests shall be performed for every lift of fill.
   3. Foundations and Floor Slabs - Make at least one field density test of subgrade and fill area for every [1,000] sq. ft. and at each footing or as directed by THE OWNER, but in no case less than three (3) tests per lift of fill.
   4. Steps and Walkways: Make at least one field density test of subgrade and fill area for every [40] lin. ft. or as directed by THE OWNER, but in no case less than three (3) tests per lift of fill.
   5. Paved Areas: Make at least one field density test of subgrade and fill area for every [2,000] sq. ft. or as directed by THE OWNER, but in no case less than three (3) tests per lift of fill.
   6. Trenches: Make at least one field density test of subgrade and fill area for every [100] lin. ft. or as directed by THE OWNER, but in no case less than three (3) tests per lift of fill.
   7. Unpaved Areas: Make at least one field density test of subgrade and fill area for every [10,000] sq. ft. or as directed by THE OWNER, but in no case less than three (3) tests per lift of fill.

B. Elevation Tolerances
   1. Subgrade: Variation from the subgrade plane shall not be more than 0.08 feet. Where bituminous surfacing materials are to be placed on the subgrade, variations in the subgrade plane shall not vary more than 0.04 feet.
   2. Finish Earthwork Grades: Variation from the specified finish grade plane shall not be more than 0.08 feet within 10 feet of any structure and not more than 0.30 feet in other areas.

3.06 TRENCHING

A. Trenching work shall be performed in a safe and proper manner with suitable precautions being taken against all hazards. Trenches shall provide adequate working space and clearances for the work to be performed therein. Adequate sheeting and shoring shall be provided as required to protect and maintain the stability of the sides of trenches until they are backfilled in accordance with OSHA 29 CFR Part 1926 and Colorado Industrial Commission Regulations for Excavation and Shoring. A Competent Person, as defined by OSHA 1926.651, shall be provided by the CONTRACTOR on-site at all times during operations involving excavation, trenching, and shoring.
B. The CONTRACTOR shall locate, protect, shore, brace, support, and maintain all existing underground pipes, conduits, drains and other underground construction which might be uncovered or otherwise affected by the Work. Trench bottoms shall be firm, dense, and thoroughly compacted and free from mud and mulch and shall remain firm and intact under the feet of the workmen. The CONTRACTOR shall not open more trench in advance of pipe laying than is necessary to expedite the Work.

C. Materials
1. Section 02 42 00: Site Drainage.
2. Section 02 51 00: Water Distribution Systems.

D. Installation
1. Piping: Where shown or called for, accurately install in accordance with the Drawings. Lines and grades between designated invert elevations shall be uniform to ensure unrestricted flow and eliminate low spots or traps that would retain water. [Pipe laying shall begin at the lowest point and pipe shall be laid so that the spigot ends point in the direction of flow.] All pipe shall be laid so that it will have uniform support throughout its length with subgrade foundation as indicated on the Drawings.
2. Backfill shall be placed and compacted as specified in Paragraph 3.05 D.
3. Hydraulic Structures: Structures shall be constructed, complete, in accordance with the details shown on the Drawings.
4. Manholes: Manholes and vaults shall be constructed, complete, in accordance with the Drawings and Section 03 43 00 “Precast Manhole and Utility Structures”.

E. Installation of Electrical and Telephone Systems: In accordance with the Drawings and Division 16, "Electrical".

F. Existing Asphalt: Asphalt shall be saw-cut and removed from THE OWNER's property. Installation of any utilities shall be in accordance with the Specifications and the Drawings. Backfill, compact, and patch asphalt to match existing asphalt thickness unless indicated otherwise on the Drawings. Paint line striping as required to match existing.

G. Undisturbed Terrain: Place and compact backfill as specified. Fill and slightly mound the backfill above the undisturbed terrain elevation, and fine grade to blend in with adjacent areas. Seed where vegetation has been damaged, in accordance with Section 02 93 60, "Seeding."

END OF SECTION
SECTION 31 63 29
DRILLED CONCRETE PIERS AND SHAFTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following:
   1. Drilling, casing (if necessary), cleaning, and dewatering (if necessary) of drilled pier holes.
   2. Removal of drilling spoil from immediate vicinity of the drilled pier hole.
   3. Forming shear rings.
   4. Installation of concrete and reinforcing in drilled piers.
   5. All other work normally related to the above or specified under this section.

B. Related Sections include the following:
   1. Division 01 Section "Unit Prices" for list of unit prices.
   2. Division 01 Section "Temporary Facilities and Controls."
   3. Division 03 Section "Cast-in-Place Concrete" for general structural and building applications of concrete.

C. Work Installed but Furnished under Other Sections.
   1. Drilled Pier Reinforcing and Dowels: Furnished under Division 3 Section "Cast-in-Place Concrete".
   2. Concrete for Drilled Pier: Furnished under Division 3 Section "Cast-in-Place Concrete".
   3. Concrete Testing: Division 3 Section "Cast-in-Place Concrete".
   4. Anchor Rods: Furnished under Division 5, Section for Structural Steel.

1.03 UNIT PRICES

A. Basis of Bids: Base bids on indicated number of drilled piers; design length from top elevation to bottom of shaft, and diameter of shaft.

B. Basis for Payment: Payment for drilled piers will be made on actual net volume of drilled piers in place and approved. Actual length, shaft diameter and, if applicable, bell diameter may vary to coincide with elevations where satisfactory bearing strata are encountered, and with actual bearing value of bearing strata determined by an independent testing and inspecting agency. Adjustments will be made on net variation of total quantities, based on design dimensions for shafts.
   1. Unit prices include labor, materials, tools, equipment, and incidentals required for excavation, trimming, shoring, casings, dewatering, reinforcement, concrete fill, and other items for complete drilled-pier installation.
   2. See Division 01 Section "Unit Prices" for list of unit prices.
1.04 SUBMITTALS

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

B. Shop Drawings: For concrete reinforcement detailing fabricating, bending, and placing.

C. Design Mixes: For each class of concrete. Include revised mix proportions when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
   1. Laboratory Test Reports: For evaluation of concrete materials and mix design.

D. Record drawings at Project closeout according to Division 01 Section "Closeout Procedures."

1.05 QUALITY ASSURANCE


B. Survey Work: Engage a qualified land surveyor or professional engineer to perform surveys, layouts, and measurements for drilled piers. Before excavating, lay out each drilled pier to lines and levels required. Record actual measurements of each drilled pier's location, shaft diameter, bottom and top elevations, deviations from specified tolerances, and other specified data.
   1. Record and maintain information pertinent to each drilled pier and cooperate with Owner's testing and inspecting agency to provide data for required reports.

C. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 to perform material evaluation tests selected and paid for by the Owner.
   1. Contractor shall furnish Testing Agency access to work, facilities, and incidental labor required for testing and inspection. Retention by the Owner of an independent Testing Agency shall in no way relieve the Contractor of responsibility for performing all work in accordance with the contract requirements. See requirements herein for Testing Agency services.
   2. The Owner's Testing and Inspection Agency shall be the Project Geotechnical Engineer where indicated.

D. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.06 PROJECT CONDITIONS

A. Existing Utilities: Locate existing underground utilities before excavating drilled piers. If utilities are to remain in place, provide protection from damage during drilled-pier operations.
   1. Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, adapt drilling procedure if necessary to prevent damage to utilities. Cooperate with Owner and utility companies in keeping services and facilities in operation without interruption. Repair damaged utilities to satisfaction of utility owner.

B. Site Information: A geotechnical report has been prepared for this Project and is available for reference for information only.
   1. The drilling log and accompanying report are believed to be accurate; however, neither the Owner, Architect, nor the Structural Engineer guarantees the
information contained nor do they guarantee the conditions indicated to exist at
the location of the test holes will prevail at other locations on the site.

PART 2 - PRODUCTS

2.01 STEEL REINFORCEMENT

A. Meet requirements of Section 033000 “Cast-in-Place Structural Concrete”.

2.02 CONCRETE MATERIALS

A. Meet requirements of Section 033000 “Cast-in-Place Structural Concrete”.

2.03 TEMPORARY STEEL CASINGS

A. Steel Pipe Casings: ASTM A 283/A 283M, Grade C; or ASTM A 36/A 36M, carbon-steel
   plate, with joints full-penetration welded according to AWS D1.1.
   1. Provide casings where required of sufficient strength to withstand handling
      stresses, concrete pressure and surrounding earth pressure. Casing inside
diameter shall equal size of drilled pier specified such that the drilled pier
diameter is within the tolerances noted below.

PART 3 - EXECUTION

3.01 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage
   caused by settlement, lateral movement, vibration, and other hazards created by drilled-
pier operations.

3.02 EXCAVATION

A. Drilling: By personnel experienced and properly equipped to construct drilled piers of
   indicated diameter and length. Drill diameter and with penetration into bearing material as
   indicated or as directed by the on-site Project Geotechnical Engineer.

B. Unclassified Excavation: Excavation is unclassified and includes excavation to bearing
   elevations regardless of character of materials or obstructions encountered.
   1. Unclassified excavation includes removal of unanticipated boulders, concrete,
      masonry, or other subsurface obstructions.
   2. Removal of unanticipated boulders, concrete, masonry, or other unforeseen
      obstructions that cannot be removed by conventional augers fitted with soil or
      rock teeth, drilling buckets, or underreaming tools attached to drilling equipment
      of size, power, torque, and downthrust necessary for the Work, will be paid
      according to Contract provisions for changes in the Work.

C. Prevent surface water from entering excavated shafts. Conduct water to site drainage
   facilities.

D. Excavate shafts for drilled piers to indicated elevations. Remove loose material from
   bottom of excavation.
   1. Excavate bottom of drilled piers to level plane within 1:12 tolerance.
   2. Ground Surface elevation at time of drilling shall preferably be within 24” of top of
      drilled pier. Form top of drilled pier if ground surface is higher than this amount

DRILLED CONCRETE PIERS AND SHAFTS

31 63 29 - 3
above top of drilled pier, as required to prevent enlargement of pier diameter at the top of pier (mushrooming). Contractor shall carefully chip top of drilled pier once the excavation reaches the drilled pier elevation. Chipping shall be done under the continuous observation of the Owner’s Testing and Inspection Agency. Do not damage rebar or concrete that remains. Chip until all contaminated concrete has been removed. Top of drilled pier after chipping shall be level to within 2” without spalls at the edges.

3. Cleaning and Dewatering: Holes shall be thoroughly dewatered and cleaned of debris by the Contractor before placing concrete. The Contractor shall provide pumps in operating condition, of proper type and capacity for this type of work and sufficient hose to carry water away from excavations. Holes shall be dewatered so no more than 3 inches of water exists in the bottom of any hole when placing of concrete is started. Necessary equipment for cleaning of holes and a back-up pump in operating condition for dewatering shall be available on site at all times.

4. Cut series of grooves about perimeter of shaft to height from bottom of shaft, vertical spacing and dimensions indicated. Roughen sides of drilled pier hole as directed by Project Geotechnical Engineer.

5. Excavate reinforce, and completely fill drilled pier with concrete on the same day.

E. Notify and allow Project Geotechnical Engineer to test and inspect bottom of excavation. If unsuitable bearing stratum is encountered, make adjustments to drilled piers as determined by Architect.

1. Do not excavate shafts deeper than elevations indicated, unless approved by Architect.
2. Additional authorized excavation will be paid according to Contract provisions for changes in the Work.

F. Excavate shafts for closely spaced drilled piers and those occurring in fragile or sand strata, only after adjacent drilled piers are filled with concrete and allowed to set.

G. Temporary Casings: Where necessary, install watertight steel casings of sufficient length and thickness to prevent entry of soil or water seepage into shaft; to withstand compressive, displacement, and withdrawal stresses; and to maintain stability of shaft walls. The use of mud slurry to lubricate casings or seal off water will be allowable only with the prior approval of the Project Geotechnical and Structural Engineers. Casings may be left in place only with prior approval of the Project Geotechnical and Structural Engineers.

1. Casing Removal: Pull temporary casing with a slow and smooth vertical motion maintaining casing in a plumb position. Casing shall not be pulled until concrete has been placed to a minimum of 5 feet above external water or slurry level or level of unstable soil. During pulling maintain concrete level a minimum of 5 feet above bottom of casing. Vibrate top 5 feet of pier after temporary casing is removed.

H. Tolerances: Construct drilled piers to remain within ACI 336.1 tolerances.

1. If location or out-of-plumb tolerances are exceeded, provide corrective construction. Submit design and construction proposals to Architect for review before proceeding.
2. Diameter tolerance is + 1”, -1”.

I. Inspection: Each drilled pier must be inspected by the Project Geotechnical Engineer before placing concrete.

1. Provide and maintain facilities with equipment required for inspecting excavations. Cooperate with testing and inspecting personnel to expedite the Work.
2. Notify Architect and Project Geotechnical Engineer at least 24 hours before excavations are ready for inspections.

3.03 STEEL REINFORCEMENT

A. Comply with recommendations in CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
   1. Reinforcing: Exact location of dowels and reinforcing extending into adjacent construction shall be verified by the Contractor. Deviations in location of such reinforcing in excess of specified placing tolerances shall be reported to the Architect within 24 hours after concrete is placed. In reinforced piers, completed installation of reinforcement must be approved by the Project Geotechnical Engineer before depositing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy bond with concrete.

C. Fabricate and install reinforcing cages symmetrically about axis of shafts in a single unit.

D. Accurately position, support, and secure reinforcement against displacement during concreting. Maintain cover to reinforcement.

E. Use templates to set anchor bolts, leveling plates, and other accessories furnished in work of other Sections. Provide blocking and holding devices to maintain required position during final concrete placement.

F. Protect exposed ends of extended reinforcement, dowels, or anchor bolts from mechanical damage and exposure to weather.

3.04 CONCRETE PLACEMENT

A. Place concrete in continuous operation and without segregation immediately after inspection and approval of shaft by the Project Geotechnical Engineer.
   1. Place concrete continuously without construction joints for full height of pier.
   2. Construct a construction joint if concrete placement is delayed more than one hour. Level top surface of concrete.

B. Place concrete to fall vertically down the center of drilled pier without striking sides of shaft or steel reinforcement.
   1. Where concrete cannot be directed down shaft without striking reinforcing, place concrete with chutes, tremies, or pumps. Free fall of vertical concrete shall not exceed 20 feet for 24 inch and smaller diameters.
   2. Vibrate top 60 inches of concrete after dowels or anchor bolts have been placed.
   3. Do not deposit concrete in more than three inches of water.

C. Screed concrete at cutoff elevation level and apply scoured, rough finish. Where cutoff elevation is above the ground elevation, form top section above grade and extend shaft to required elevation. Enlargement or "mushrooming" of top part of drilled pier is not permitted.

D. Protect concrete work, according to ACI 301, from frost, freezing, or low temperatures that could cause physical damage or reduced strength.
   1. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
2. Do not use calcium chloride, salt, or other mineral-containing antifreeze agents or chemical accelerators.

E. When hot-weather conditions exist that would seriously impair quality and strength of concrete, place concrete according to ACI 301 to maintain delivered temperature of concrete at no greater than 90 deg F.

3.05 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency and the Project Geotechnical Engineer to sample materials, and submit reports during excavation and concrete placement for drilled piers.

B. A drilled-pier report will be prepared by the Project Soils Geotechnical Engineer for each drilled pier as follows:
1. Identification Mark and location.
2. Shaft diameter.
3. Actual top and bottom elevations, and design bottom elevation.
4. Top of bearing strata elevation.
5. Description of soil materials.
6. Description, location, and dimensions of obstructions.
7. Final top centerline location and deviations from requirements.
8. Variation of shaft from plumb.
10. Levelness of bottom and adequacy of cleanout.
11. Ground-water conditions and water-infiltration rate, depth, and pumping.
12. Description, diameter, and top and bottom elevations of temporary or permanent casings. Include elevation of top of concrete, elevation of bottom of casing and elevation of external water level/slurry immediately before casing is pulled.
13. Description of soil or water movement, sidewall stability, loss of ground, and means of control.
14. Bell dimensions and variations from original design.
15. Date and time of starting and completing excavation.
16. Size, number, and position of reinforcing steel.
17. Concrete placing method, including elevation of consolidation and delays.
20. Remarks, unusual conditions encountered, and deviations from requirements.
21. Concrete testing results.
22. Overrun or underrun.

C. Soil Inspection: Bottom elevations, bearing capacities, and lengths of drilled piers indicated have been estimated from available soil data. Actual elevations and drilled-pier lengths will be determined by the Project Geotechnical Engineer. Final evaluations and approval of data will be determined by Architect.

D. The Testing Agency shall test concrete as specified in Section 033000 Cast-in-Place Structural Concrete. Take test specimens, consisting of at least one set of four cylinders as follows:
1. If more than one pier is cast from the same truckload, take one set per truckload.
2. If more than one truckload is placed in a pier, take one set per pier.
3. Take not less than one set for each 100 cubic yards and take not less than one set each day.
3.06 DISPOSAL OF MATERIALS

A. Dispose of such material as specified under Section 135000 Earthwork.

END OF SECTION
SECTION 32 01 90.33
TREE AND SHRUB PRESERVATION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Protection of existing trees indicated to remain.
   2. Protection of other existing plants indicated to remain.

B. Related Sections:
   1. Site Grading and Excavation: Section 31 00 00 Earthwork

PART 2 - PRODUCTS

2.01 MATERIALS

A. Barricades: Contractor's option as appropriate to serve required purpose and accepted by Architect.

PART 3 - EXECUTION

3.01 TREE AND PLANT PROTECTION

A. General: Preserve and protect existing trees and plants at site that are designated to remain, and those adjacent to site.

B. Barriers: Provide temporary barriers to height of six feet, around each, or around each group, of trees and plants at drip line.

C. Trimming: Consult with Architect, and trim agreed on roots and branches that interfere with construction.
   1. Employ qualified tree surgeon to remove, and to treat cuts.
   2. Trim under Architect's direction.
   3. Do not cut roots greater than 1" in diameter without advance notice to Architect.
   4. Cut close to boles in manner that tree will present balanced appearance.
   5. Treat scars resulting from removal of branches over 1" in diameter with heavy coat of approved tree paint.

D. Root Systems: Maintain natural cover of turf around root systems. Replace turf if necessary.

E. Stockpiles: Place stockpiles of topsoil and other excavated material so that they will not slough off onto root systems of existing trees.

F. Contaminates: Dispose of solvents, oils and other materials that may be harmful to plant life in containers and remove from site. Remove and replace contaminated soil with good soil at completion of work.

G. Areas Under Trees: Within drip line of existing trees to remain:
   1. Do not allow vehicular traffic or parking.
   2. Do not store materials or products.
3. Prevent dumping of refuse or chemically injurious materials or liquids.
4. Prevent puddling or continuous running water.
5. Do not leave diesel or gasoline equipment running.

H. Protection: Carefully supervise excavating, grading and filling and subsequent construction operations, to prevent damage to plant materials. Protect against breaking and skinning of roots and skinning and bruising of bark.

3.02 WATERING

A. Trees: Water at least every 14 days during construction period by forming suitable dikes and/or soaking devices at drip line and applying approximately 6" of water each time. Water frequency during winter rain season may be reduced upon acceptance of Architect.

3.03 TREE REMOVAL

A. General: Remove trees indicated to be removed. Architect will tag trees to be removed.

B. Removal: Include new and old stumps of trees and their roots. Fell trees in manner not to injure standing trees, plants and other improvements to remain. If impossible to remove roots, grind stumps to 6" below finish grade.

3.04 REPLACEMENT

A. General: Be responsible for care and preservation of existing trees and other plant material that are indicated to remain.

B. Replace, or suitably repair, trees and plants designed to remain which are damaged or destroyed due to construction operations.
   1. Architect will determine repair and replacement requirements.
   2. For trees impossible to replace, Architect will place value on units based on latest edition of "Guide for Establishing Values of Trees and Other Plants" prepared by Council of Tree and Landscape Appraisers.

END OF SECTION
SECTION 32 12 16
HOT MIX ASPHALT PAVEMENTS (HMAP)

All section references are to Section 401 of the Colorado Department of Transportation Standard Specifications for Roads and Bridges, 2005 Edition.

PART 1 - DESCRIPTION

1.01 GENERAL

A. These specifications cover the requirements for the construction of Superpave Hot Mix Asphalt pavements. They include the general requirements for the construction of one or more lifts of Hot Mix Asphalt Pavement on a prepared surface. The work shall consist of the preparation of the Hot Mix Asphalt (HMA) meeting the requirements herein, and the placement of the HMA to the lines, grades, thicknesses and typical cross-sections shown on the plans or established by the Owner. When more than one lift is required, each lift shall be compacted to the required density and approved prior to the placement of the succeeding lift.

B. The volume and loading levels for the various designations are listed in table 401-1 and shall be used for these specifications.

<table>
<thead>
<tr>
<th>Designation</th>
<th>Volume and Loading Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>≤ 300,000 ESALs</td>
</tr>
<tr>
<td>Moderate</td>
<td>&gt; 300,000 and ≤ 10,000,000 ESALs</td>
</tr>
<tr>
<td>High</td>
<td>&gt; 10,000,000 ESALs</td>
</tr>
<tr>
<td>Trails and Pathways</td>
<td>&lt; 100,000 ESALs – able to accommodate a 4000 lb vehicle for safety and maintenance purposes</td>
</tr>
<tr>
<td>Parking Lots</td>
<td>25% of volume used for entrance roadways</td>
</tr>
</tbody>
</table>

C. Work included: Hot Mix Asphalt paved areas as indicated on the Drawings and including, but not necessarily limited to the following:

1. Final preparation of subgrade.
2. Soil sterilization under pavement.
4. Asphalt tack coat.
5. Asphalt surfacing materials.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

1. Division 1: General Requirements
2. Section 02 30 00: Earthwork
3. Section 02 42 00: Site Drainage
4. Section 03 30 00: Concrete Cast-In-Place.
1.03 QUALITY ASSURANCE

A. Contractor’s Qualifications: Minimum of five (5) years experience on projects of equal size and complexity.

B. Mix designs: The Testing Laboratory shall, at the CONTRACTOR’s expense, test all materials for compliance with these specifications and establish a job mix formula for each mixture proposed for use on this project. Using the blank copy herein, the CONTRACTOR shall include a completed copy of MGPEC Form #9 with each mix design submittal. Each mix design submittal shall include the following:

1. Aggregate gradation, specific gravity, LA Abrasion, and all other physical properties.
2. Asphalt Cement properties, with recommended field compaction temperature limits.
4. Mixing and Compaction temperatures.
5. Mixture properties at a minimum of four (4) asphalt contents.

The Testing Laboratory shall submit to THE OWNER for approval three (3) copies of a report containing legible copies of all test data, graphs, tables, and charts used to establish the job mix formula, as well as MGPEC form #9. The report shall bear the seal of a Professional Engineer registered in the State of Colorado and competent in Hot Mix Asphalt mix design and construction. In order for a proposed material to be acceptable, the Testing Laboratory must report that the proposed materials and job mix meet or exceed this specification.

PART 2 - MATERIALS

2.01 GENERAL

A. The HMA shall be composed of a mixture of aggregates, approved filler or additives, asphalt binder, and reclaimed asphalt pavement (RAP), when permitted.

2.02 AGGREGATES

A. Aggregates shall be of uniform quality, clean, hard, durable particles of crushed stone, crushed gravel or crushed slag free from clay balls, vegetable matter or other deleterious materials meeting the requirements of Table 401-2.
### Table 401-2
#### Aggregate Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Procedure</th>
<th>Coarse Retained on #4 Sieve</th>
<th>Fine Passing the #4 Sieve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fine Aggregate Angularity</td>
<td>CP-L5113 Method A</td>
<td>40% Minimum</td>
<td>45% Minimum</td>
</tr>
<tr>
<td>Traffic Level Low, Moderate, Trails and Pathways</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traffic Level 3 to 5 Moderate, High, Parking Lots</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fractured Faces (minimum of 2)</td>
<td>CP-45</td>
<td>80% Minimum</td>
<td></td>
</tr>
<tr>
<td>LA Abrasion</td>
<td>AASHTO T96</td>
<td>45% Minimum</td>
<td></td>
</tr>
<tr>
<td>Flat and Elongated Pieces</td>
<td>AASHTO M283</td>
<td>10% Maximum</td>
<td></td>
</tr>
<tr>
<td>Sodium Sulfate Soundness</td>
<td>AASHTO T104</td>
<td>12% Maximum Combined Coarse and Fine</td>
<td></td>
</tr>
<tr>
<td>Adherent Coating (Dry Sieve)</td>
<td>ASTM D5711</td>
<td>0.5%</td>
<td>45% Minimum</td>
</tr>
<tr>
<td>Sand Equivalent</td>
<td>AASHTO T176</td>
<td>45% Minimum</td>
<td></td>
</tr>
</tbody>
</table>

Aggregates meeting the requirements of Table 401-2 shall be used to develop the Job Mix Formula (JMF) for the HMA mixture. The aggregate should be composed of angular, coarse textured, cube shaped particles. Excess of fine material shall be wasted before crushing. Sand may be used to obtain gradation of the blended aggregate mixture but should not exceed more than 15%. If the percent of aggregate passing the #4 sieve is greater than 10% by weight of the individual aggregate sample, Plasticity will be determined in accordance with AASHTO T90. The gradation of the aggregates used in the mixture shall meet the criteria shown in Table 703-3, and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve, or vice versa, but shall be well graded from coarse to fine. The nominal size aggregate used in the HMA mixture shall not be more than one-third the thickness of the HMA lift being constructed.

2.03 MINERAL FILLER

A. If mineral filler is required to meet the JMF it shall conform to the requirements of Section 703.06.

2.04 ADDITIVES

A. Additives to the mineral aggregate shall be used if the asphalt binder will not coat or stick to the aggregates. Additives shall be in the form of hydrated lime and shall conform to ASTM C207, Type N. The residue retained on a #200 sieve shall not exceed 10% when determined in accordance with ASTM C110. Hydrated lime shall be added at the rate of 1% by dry weight of the aggregate.

2.05 RECLAIMED ASPHALT PAVEMENT

A. Reclaimed Asphalt Pavement (RAP) shall be allowed in the HMA mixture. It shall be of
uniform quality and gradation with a maximum size no greater the nominal size of the HMA mixture. HMA mixtures containing RAP shall meet the same gradation requirements as a virgin HMA mix.

2.06 ASPHALT BINDER

A. Performance Grade asphalt binders shall meet the requirements of Table 702-2. Any asphalt binder supplied must be from an approved source. An approved source for asphalt binders has to be certified by the Colorado Department of Transportation. The Contractor shall provide to the Owner acceptable “Certification of Compliance” for each applicable asphalt binder grade that will be used on the project. Binder grades other than those shown in Table 702-2 will not be allowed unless the proposed binder and mix design are approved by the Owner.

1. Mixture Binder Selection. The binder to be used in the HMA mixture will depend on the local traffic level and traffic conditions. Binder grade selection for the HMA mixture for different traffic levels is shown in Table 401-3.

<table>
<thead>
<tr>
<th>Traffic Levels</th>
<th>Binder Grades</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low (&lt;300,000 ESALs)</td>
<td>PG 58-28</td>
</tr>
<tr>
<td>Moderate (300,000 to ≤10,000,000 ESALs)</td>
<td>PG 64-22</td>
</tr>
<tr>
<td>High (&gt;10,000,000 ESALs)</td>
<td>PG 76-28</td>
</tr>
<tr>
<td>Trails and Pathways (100,000 ESALs)</td>
<td>PG 58-28</td>
</tr>
<tr>
<td>Parking Lots (25% of entrance roadway)</td>
<td>PG 64-22</td>
</tr>
</tbody>
</table>

(a) Prime Coat Material. Prime coat material shall either be an emulsified asphalt prime coat conforming to the requirements of Table 702-6 or a penetrating priming stabilizer conforming to the requirements of Table 702-7.

(b) Tack Coat Material. Tack coat material shall be an emulsified asphalt conforming to AASHTO M140 or M208 for the designated grades. When grade CSS-1h or SS-1h emulsified asphalt is used, residue penetration test values shall be between 40 and 120.

2.07 MATERIAL ACCEPTANCE

A. Prior to the delivery of materials to the job site, the Contractor shall submit certification tests to the Owner, for his approval, showing all materials to be used on the project. The certification shall show appropriate test(s) for each material, the test results, and a statement that the materials meet the appropriate specification. If the Owner requests samples of the materials for verification testing prior to and/or during the production of the HMA mixture, the Contractor shall deliver the requested materials to the owner’s designated representative within 2 days of the initial request.

PART 3 - CONSTRUCTION REQUIREMENTS

3.01 GENERAL

A. The Contractor shall submit his JMF to the Owner for approval fourteen (14) calendar days prior to the beginning of paving operations. The JMF for each mixture to be used
on the project shall be approved prior to the start of any paving operation. The mix design(s) shall be developed using the Superpave mix design procedures and shall be prepared under the direct supervision of an engineer licensed in the State of Colorado practicing in this field.

The Contractor shall submit the following as part of each mix design:

1. Source(s) of materials.
2. Aggregate gradation, specific gravity, source and description of individual aggregates in the final mixture blend.
3. Aggregate physical properties.
4. Source and grade of performance graded binder along with certification of binder.
5. Proposed JMF: aggregate and additive blending, final gradation shown on a 0.45 power graph, optimum binder content.
6. Mixing and compaction temperatures.
7. N_{ini}, N_{des}, and N_{max}.
8. Mixture properties determined at the minimum of four binder contents and interpolated at optimum and graphs showing mixture properties versus binder content.
9. Percent of RAP if used in the mixture.

The mix design(s) shall meet the requirements of Table 703-3, Table 401-3, Table 401-4, and Table 401-5. The HMA mixture(s) will be designed for each item listed in Section 403.05 as shown in the bid schedule.

Table 401-4
Superpave Mixture Properties

<table>
<thead>
<tr>
<th>Test Property</th>
<th>Traffic Levels</th>
<th>Trails and Pathways</th>
<th>Low, Moderate, Parking Lots</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic Level – Design period ESALs</td>
<td></td>
<td>&lt; 3 million</td>
<td>&gt; 3 million</td>
<td></td>
</tr>
<tr>
<td>Initial gyrations, N_{ini}</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Air voids @ N_{ini}</td>
<td>&gt; 8.5</td>
<td>&gt; 9.5</td>
<td>&gt; 11.0</td>
<td></td>
</tr>
<tr>
<td>Design gyrations, N_{des}</td>
<td>50</td>
<td>75</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Hveem stability, CP-L 5106</td>
<td>NA</td>
<td>28 min.</td>
<td>30 min.</td>
<td></td>
</tr>
<tr>
<td>Voids filled with asphalt, VFA, MS-2</td>
<td>70 – 80</td>
<td>65 – 78</td>
<td>65 – 75</td>
<td></td>
</tr>
<tr>
<td>Lottman, Tensile strength ratio, % retained CP-L 5109</td>
<td>80 min.</td>
<td>80 min.</td>
<td>80 min.</td>
<td></td>
</tr>
<tr>
<td>Lottman, Dry tensile strength, psi, CP-L 5109</td>
<td>30 min.</td>
<td>30 min.</td>
<td>30 min.</td>
<td></td>
</tr>
</tbody>
</table>

Table 401-5
Voids in Mineral Aggregate

<table>
<thead>
<tr>
<th>Nominal Maximum Particle Size</th>
<th>Nominal VMA - %</th>
<th>Design Air Voids - %</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.0</td>
<td>4.0</td>
<td>5.0</td>
</tr>
<tr>
<td>½””</td>
<td>13</td>
<td>14</td>
</tr>
<tr>
<td>¾””</td>
<td>12</td>
<td>13</td>
</tr>
<tr>
<td>1””</td>
<td>11</td>
<td>12</td>
</tr>
</tbody>
</table>

1The nominal maximum particle size is one sieve larger than the first sieve to retain more than 10 percent

If the Contractor proposes to use RAP in the HMA mixture(s), the resulting mixture(s)
must meet the same requirements as the mixture(s) that do not contain RAP. The RAP shall meet the requirements of Sec. 401.06.

Mixture(s) shall be verified prior to the start of placement. Verification of the volumetric properties of the mixture(s) shall be performed by a LabCAT Level C certified technician(s). If the mixture(s) has (have) been produced for another project within the last 90 days, verification results from that project may be submitted for this verification. Superpave mix design volumetric tolerances for the approved HMA mixture(s) shall be within the limits shown in Table 401-6.

### Table 401-6
**HMA Mixture Design Verification Tolerances**

<table>
<thead>
<tr>
<th>Property</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Voids</td>
<td>± 1.2%</td>
</tr>
<tr>
<td>VMA</td>
<td>± 1.2%</td>
</tr>
<tr>
<td>Binder Content</td>
<td>± 0.3%</td>
</tr>
<tr>
<td>Stability</td>
<td>Applicable minimum</td>
</tr>
</tbody>
</table>

B. Prior to the start of the paving operation, all key parties involved in the supply, haul, placement, compaction, inspection and quality control and quality acceptance (QC/QA) of the HMA pavement shall attend a pre-paving meeting to go over procedures and acceptance of the HMA placement. The meeting will be scheduled by the Owner. Areas of responsibility and contact names and phone numbers will be shared.

### 3.02 WEATHER RESTRICTIONS

A. The HMA mixture shall be placed only on properly constructed surfaces that are dry and unfrozen, and only when weather conditions allow for the proper handling and compaction of the mixture. The HMA shall be placed in accordance with the temperature limitations shown in Table 401-7 and only when weather conditions permit the pavement to be properly placed and compacted as determined by the Owner.

### Table 401-7
**HMA Placement Temperature Limitations**

<table>
<thead>
<tr>
<th>Paving Course</th>
<th>Thickness</th>
<th>Air Temperature</th>
<th>Surface Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface</td>
<td>All</td>
<td>50 °F</td>
<td>55 °F</td>
</tr>
<tr>
<td>Subsurface</td>
<td>≤ 3&quot;</td>
<td>40 °F</td>
<td>44 °F</td>
</tr>
<tr>
<td>Subsurface</td>
<td>&gt; 3&quot;</td>
<td>32 °F</td>
<td>36 °F</td>
</tr>
</tbody>
</table>

\(^1\)Temperatures shall be taken in the shade. Temperatures shall be stable or rising in order for work to progress.

### 3.03 HMA PRODUCTION FACILITIES

A. The HMA plant used to produce the asphalt aggregate mixture shall meet the requirements of AASHTO M156 and shall have adequate capacity and be maintained in good mechanical condition. The plant shall control dust, smoke, and/or other contaminants such that it meets the Colorado Air Quality Control Act, Title 25, Article 7, CRS and all regulations promulgated thereunder. The Owner or his authorized representative shall have access, at all times, to all areas of the plant for checking: the adequacy of the equipment; inspecting the operation of the plant, verifying weights, proportions and material properties; and checking the temperatures maintained in the preparation of the mixtures.

1. **Truck Scales.** The HMA mixture shall be weighed on approved scales furnished...
by the Contractor or on public scales at the Contractor’s expense. Such scales shall be inspected and sealed as often as the Owner deems necessary to assure accuracy.

2. 

Storage and Surge Bins. Use of surge bins or storage bins for temporary storage of HMA mixtures will be permitted as follows:

a. The HMA mixture may be stored in surge bins for a period of time not to exceed three (3) hours.

b. The HMA mixture may be stored in insulated storage bins for a period of time not to exceed nine (9) hours, unless otherwise approved.

c. The mix drawn from the bins shall meet the same requirements as the mix loaded directly into trucks. If the Owner determines that there is excessive amount of heat loss, segregation or oxidation of the mixture, or other adverse effects on the quality of the finished product due to the temporary storage, corrective action shall be taken. Unsuitable material shall be disposed of at the Contractor’s expense.

3.04 HAULING EQUIPMENT

A. Trucks used for hauling HMA mixtures shall have tight, clean, and smooth metal beds. To prevent the mixture from adhering to them, the truck beds shall be lightly coated with a minimum amount of paraffin oil, lime solution, or other approved material. Each truck shall have a suitable cover to protect the mixture from adverse weather and to maintain temperature of the mixture. When necessary, to ensure that the mixture will be delivered to the site at the specified temperature, truck beds shall be insulated or heated and covers shall be securely fastened.

3.05 PLACEMENT EQUIPMENT

A. Pavers shall be self-propelled, with activated screed assemblies, heated as necessary, to spread and finish the HMA mixture to the specified width, thickness, smoothness, and grade shown. The pavers shall have sufficient power to propel themselves and the hauling equipment without adversely affecting the finished pavement surface.

B. The receiving hopper of the paver shall have sufficient capacity to permit a uniform spreading operation. The hopper shall be equipped with a distribution system to place the mixture uniformly in front of the screed without segregation. The screed shall effectively produce a finished surface of the required evenness and texture without tearing, shoving, or gouging of the mixture.

C. The paver shall be capable of operating at consistent speeds to apply the mixture in an even, continuous layer avoiding stop and go operations. If an automatic grade and slope control device is used, the paver shall be equipped with a control system capable of automatically maintaining the specified screed elevation. The control system shall be automatically actuated from a reference line or through a system of mechanical sensors or sensor-directed mechanisms which will maintain the paver screed at a predetermined transverse slope and at the proper elevation to obtain the required surface. The transverse slope controller shall be capable of maintaining the screed at the desired slope within ±0.1%.

D. If the Contractor fails to obtain and maintain the specified surface tolerances, the paving operations shall be suspended until satisfactory corrections, repairs, or equipment replacements are made.
3.06 COMPACTION EQUIPMENT

A. All compaction equipment used on the project for obtaining the required density of the HMA pavement shall be self propelled vibratory, steel wheel or pneumatic tire type capable of obtaining 92 to 96 percent of the maximum theoretical density without crushing the aggregate. They shall be in good condition and capable of operating at slow speeds to avoid displacement and tearing of the HMA mixture. Vibratory rollers shall have separate energy and propulsion controls. The number, type, and weight of rollers shall be sufficient to compact the mixture to the required density while it is still in a workable condition. The use of equipment which causes excessive crushing of the aggregate will not be permitted.

3.07 HMA MIXTURE PRODUCTION

A. The HMA mixture shall be produced in a plant meeting the requirements of Sec. 401.12. The dried aggregates and asphalt binder shall be combined in the plant in the quantities required to meet the JMF.

1. **Asphalt Binder.** The asphalt binder shall be heated in a manner that will avoid local overheating and provide a continuous supply of the HMA material to the plant at a uniform temperature. The temperature of the asphalt binder delivered to the mixer shall be sufficient to provide a suitable viscosity for adequate coating of the aggregate particles but shall not exceed the maximum temperature prescribed by the asphalt refiner.

2. **Aggregate.** The aggregate for the mixture shall be dried and heated prior to induction into the mixer. The maximum temperature and rate of heating shall be such that no damage occurs to the aggregates. The temperature of the aggregate and mineral filler shall not exceed 350°F when the asphalt is added. Particular care should be taken that aggregates high in calcium or magnesium content are not damaged by overheating. The temperature shall not be lower than is required to obtain complete coating and uniform distribution on the aggregate particles and to provide a mixture of satisfactory workability.

When hydrated lime is required to achieve complete and uniform coating of the aggregate by the asphalt binder, it shall be added to the aggregate in the form of a slurry and then thoroughly mixed in an approved pug mill. The slurry shall contain a minimum of 70% water by weight. If dry hydrated lime is used, it shall be added to the wet aggregate at a minimum of 3% above saturated surface dry and then mixed thoroughly in an approved pug mill.

3. **HMA Mixture.** The heated and dried aggregates and the asphalt binder shall be combined by weight in the mixer in the amount specified by the JMF. The materials shall be mixed until the aggregate is completely and uniformly coated, and the asphalt cement is uniformly distributed throughout the aggregate. Baghouse fines shall be fed back to the mixing plant in a uniform and continuous manner to maintain uniformity in the mixture. The baghouse, fines feeder, auger, and related equipment shall be in good working condition and operated in accordance with the manufacturer’s recommendation. If the Owner determines that non-uniform operation of the equipment is detrimental to the mixture, he may suspend all paving operations until the Contractor takes appropriate action.

The temperature of the HMA mixture, for different asphalt binder grades, when discharged from the plant shall be within the limits shown in Table 401-8. The HMA mixture shall be produced at the lowest temperature within the specified range that produces a workable mix and provides for uniform coating of...
aggregates (95% minimum in accordance with AASHTO T195), and allows the required compaction to be achieved.

<table>
<thead>
<tr>
<th>Asphalt Binder Grade</th>
<th>Minimum Discharge Temperature</th>
<th>Maximum Discharge Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>PG 58-28</td>
<td>275°F</td>
<td>305°F</td>
</tr>
<tr>
<td>PG 64-22</td>
<td>290°F</td>
<td>320°F</td>
</tr>
<tr>
<td>PG 76-28</td>
<td>320°F</td>
<td>350°F</td>
</tr>
</tbody>
</table>

HMA mix may be stored provided that any and all characteristics of the mixture are not altered by such storage. If storing or holding of the mixture causes segregation, excessive heat loss, or adversely affects the quality of the finished product, corrective action shall be taken. Unsuitable mixture shall be disposed of at the Contractor’s expense.

4. *Underlying Surface.* The HMA mixture shall be placed on a prepared surface. Prior to placement of the mixture, irregularities in the underlying surface shall be brought to uniform grade and cross section. The surface shall be cleaned of dust and debris. A prime or tack coat shall be applied if required.

Surfaces of curbing, gutters, manholes, valve boxes and other structures coming into contact with the HMA mixture shall be coated with a uniform coating of asphaltic material prior to the placement of the HMA mixture against them.

(a) *Prime Coat.* Prime coat materials shall meet the requirements of Sec. 401.07(b).

Prime coats shall not be applied when the surface to receive the prime coat is wet or when weather conditions would prevent the proper construction of the prime coat.

The Contractor shall provide equipment for heating and uniformly applying the prime coat material. The distributor shall be capable of uniformly spraying the material at even temperature and uniform pressure on variable widths of surface up to 15 feet in width at readily determined and controlled rates from 0.05 to 2.0 gallons per square yard at an allowable variation from any specified rate of ±0.02 gallons per square yard.

The prime coat shall be applied in a uniform and continuous spread. Excess material shall be removed or distributed as directed. Prime coat material shall not be placed on any surface where traffic will be allowed to travel on the freshly applied material.

The rate of application, temperatures, and areas to be treated shall be as stated in the contract documents or as directed by the Owner and shall be approved prior to the application of the prime coat.

(b) *Tack Coat.* Tack coat materials shall meet the requirements of Sec. 401-07(c).

The emulsified asphalt shall be diluted 1:1 with water and applied at 0.10 ±0.01 gallons per square yard of diluted material.
Tack coats shall not be applied when the surface to receive the prime coat is wet or when weather conditions would prevent the proper construction of the prime coat.

The Contractor shall provide equipment for heating and uniformly applying the tack coat material. The distributor shall be capable of uniformly spraying the material at even temperature and uniform pressure on variable widths of surface up to 15 feet in width at readily determined and controlled rates from 0.05 to 2.0 gallons per square yard.

The tack coat shall be applied in a uniform and continuous spread. Excess material shall be removed or distributed as directed. Tack coat material shall not be placed on any surface where traffic will be allowed to travel on the freshly applied material.

The rate of application, temperatures, and areas to be treated shall be as stated in the contract documents or as directed by the Owner and shall be approved prior to the application of the tack coat.

3.08 HAULING OF HMA MIXTURE

A. Transporting the HMA mixture from the plant to the job site shall be done in vehicles meeting the requirements of Sec. 401.13. The Contractor shall have an adequate number of vehicles so delivery of the HMA mixture can be continuous with a minimum of interruptions of materials to the paving equipment in order for a continued non-stop paving operation and before the temperature of the HMA material falls below 250°F or satisfactory compaction temperature. Deliveries shall be planned so the placing and compaction of all of the mixture prepared for one day’s operation can be completed during daylight, unless adequate artificial lighting is provided by the Contractor and approved by the Owner. Hauling over newly placed mixture shall not be permitted until the mixture has been compacted as specified and allowed to cool to atmospheric temperature.

3.09 PLACING OF HMA MIXTURE

A. The HMA mixture shall be placed, using equipment meeting the requirements of Sec. 401.14, to the established grade and required thickness over the entire width or partial width as is practicable.

B. The mixture shall be placed on an approved surface, spread and struck off to obtain the required grade and elevation after compaction. The mixture placed directly behind the paver shall be 25% thicker than desired to account for compaction. Raking is discouraged and will not be allowed except to correct major problems of grade and elevation, casting or raking that causes any segregation will not be permitted.

C. On areas where the use of mechanical spreading and finishing equipment is impracticable, the mixture shall be carefully dumped, spread, raked, screeded, and luted by hand tools to the required compacted thickness plus 25%. Carefully move or minimally work the HMA mixture with rakes, lutes, or shovels to avoid segregation. Mixtures made with modified asphalt binders require more rapid completion of the handwork.

D. Hauling and placement sequences shall be coordinated so that the paver is in constant motion. Excessive starting and stopping will not be allowed. A construction joint shall be
placed any time the paver stops and the screed drops enough to cause a surface dip in violation of Sec. 401.19 or the mat temperature falls below that which is allowed in Sec. 401.18(d).

E. When echelon paving is permitted and approved by the Owner, production of the mixture shall be maintained so that pavers can be used in echelon to place the wearing course in adjacent lanes.

1. Segregation. The bituminous material shall be transported and placed on the roadway without segregation. All segregated areas behind the paver shall be removed immediately upon discovery. The segregated material shall be replaced with specification material before the initial rolling has taken place. If more than 50 square feet of segregated pavement is ordered removed and replaced in any continuous 500 linear feet of paver width, laydown, operations shall be discontinued until the source of segregation has been found and corrected. The Owner will determine the extent of the segregated areas. Segregated areas shall be corrected at the Contractor’s expense.

(a) Lift Thickness. Each lift of compacted bituminous pavement shall be of uniform thickness. The minimum compacted lift thickness shall be three times the nominal aggregate size of the HMA mixture. The maximum lift thickness shall be three (3) inches unless the Contractor can demonstrate his ability to achieve the required compaction of thicker lifts.

The final lift, when placed adjacent to guttering, shall extend ¼” to ½” above the lip of the gutter when compacted.

(b) Joint Construction. The formation of all joints shall be made in such a manner as to ensure a continuous bond between the courses and obtain the required density. All joints shall have the same texture, density and smoothness as other sections of the mat, and meet the requirements for smoothness and grade.

The roller shall not pass over the unprotected end of the freshly laid mixture except when necessary to form a transverse joint. When a transverse joint is necessary, it shall be made by means of placing a bulkhead or by tapering the course.

The free edge of the paved pass shall be laid as straight as possible and to the satisfaction of the Owner. This joint, if cold, shall be tack coated prior to placement of the adjoining mat.

The new compacted mat shall overlap the adjacent previously placed mat no more than 1.5 inches. Excess overlap or thickness shall not be raked or cast onto the new mat, but shall be wasted by pulling back and removing. The hot edge shall be blocked or bumped in a smooth line consistent with the previous longitudinal edge. Minor raking will only be allowed to correct major grade problems or provide mix around manholes and valve boxes.

1. Longitudinal Joints. The longitudinal joint in both a new pavement structure and an overlay pavement layer shall offset the joint in the layer immediately below by six (6) inches. The joints in any pavement layer shall not fall in a wheel path. The Contractor shall submit a longitudinal joint and pavement marking plan three days
prior to the Pre-Paving meeting. The plan shall show the location and configuration of the proposed longitudinal joints and pavement marking materials, and shall detail the methods to be used in the field to establish a control line. The Contractor shall use a continuous string line to delineate every longitudinal joint during paving operations. All exposed string line shall be picked up and disposed of at the end of each day’s paving. Paving shall not commence until the plan has been approved in writing by the Owner.

The joints in the top layer of pavement shall be located as follows unless otherwise approved by the Owner:

A. For two lane roadways, offset 6 to 12 inches from the center of pavement and from the outside edge of the travel lanes.

B. For roadways of more than two lanes, offset 6 to 12 inches from lane lines and the outside edge of travel lanes.

Longitudinal joints shall not cross the centerline, lane lines, or edge lines unless approved by the Owner.

Where paving operations are on the present traveled roadway, the Contractor shall arrange paving operations so there will be no exposed longitudinal joints between adjacent travel lanes longer than 25 feet at the end of a day’s run. With the approval of the Owner, the Contractor may be permitted to:

A. Leave a vertical exposed longitudinal joint when the thickness of the pavement course being placed is 1.5 inches or less.

B. Leave an exposed longitudinal joint when the thickness of the pavement course being placed is greater than 1.5 inches provided that the top 1.5 inches of the joint is vertical and the remainder of the joint is tapered. The minimum width of the taper shall be three times the thickness of the remaining pavement course.

The tapered portion of the joint shall be cut back to its full depth and width on a straight line to expose a vertical face prior to placing the adjacent mat. In both methods, all contact surfaces shall be given a tack coat of bituminous material before placing any fresh mixture against the joint.

2. **Transverse Joints.** Along with the longitudinal joint plan, the Contractor shall submit a transverse joint plan showing the locations and the methods to be used to construct transverse joints. The Owner must approve such plans prior to paving. Placing of the HMA mixture shall be continuous with a minimum of transverse joints.

Rollers shall not pass over the unprotected end of a freshly laid mixture.

Transverse joints shall be formed by cutting back on the previous run to expose the full depth of the course. Tack coat material shall be applied to contact surfaces of all joints prior to placement of fresh mixture against the joint.
The end of transverse joints shall be located so they will be constructed with a full head of mix in front of the screed. When butt joints are constructed, runoff boards shall be used to support the roller on the downstream side of the joint. All tapered sections, rounded edges, and segregated areas shall be removed to achieve a vertical face at the butt joint before paving is restarted.

When a tapered joint is required for traffic access, the taper shall be removed back to a full depth before paving is restarted.

When restarting paving operations, the paver screed shall be placed on starter blocks on the completed side of the transverse joint. The starter blocks should be approximately 25% of the thickness of the existing completed mat, so that adequate grade and compaction can be achieved on starting the paving operation. Raking of this joint shall not be allowed except to correct major grade problems.

(c) Compaction. The plant mix bituminous pavement shall be compacted by rolling. Both steel wheel and pneumatic tire rollers will be required. The number, weight, and type of rollers required shall be sufficient to obtain the required density while the mixture is in a workable condition.

The Contractor shall construct a control strip with production materials and equipment and shall determine the roll pattern necessary to meet the specified density. This roll pattern shall be used throughout the paving operation unless conditions change.

Compaction shall begin immediately after the mixture is placed and shall be continuous until the required density is obtained. When the temperature of the mixture’s surface falls below 185°F, no further compaction effort will be permitted unless approved by the Owner.

The Contractor shall prevent the HMA material from adhering to the rollers by using a very small quantity of detergent or other approved material.

The longitudinal joint shall be rolled from the hot side and overlap the joint by approximately 6 inches on the cold side.

The speed of the roller shall, at all times, be sufficiently slow to avoid displacement of the hot mixture and be effective in compaction. Any displacement occurring as a result or reversing the direction of the roller or from any other causes shall be corrected immediately.

In areas not accessible to the roller, the mixture shall be thoroughly compacted with hand tampers or small mechanical hand compactors.

Any mixture that becomes loose and broken, mixed with dirt, contains check-cracking, or in any way is defective shall be removed and replaced with fresh material and immediately compacted to conform to the surrounding area at the Contractor’s expense. Skin patching will not be allowed.

While the surface is being compacted and finished, the Contractor shall carefully trim the outside edges of the pavement to the proper alignment. Edges so formed shall be beveled while still hot and...
thoroughly compacted by tampers or by other satisfactory methods.

All roller marks shall be removed with the finish rolling. The use of vibratory rollers with the vibrator on will not be permitted during the final rolling of any pavement course.

The pavement shall be compacted to a density of 92 to 96 percent of the maximum theoretical density, determined according to AASHTO T209.

3.10 TESTING, INSPECTION, AND ACCEPTANCE

A. Testing of the HMA mixture shall be performed in accordance with the requirements of Sec. 720. Failing results on two consecutive tests shall be cause for suspension of the paving operation until corrective measures have been implemented.

B. Surface smoothness testing of the final riding surface of all pavements are subject to testing by the 10-foot straightedge method. The Contractor shall furnish an approved 10-foot straightedge and depth gauge and provide an operator to assist the Owner in testing the finished pavement surface. Areas to be tested shall be determined by the Owner. The variation between any two contacts with the surface shall not exceed 3/16inch in 10 feet. Areas showing deviation of more than 3/16 inch shall be marked and corrected at the Contractor’s expense.

C. Inspection shall be provided by the Owner. The Contractor shall notify the Owner, a minimum of 48 hours in advance, of his intent to commence paving operations so that adequate inspection can be scheduled. Failure on the part of the Contractor to provide proper notification shall be grounds for suspending the paving operation. Any pavement surface placed without proper inspection or authorization shall be subject to immediate rejection, and shall be removed at the Contractor’s expense.

D. Acceptance of the pavement(s) shall be based on: conformity with the lines, grades, cross sections, and thicknesses shown in the contract; surface smoothness in accordance with this specification; passing test results in accordance with Sec. 720; and a visual appearance that is consistent for the HMA mixture used.

E. Non-conformity shall be determined in accordance with the MGPEC Pavement Design Standards & Construction Specifications manual, latest edition thereof.

END OF SECTION
608.01

SECTION 608
SIDEWALKS AND BIKEWAYS

DESCRIPTION
608.01 This work consists of the construction of bituminous or concrete sidewalks, bikeways, and curb ramps in accordance with these specifications and in conformity with the lines and grades shown on the plans or established.

MATERIALS
608.02 Materials shall meet the requirements specified in the following subsections:
   Joint Fillers  705.01
   Bed Course Material  703.07

Concrete for sidewalks, bikeways, and curb ramps shall be Class B, and meet the requirements of Section 601.

Bituminous material for sidewalks, bikeways, and curb ramps shall meet the requirements of Section 403.

Concrete and bituminous mixes will be subject to inspection and tests as required to assure compliance with quality requirements.

CONSTRUCTION REQUIREMENTS
608.03 Concrete Sidewalks and Bikeways.
(a) Excavation. Excavation shall be made to the required depth and to a width that will permit the installation and bracing of the forms. The foundation shall be shaped and compacted to a firm even surface conforming to the section shown on the plans or as staked. When the Engineer determines that material is uncompactable, the material shall be removed and replaced in accordance with subsection 206.03.

(b) Forms. Forms shall be of wood, metal, or other suitable material, and shall extend for the full depth of the concrete. All forms shall be straight, free from warp and of sufficient strength to resist the pressure of the concrete without springing. Bracing and staking of forms shall be such that the forms remain in both horizontal and vertical alignment until their removal. A satisfactory slipform method may be used.

(c) Placing Concrete. The foundation shall be thoroughly moistened immediately prior to the placing of the concrete. The proportioning, mixing and placing of the concrete shall be in accordance with the requirements for the class of concrete specified.

(d) Finishing. The surface shall be floated with a wooden or magnesium float and given a transverse broom finish. Plastering of the surface will not be permitted.
All outside edges of the slab and all joints shall be edged with a ¼ inch radius edging tool.

(c) Joints. Expansion joints, at intervals of not more than 500 feet, shall be filled with ½ inch thick full depth, preformed expansion joint filler. The sidewalk or bikeway shall be divided into sections by dummy joints formed by a jointing tool or other acceptable means as directed. These dummy joints shall extend into the concrete for at least ¼ of the depth and shall be approximately ½ inch wide. Dummy joints shall be spaced at intervals approximately equal to the width of the sidewalk or bikeway.

Construction joints shall be formed around all appurtenances such as manholes, utility poles, etc., extending into and through the sidewalk. Preformed expansion joint filler ½ inch thick shall be installed in these joints. Expansion joint filler ½ inch thick or the thickness indicated shall be installed between new concrete and any fixed structure such as a building or bridge. This expansion joint material shall extend for the full depth of the contact surface.

(f) Curing. Immediately upon completion of the finishing, sidewalks and bikeways shall be moistened and kept moist for three days, or they shall be cured by the use of membrane forming curing compound. The method and details of curing shall be subject to the approval of the Engineer.

During the curing period all traffic, both pedestrian and vehicular, shall be excluded. Vehicular traffic shall be excluded for such additional time as the Engineer may direct.

608.04 Bituminous Sidewalks and Bikeways.

(a) Excavation and Forms. Excavation and forms shall meet the requirements of subsection 608.03 (a) and (b).

(b) Bed Course. Bed course material shall be placed in layers not exceeding 4 inches in depth and each layer shall be thoroughly compacted.

(c) Placing Bituminous Material. Bituminous sidewalk and bikeway material shall be placed on the compacted bed course in one or more courses as indicated so as to give the required depth when rolled. When practicable, spreading, finishing, and compaction shall be accomplished by equipment conforming to the requirements of Section 401. When the Engineer determines such equipment is not practicable, bituminous material may be spread by small or special pavers, by spreader boxes or by blade graders and may be compacted by small self propelled rollers or vibratory compactors acceptable to the Engineer. In areas inaccessible to the roller, hand or mechanical tamping will be permitted. Bituminous material shall be uniformly compacted.

The Contractor shall state at the preconstruction conference what type of paving equipment will be used.
METHOD OF MEASUREMENT

608.05 Concrete sidewalks, bikeways, and curb ramps will be measured by the square yard of finished surface. Bituminous sidewalks, bikeways, and curb ramps will be measured by the ton of bituminous mixture placed.

BASIS OF PAYMENT

608.06 The accepted quantities will be paid for at the contract unit price for each of the pay items listed below that appear in the bid schedule.

Pay Item                  Pay Unit
Concrete Sidewalk         Square Yard
Bituminous Sidewalk       Ton
Concrete Curb Ramp         Square Yard
Bituminous Curb Ramp       Ton
Concrete Bikeway           Square Yard
Bituminous Bikeway         Ton

Bed course material will be measured and paid for in accordance with Section 206.

All work necessary and incidental to the construction of sidewalks, bikeways, and curb ramps will not be measured and paid for separately but shall be included in the work.
SECTION 609  
CURB AND GUTTER  

DESCRIPTION  
609.01 This work consists of the construction of curb, gutter or combination curb and gutter in accordance with these specifications and in conformity with the lines and grades shown on the plans or established. 

The types of curb are designated as follows:  
Type 2 Cast-in-Place Concrete Curb  
Type 4 Dowelled Concrete Curb  
Type 6 Sloping Curb  

The section will be as shown on the plans.  

MATERIALS  
609.02 Except as provided below the materials used shall meet the requirements of the following subsections:  
Bed Course Material  703.07  
Joint Filler  705.01  
Reinforcing Steel  709.01  

Concrete for curb shall be Class B, and meet the requirements of Section 601, except that when curb machines are used, a lesser slump will be permitted.  

Bituminous curb shall be constructed of the same gradation of aggregate and the same grade of bituminous material as the top layer or top course of bituminous pavement used on the project.  

Concrete and bituminous mixes will be subject to inspection and tests at the plants for compliance with quality requirements.  

CONSTRUCTION REQUIREMENTS  
609.03 Cast-in-Place Concrete Curb.  
(a) **Excavation.** Excavation and bedding shall conform to the requirements of subsection 608.03 (a).  

(b) **Forms.** Forms shall be of wood or metal, straight, free from warp and of such construction that there will be no interference to the inspection of grade or alignment. All forms shall extend for the entire depth of the curb and shall be braced and secured sufficiently so that no deflection from alignment or grade will occur during the placing of the concrete.  

(c) **Mixing and Placing.** Concrete shall be proportioned, mixed and placed in accordance with the requirements for the class of concrete specified.

Compaction of concrete curb, gutters or combination curb and gutter, placed in forms shall have thorough consolidation which shall be achieved by tamping and spading, vibrating or other acceptable methods. Forms shall be left in place until the concrete has set sufficiently so that they can be removed without injury to the curb. Upon removal of the forms, the exposed curb face shall be immediately finished to a uniform surface. For the purpose of matching adjacent concrete finishes or for other reasons, the Engineer shall approve methods of finishing. Plastering will not be permitted.

(d) *Sections.* Curb shall be constructed in sections having a uniform length of 10 feet, unless otherwise ordered. Sections shall be separated by open joints \( \frac{1}{4} \) inch wide except at expansion joints.

(e) *Expansion Joints.* Expansion joints shall be formed at the intervals shown on the plans using a \( \frac{1}{2} \) inch preformed expansion joint filler. When the curb is constructed adjacent to or on concrete pavement, expansion joints shall be located opposite the expansion joints in the pavement.

Expansion joints shall be installed between concrete curb and any fixed structure or bridge. Expansion joint material shall extend the full depth of contact surface.

(f) *Curing.* Immediately upon completion of the finishing, the curb shall be moistened and kept moist for three days, or the curb shall be cured by the use of membrane forming curing compound. The method and details of curing shall be subject to the approval of the Engineer.

(g) *Backfilling.* After the concrete has set sufficiently, the spaces in back of the curb shall be backfilled to the required elevation with suitable material which shall be thoroughly tamped.

(h) *Curb Machine.* With the approval of the Engineer, the curb may be constructed by the use of a curb forming machine.

(i) *Surface Tolerance.* The Engineer may determine that the exposed surfaces of the concrete curb, gutters, or combination curb and gutter shall be tested with a 10 foot straightedge laid along the exposed surface in a longitudinal direction. The Contractor shall furnish an approved 10 foot straightedge and provide an operator to aid the Engineer in testing the exposed surfaces. All surfaces shall be measured in a longitudinal direction. Deviation of any exposed surface in excess of that specified shall be corrected at the Contractor's expense.

Longitudinal surface tolerances for the top and face are:

1. On tangent roadway alignments and curves with radius greater than 1000 feet: 0.25 inch from the edge of the straightedge.
(2) On sharp vertical curves and horizontal curves with radius of 1000 feet or less: 0.25 inch from the edge of the straight edge with allowance made for curve deflection.

609.04 (unused)

609.05 Bituminous Curb.

(a) Preparation. Bituminous curb shall be placed on a clean dry surface. Immediately prior to placing of the bituminous mixture, the surface shall receive a tack coat of bituminous material of the type and grade approved by the Engineer. The rate of application of the tack coat material shall be 0.05 to 0.15 gallons per square yard of surface. In the application of this tack coat, the Contractor shall prevent the spread of this tack coat to areas outside of the area to be occupied by the curb.

(b) Placing. Bituminous curb shall be constructed by use of a self-propelled curb machine or a paver with curb attachments.

The automatic curb machine shall meet the following requirements and shall be approved prior to its use:

(1) The weight of the machine shall be such that compaction is obtained without the machine riding above the bed on which curb is constructed.

(2) The machine shall form curb that is uniform in texture, shape and density.

(3) The Engineer may permit the construction of curb by other means, when short sections or sections with short radii are required, or for such other reasons as warranted. The resulting curb shall conform in all respects to the curb produced by the use of the machine.

Upon completion of placement of bituminous curb, a fog coat of emulsified asphalt shall be placed on the exposed surfaces of the curb at the rate of approximately 0.1 gallon per square yard.

(c) Painting and Sealing. When sealing or painting is required, it shall be performed only on a curb which is clean and dry and which has reached the ambient temperature.

**METHOD OF MEASUREMENT**

609.06 Curb will be measured by linear foot along the front face of the section at the finished grade elevation. Gutter will be measured along centerline of the gutter. Curb and gutter will be measured along the face of the curb. Deduction in length will be made for drainage structures, such as catch basins, drop inlets, etc., installed in the curb, gutter, or curb and gutter.
609.07

**BASIS OF PAYMENT**

609.07 The accepted quantities will be paid for at the contract unit price for each of the pay items listed below that appear in the bid schedule, including dowels and expansion joint material.

Payment will be made under:

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curb, Type__ (Section__)</td>
<td>Linear Foot</td>
</tr>
<tr>
<td>Gutter, Type__ (__ Foot)</td>
<td>Linear Foot</td>
</tr>
<tr>
<td>Curb and Gutter, Type__ (Section__)</td>
<td>Linear Foot</td>
</tr>
</tbody>
</table>

Bed course material will be measured and paid for in accordance with Section 206.

Fog coat and tack coat for Curb Type 6 will not be measured and paid for separately but shall be included in the work.
PART 1 - GENERAL

1.01 WORK INCLUDED - Work of this Section generally includes provisions for the installation of an underground landscape irrigation system including the following:

A. Static pressure verification and coordination of irrigation system installation with landscape material installation.

B. Trenching, stockpiling excavation materials, refilling and compacting trenches.

C. Complete irrigation system including but not limited to piping, backflow preventer assemblies, valves, fittings, heads, controllers and wiring, and final adjustments to insure complete coverage.

D. Water connections.

E. Replacement of unsatisfactory materials.

F. Clean-up, Consultant Reviews, and Project Acceptance.

G. Tests.

1.02 RELATED SECTIONS

A. Examine all sections related to project work.

1.03 REFERENCES

A. Perform Work in accordance with requirements of Conditions of the Contract and Division 01 - General requirements as well as provisions of all applicable laws, codes, ordinances, rules, and regulations.

B. Conform to requirements of reference information listed below except where more stringent requirements are shown or specified in Contract Documents.

1. American Society for Testing and Materials (ASTM) - Specifications and Test Methods specifically referenced in this Section.

2. Underwriters Laboratories (UL) - UL Wires and Cables.

1.04 QUALITY ASSURANCE

A. Installer Qualifications - Installer shall have had considerable experience and demonstrate ability in the installation of irrigation system(s) of specific type(s) in a neat orderly, and responsible manner in accordance with recognized standards of workmanship. To demonstrate ability and experience necessary for this Project, and financial stability, submit if requested by Consultant, prior to contract award the following:

1. List of 3 projects completed in the last 2 years of similar complexity to this Project. Description of projects shall include:
   a. Name of project.
b. Location.
c. Owner.
d. Brief description of work and project budget.

B. Special Requirements:

1. Work involving substantial plumbing for installation of copper piping, backflow preventer(s), and related work shall be executed by licensed and bonded plumber(s). Secure a permit at least 48 hours prior to start of installation.
2. Tolerances - Specified depths of mains and laterals and pitch of pipes are minimums. Settlement of trenches is cause for removal of finish grade treatment, refilling, compaction, and repair of finish grade treatment.
3. Coordination with Other Contractors - Protect, maintain, and coordinate Work with Work under other Section.
4. Damage To Other Improvements - Contractor shall replace or repair damage to grading, soil preparation, seeding, sodding, or planting done under other Sections during Work associated with installation of irrigation system at no additional cost to Owner.

C. Pre-Construction Conference - Contractor shall schedule and conduct a conference to review in detail quality control and construction requirements for equipment, materials, and systems used to perform the Work. Conference shall be scheduled not less than 10 days prior to commencement of Work. All parties required to be in attendance shall be notified no later than 7 days prior to date of conference. Contractor shall notify qualified representatives of each party concerned with that portion of Work to attend conference, including but not limited to Architect, Consultant, Contractor's Superintendent, and Installer.

1. Minutes of conference shall be recorded and distributed by Contractor to all parties in attendance within five days of conference.

1.05 SUBMITTALS - Prepare and make submittals in accordance with conditions of the Contract.

A. Materials List - Submit six copies of a complete materials list indicating manufacturer, model number, and description of all materials and equipment to be used. Show appropriate dimensions and adequate detail to accurately portray intent of construction.

B. Record Drawings (As-Builts):

1. At onset of irrigation installation secure Autocadd files of original irrigation design from Owner. At the end of every day, revise as-built prints for work accomplished that day in red ink. As-built field prints shall be brought up-to-date at the close of the working day every Friday by a qualified draftsperson. A print of record plan(s) shall be available at Project Site. Indicate zoning changes on weekly as-built drawings. Indicate non-pressure piping changes on as-built. Upon completion of Project, but prior to scheduling of substantial acceptance walk-through, submit for review a final set of as-built mylars and an Autocadd disk copy. Dimensions, from two permanent points of reference (building corners, sidewalk, road intersections or permanent structures), location of following items:
a. Connection to existing water lines.
b. Routing of sprinkler pressure lines (dimension maximum 100 feet along routing).
c. Sprinkler control valves.
d. Quick coupling valves.
e. Manual drains and stop and waste valves.
f. Drip line blow-out stubs.
g. Control wire routing if not with pressure mainline.
h. Gate valves.
i. Control wire and communication cable splices
j. Water meters
k. Locations of all sleeving including size, quantity and depth of sleeve
l. Flow sensors
m. Pressure regulating valves

2. Owner’s Representative will not certify any pay request submitted by the Contractor if the as-built drawings are not current, and processing of pay request will not occur until as-builts are updated.

C. Operation Instructions - Submit 3 written operating instructions including winterization procedures and start-up, with cut sheets of products, and coordinate controller/watering operation instruction with Owner maintenance personnel.

1. Controller Charts:
a. Do not prepare charts until Consultant has reviewed record (as-built) drawings.
b. Provide one controller chart for each automatic controller installed.
   1) Chart may be reproduction of record drawing, if scale permits fitting of controller door. If photo reduction prints are required, keep reduction to maximum size possible to retain full legibility.
   2) Chart shall be blueline print of actual "as-built" system, showing area covered by that controller.
c. Identify area of coverage of each remote control valve, using a distinctly different pastel color drawing over entire area of coverage.
d. Following review of charts by Consultant, they shall be hermetically sealed between two layers of 20-mm thick plastic sheet.
e. Charts shall be completed and reviewed prior to final review of irrigation system.

1.06 DELIVERY, STORAGE, AND HANDLING - Deliver, unload, store, and handle materials, packaging, bundling, products in dry, weatherproof, condition in manner to prevent damage, breakage, deterioration, intrusion, ignition, and vandalism. Deliver in original unopened packaging containers prominently displaying manufacturer's name, volume, quantity, contents, instructions, and conformance to local, state, and federal law. Remove and replace cracked, broken, or contaminated items or elements prematurely exposed to moisture, inclement weather, snow, ice, temperature extremes, fire, or jobsite damage.

A. Handling of PVC Pipe - Exercise care in handling, loading and storing, of PVC pipe. All PVC pipe shall be transported in a vehicle that allows length of pipe to lie flat so as not to subject it to undue bending or concentrated external loads. All sections of pipe that have been dented or damaged shall be discarded, and if installed, shall be replaced with new piping.

1.07 JOBSITE CONDITIONS:

A. Protection of Property:

1. Preserve and protect all trees, plants, monuments, structures, and paved areas from damage due to Work of this Section. In the event damage does occur, all damage to inanimate items shall be completely repaired or replaced to satisfaction of Owner, and all injury to living plants shall be repaired by Owner. All costs of such repairs shall be charged to and paid by Contractor.
2. Protect buildings, walks, walls, and other property from damage. Flare and barricade open ditches. Damage caused to asphalt, concrete, or other building material surfaces shall be repaired or replaced at no cost to Owner. Restore
disturbed areas to original condition.

B. Existing Trees:

1. All trenching or other Work under limb spread of any and all evergreens or low branching deciduous material shall be done by hand or by other methods so as to prevent damage to limbs or branches.

2. Where it is necessary to excavate adjacent to existing trees use all possible care to avoid injury to trees and tree roots. Excavation, in areas where 2 inch and larger roots occur, shall be done by hand. Roots 2 inches or larger in diameter, except directly in the path of pipe of conduit, shall be tunneled under and shall be heavily wrapped with burlap to prevent scarring or excessive drying. Where a trenching machine is operated close to trees having roots smaller than 2 inches in diameter, wall of trench adjacent to tree shall be hand trimmed, making clean cuts through roots. Trenches adjacent to trees shall be closed within 24 hours, and when this is not possible, side of trench adjacent to tree shall be kept shaded with moistened burlap or canvas.

C. Protection and Repair of Underground Lines:

1. Request proper utility company to stake exact location (including depth) of all underground electric, gas, or telephone lines. Take whatever precautions are necessary to protect these underground lines from damage. If damage does occur, Utility Owner shall repair all damage. Contractor shall pay all costs of such repairs unless other arrangements have been made.

2. Request Owner, in writing, to locate all private utilities (i.e., electrical service to outside lighting) before proceeding with excavation. If, after such request and necessary staking, private utilities that were not staked are encountered and damaged by Installer, Owner shall repair them at no cost to Installer. If Contractor damages staked or located utilities, they shall be repaired by Utility Owner at Contractor's expense unless other arrangements have been made.

D. Replacement of Paving and Curbs - Where trenches and lines cross existing roadways, paths, curbing, etc., damage to these shall be kept to a minimum and shall be restored to original condition.

1.08 WARRANTY/GUARANTY: Manufacturer shall warrant materials against defects for a period of one year from date of Substantial Completion. Installer(s) shall guaranty workmanship for similar period.

A. Settling of backfilled trenches that may occur during guaranty period shall be repaired at no expense to Owner, including complete restoration of damaged property.

B. Expenses due to vandalism before substantial completion shall be borne by Contractor.

C. Owner will maintain turf and planting areas during warranty period, so as not to hamper proper operation of irrigation system.

1.09 MAINTENANCE:

A. Furnish the following maintenance items to Owner prior to final Acceptance:

1. Two Sets of special tools required for removing, disassembling, and adjusting each type of sprinkler head and valve supplied on this Project.

2. One eight foot valve key for operation of stop and waste valve.

2. Two six foot valve keys for operation of gate valves.

3. Two keys for each automatic controller.
4. Two quick coupler keys and two matching hose swivels for each type of quick coupling valve installed.
5. Two aluminum drain valve keys of sufficient length for operation of drain valves.

B. Winterization - include cost in bid for winterizing complete system at conclusion of sprinkling season (in which system received final acceptance) within 3 days notification by the Owner. System shall be voided of water using compressed air or similar method reviewed by Consultant. Reopen, operate, and adjust system malfunctions accordingly during April of following season within 3 days of notification by Owner.

1.10 EXTRA STOCK - In addition to installed system furnish the following items to Owner:

A. 10 Pop-up spray heads with nozzles of each type used.
B. 4 Rotor heads of each type used.
C. 30 Drip emitters of each type used.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. General Piping:

1. Pressure Supply Line (from point of connection through backflow prevention unit) - Type "k" Hard Copper (3/4" – 2 1/2") and ductile iron (3" and larger).
2. Pressure Supply Lines (downstream of backflow prevention units) - Class 200 PVC BE (1" - 2 1/2").
3. Non-pressure Lines – Class 200 PVC BE
4. PVC Sleeving - Class 160 PVC.
5. Drip Tubing - Toro Dura-Pol EHD 1645 3/4" with .050 inch wall thickness.
6. Emitter Tubing - As recommended by emitter manufacturer.

B. Copper Pipe and Fittings:

1. Copper Pipe - Type K, hard tempered.
2. Fittings - Wrought copper, solder joint type.
3. Joints - Soldered with solder, 45% silver, 15% copper, 16% zinc, and 24% cadmium and solidus at 1125°F and liquids at 1145°F.

C. Brass Pipe and Fittings:

1. Brass Pipe - 85% red brass, ANSI Schedule 40 screwed pipe.
2. Fittings - Medium brass, screwed 125-pound class.

D. Plastic Pipe and Fittings:

1. Identification Markings:
   a. Identify all pipe with following indelible markings:
      1) Manufacturer's name.
      2) Nominal pipe size.
      3) Schedule of class.
      4) Pressure rating.
      5) NSF (National Sanitation Foundation) seal of approval.
6) Date of extrusion.

2. Solvent Weld Pipe - Manufactured from virgin polyvinyl chloride (PVC) compound in accordance with ASTM D2241 and ASTM D1784; cell classification 12454-B, Type 1, Grade 1.
   a. Fittings - Standard Wright, Schedule 40, injection molder PVC; complying with ASTM D1784 and D2466, cell classification 12454-B.
      1) Threads - Injection molded type (where required).
      2) Tees and ells - Side gated.
   b. Threaded Nipples - ASTM D2464, Schedule 80 with molded threads.
   c. Teflon Tape – All PVC male threaded fittings and nipples, excluding marlex fittings, shall receive wrapping of Teflon tape applied to threaded surfaces per pipe manufacturer’s recommendations.
   d. Joint Cement and Primer - Type as recommended by manufacturer of pipe and fittings.

3. Flexible Plastic Pipe - Manufactured from virgin polyethylene in accordance with ASTM D2239, with a hydrostatic design stress of 630 psi and designated as PE 2306.
   a. Fittings – Insert type manufactured in accordance with ASTM D2609; PVC Type 1 cell classification 12454-B.
   b. Clamps - All stainless steel worm gear screw clamps. Use 2 clamps per joint on 1-1/2 inch and 2 inch fittings.

E. Drip and Sub-Surface Irrigation Systems:

1. Drip Tubing - Manufactured of flexible vinyl chloride compound conforming to ASTM D1248, Type 1, Class C, Category 4, P14 and ASTM D3350 for PE 122111C.
2. Fittings - Type and diameter recommended by tubing manufacturer.
3. Drip Valve Assembly - Type and size shown on Drawings.
   a. Wye Strainer - Plastic construction with 150 mesh nylon screen and 1/2 inch blowout assembly.
   b. Control Valve - 2 way, solenoid pilot operated type made of synthetic, non-corrosive material; diaphragm activated and slow closing. Include freely pivoted seat seal; retained (mounted) without attachment to diaphragm.
   c. Pressure Reducing Valve - Plastic construction as detailed.
4. Emitters - Single port, pressure compensating, press on type.
5. Sub-Surface tubing - Size and type shown on Drawings; installed as detailed.

F. Gate Valves:

1. Gate Valves for 3/4 inch through 2-1/2 Inch Pipe - Brass construction; solid wedge, IPS threads, and non-rising stem with wheel operating handle.

G. Quick Coupling Valves - Brass two-piece body designed for working pressure of 150 PSI; operable with quick coupler. Equip quick coupler with locking rubber cover.

H. Valve Boxes:

1. Gate Valves, Quick Coupling Valves, Drain Valves, Drip Line Blow-out Stubs, and Wire Splice or Stub Box - Carson Brooks #910-10, box as detailed.
2. 1 inch through 2 inch Control Valves, Master Valves, Pressure Regulating Valves and Communication Cable Splice box - Carson Brooks #1419-12 box as detailed.

I. Electrical Control Wiring:
1. Low Voltage:
   a. Electrical Control Wire - AWG UFUL approved No. 14 direct burial copper wire or larger, if required to operate system as designed.
   b. Electrical Common Wire - AWG UFUL approved No. 14 direct burial copper wire or larger, if required to operate system as designed.
   c. Wire Colors:
      1) Control Wires - Red.
      2) Common Wires - White.
      3) Master Valve Wires - Blue.
      4) Drawing Spare Control Wires - Black.
      5) Drawing Spare Common Wires - Yellow.
   d. If multiple controllers are utilized, and wire paths of different controllers cross each other, both common and control wires from each controller shall be different colors approved by Consultant.
   e. Control Wire connections and splices shall be made with 3M DBY direct bury splice.

2. High Voltage - Type required by local codes and ordinances, of proper size to accommodate needs of equipment serviced.

J. Automatic Controller - Size and type shown on Drawings; mounted as detailed.

K. Electric Control Valves - Size and type shown on Drawings having manual flow adjustment and manual bleed nut.

L. Sprinkler Heads - As indicated on Drawings. Fabricated riser units in accordance with details on Drawings - with fittings and nipples of equal diameter as riser inlet in sprinkler body.

M. Backflow Preventer - Size and type indicated on Drawings; Brass or iron construction with 150 psi working pressure.

PART 3 - EXECUTION

3.01 SITE CONDITIONS, LANDSCAPE PLAN REVIEW AND COORDINATION

A. Contractor will be held responsible for coordination between landscape and irrigation system installation. Landscape material locations shown on the Landscape Plan shall take precedence over the irrigation system equipment locations. If irrigation equipment is installed in conflict with the landscape material locations shown on the Landscape Plan, the Contractor will be required to relocate the irrigation equipment, as necessary, at Contractor's expense.

B. Contractor is responsible to notify Consultant of any field conditions that vary from the conditions shown on the Irrigation Construction Documents. If Contractor fails to notify Consultant of these conditions, Contractor will be held responsible for all costs associated with system adjustments required due to the change in field conditions.

3.02 STATIC PRESSURE VERIFICATION - Contractor shall field verify the static pressure at the project site, prior to commencing work or ordering irrigation materials, and submit findings, in writing, to Consultant. If Contractor fails to verify static water pressure prior to commencing work or ordering irrigation materials, Contractor shall assume responsibility for all costs required to make system operational and the costs required to replace any damaged landscape material. Damage shall include all required material costs, design costs and plant replacement costs.
3.03 INSPECTION: - Examine areas and conditions under which Work of this Section is to be performed. Do not proceed with Work until unsatisfactory conditions have been corrected.

A. Grading operations, with the exception of final grading, shall be completed and approved by Owner before staking or installation of any irrigation system begins.

B. Underground Utilities shall be installed prior to installation of irrigation system. If irrigation installation takes place prior to utility installation, Contractor shall notify Owner of this condition in writing prior to commencement of irrigation installation.

3.04 PREPARATION:

A. Staking shall Occur as Follows:

1. Mark, with powdered lime, routing of pressure supply line and flag heads for first few zones. Contact Consultant 48 hours in advance and request review of staking. Proposed locations of all trees shall be field staked by Contractor and approved by Owner/Landscape Architect prior to Consultant review of irrigation staking. Consultant will advise installer as to the amount of staking to be prepared. Consultant will review staking and direct changes if required. Review does not relieve installer from coverage problems due to improper placement of heads after staking.

2. Contractor shall contact Consultant if field spacing varies by +/- 10% of the spacing shown on the irrigation plans. If Contractor fails to notify Consultant of variances exceeding 10%, Contractor assumes full responsibility for the costs associated with any required system modifications deemed necessary by the Consultant or Owner.

3. If Project has significant topography, freeform planting beds, or other amenities, which could require alteration of irrigation equipment layout as deemed necessary by Consultant, do not install irrigation equipment in these areas until Consultant has reviewed equipment staking.

B. Install sleeving under asphalt paving and concrete walks, prior to concreting and paving operations, to accommodate piping and wiring. Compact backfill around sleeves to 95% Modified Proctor Density within 2% of optimum moisture content in accordance with STM D1557.

C. Trenching - Trench excavation shall follow, as much as possible, layout shown on Drawing. Dig trenches straight and support pipe continuously on bottom of trench. Trench bottom shall be clean and smooth with all rock and organic debris removed.

1. Clearances:
   a. Piping 3 Inches and Larger - Make trenches of sufficient width (14 inches minimum) to properly assemble and position pipe in trench. Minimum clearance of piping 3 inches or larger shall be 5 inches horizontally on both sides of the trench.
   b. Piping Smaller than 3 Inches - Trenches shall have a minimum width of 7 inches.
   c. Line Clearance - Provide not less than 6 inches of clearance between each line and not less than 12 inches of clearance between lines of other trades.

2. Pipe and Wire Depth:
   a. Pressure Supply Piping - 18 inches from top of pipe.
   b. PVC Sleewing – To match depth of sleeved material.
   c. Non-pressure Piping (rotor) - 18 inches from top of pipe.
   d. Non-pressure Piping (pop-up) - 12 inches from top of pipe.
   e. Control Wiring/Communication Cable - Side of pressure main or at 18 inch
depth if installed in a separate trench with no mainline piping.

f. Drip Tubing - 12 inches from top of pipe.
g. Emitter Tubing (Micro-tubing) - 8 inches from top of pipe.

3. Boring will be permitted only where pipe must pass under obstruction(s) which cannot be removed. In backfilling bore, final density of backfill shall match that of surrounding soil. It is acceptable to use sleeves of suitable diameter installed first by jacking or boring, and pipe laid through sleeves. Observe same precautions as though pipe were installed in open trench.

4. Vibratory Plow - Non-pressure piping may be installed through use of vibratory plow method if consultant determines soil conditions are satisfactory for this method of installation. Vibratory plowing does not relieve installer of minimum pipe depths.

D. Pressure Supply Piping Locating Tape for Non-Potable Systems: Markline Tape, 3" wide detectable tape, NP purple in color with the words "CAUTION: RECYCLED/RECLAIMED WATERLINE BELOW" printed every 36 inches. Place 12" below finish grade.

3.05 INSTALLATION - Locate other equipment as near as possible to locations designated. Consultant shall review deviations prior to installation.

A. PVC/POLY Piping - Snake pipe in trench as much as possible to allow for expansion and contraction. Do not install pipe when air temperature is below 40 degrees F. Place manual drain valves at low points and dead ends of pressure supply piping to insure complete drainage of system. When pipe installation is not in progress, or at end of each day, close pipe ends with tight plug or cap. Perform Work in accordance with good practices prevailing in piping trades.

1. Solvent Weld PVC Pipe - Lay pipe and make all plastic to plastic joints in accordance with manufacturer's recommendations.
2. Flexible Plastic (Polyethylene) Pipe - Lay pipe and assemble fittings following manufacturer's recommendations.

B. Drip Tubing:

1. Make all fitting connections as per manufacturers recommendations.
2. Use only manufacturer provided or recommended hole punch when making penetrations in drip tubing for insert fittings. Use of any other hole punch shall be cause for immediate removal and replacement of all installed drip tubing.
3. Install drip line blow-out stubs at all dead ends of drip tubing.

C. Control Wiring:

1. Low Voltage Wiring:
   a. Bury control wiring between controller and electric valves in pressure supply line trenches, strung as close as possible to main pipe lines with such wires to be consistently located below and to one side of pipe, or in separate trenches.
   b. Bundle all 24 volt wires at 10 foot intervals and lay with pressure supply line pipe to one side of the trench.
   c. Provide an expansion loop at every pressure pipe angle fitting, every electric control valve location (in valve box), and every 500 feet. Form expansion loop by wrapping wire at least 8 times around a 3/4 inch pipe and withdrawing pipe.
   d. Make all splices and E.C.V. connections using 3M DBY connectors or similar dry splice method.
   e. Install all control wire splices not occurring at control valve in a separate splice valve box.
f. Install one control wire for each control valve.
g. Maintenance spare wires - In addition to spare wires labeled on drawings, extend two spare #14 AWG UFUL control wires and one spare #14 AWG UFUL common wire from controller pedestal to the end of each and every leg of mainline. Label maintenance spare wires at controller and wire stub box.

2. High Voltage Wiring for Automatic Controller:
   a. Provide 120 volt power connection to automatic controller,
   b. All electric work shall conform to local codes, ordinances, and authorities having jurisdiction. All high voltage electrical work shall be performed by licensed electrician.

D. Automatic Controller:
   1. Install controller in accordance with manufacturer's instructions as detailed and where shown on Drawings.
   2. Connect remote control valves to controller in numerical sequence as shown on Drawings.
   3. Owner shall approve final location of controller prior to installation.
   4. Each controller shall be a dedicated separate ground wire and grounding rod as detailed.
   5. All above ground conduit shall be rigid galvanized with appropriate fittings. All below ground conduit shall be schedule 40 PVC.

E. Electric Control Valves - Install cross-handle four inches below finished grade where shown on Drawings as detailed. When grouped together, allow minimum of 12 inches between valve box sides. Install each remote control valve in a separate valve box. Install valve box flush with grade or when present flush with surfacing material (rock mulch). When parallel to roadway, sidewalk or other permanent element or structure, control valve and box to be installed perpendicular to element or structure, spaced equally.

F. Quick Coupling Valves - Install quick couplers on swing-joint assemblies as indicated on construction details; plumb and flush to grade. Angled nipple relative to pressure supply line shall be no more than 45 degrees and no less than 10 degrees.

G. Drip and Sub-Surface Valve Assemblies - Install valve assembly as detailed.

H. Drip Emitters - Stake all surface emitters as detailed and staked with acceptable tubing stakes.
   Sub-Surface tubing - Size and type shown on Drawings; installed as detailed, per manufactures recommendations.

I. Drain Valves - Install one manual drain valve on pressure supply line directly downstream of backflow preventer as detailed. Provide a three cubic foot drainage sump for drain valve as detailed.

J. Valve Boxes:
   1. Install one valve box for each type of valve installed as detailed. Valve box extensions are not acceptable except for master valves and flow sensors. Install gravel sump after compaction of all trenches. Place final portion of gravel inside valve box after valve box is backfilled and compacted.
   2. Brand controller letter and station number on lid of each valve box. Letter and number size shall be no smaller than 1 inch and no greater in size than 1 1/2 inches. Depth of branding shall be no more than 1/8 inch into valve box lid.
K. Gate Valves - Install where shown on Drawings as detailed.

L. Sprinkler Heads - Install sprinkler heads where designated on Drawings or where staked. Set to finish as detailed. Spacing of heads shall not exceed the maximum indicated on Drawing unless re-staked as directed by Consultant. In no case shall the spacing exceed maximum recommended by manufacturer. Install heads on swing joints or riser assemblies as detailed. Adjust part circle heads for proper coverage. Adjust heads to correct height after sod is installed. Plant placement shall not interfere with intended sprinkler head coverage, piping, or other equipment. Consultant may request nozzle changes or adjustments without additional cost to the Owner.

M. Backflow Preventer - Install as detailed at location designated on Drawings.

N. Backfilling - Do not begin backfilling operations until required system tests have been completed. Backfill shall not be done in freezing weather except with review by Consultant. Leave trenches slightly mounded to allow for settlement after backfilling is completed. Trenches shall be finished graded prior to walk-through of system by Consultant.

1. Materials - Excavated material is generally considered satisfactory for backfill purposes. Backfill material shall be free of rubbish, vegetable matter, frozen materials, and stones larger than 1 inch in maximum dimension. Do not mix subsoil with topsoil. Material not suitable for backfill shall be hauled away. Contractor shall be responsible for providing suitable backfill if excavated material is unacceptable or not sufficient to meet backfill, compaction, and final grade requirements.

2. Do not leave trenches open for a period of more than 48 hours. Open excavations shall be protected in accordance with OSHA regulations.

3. Compact backfill to 90% maximum density, determined in accordance with ASTM D155-7 utilizing the following methods:
   a. Mechanical tamping.
   b. Puddling or ponding. Puddling or ponding and/or jetting is prohibited within 20'-0" of building or foundation walls.

O. Piping Under Paving:

1. Provide for a minimum cover of 18 inches between the top of the pipe and the bottom of the aggregate base for all pressure and non-pressure piping installed under asphaltic concrete or concrete paving.

2. Piping located under areas where asphalt or concrete paving will be installed shall be bedded with sand (a layer 6" below pipe and 6" above pipe).

3. Compact backfill material in 6" lifts at 90% maximum density determined in accordance with ASTM D155-7 using manual or mechanical tamping devices.

4. Set in place, cap, and pressure test all piping under paving, in presence of Owner prior to backfilling and paving operations.

5. Piping under existing walks or concrete pavement shall be done by jacking, boring, or hydraulic driving, but where cutting or breaking of walks and/or concrete is necessary, it shall be done and replaced at no cost to Owner. Obtain permission to cut or break walks and/or concrete from Owner.

P. Water Supply and Point of Connection - Water supply shall be extended as shown from water supply lines.

3.06 FIELD QUALITY CONTROL:

A. Flushing - After piping, risers, and valves are in place and connected, but prior to installation of sprinkler heads, quick coupler assemblies, and hose valves, thoroughly flush piping system under full head of water pressure from dead end fittings. Maintain flushing for 5
minutes through furthest valves. Cap risers after flushing.

B. Pressure Testing - Conduct test in presence of Consultant. Arrange for presence of Consultant 48 hours in advance of testing. Supply force pump and all other test equipment. Compressed air shall not be used for pressure testing system.

1. After backfilling, and installation of all control valves, fill pressure supply line with water, and pressurize to 40 PSI over the designated static pressure or 120 PSI, whichever is greater, for a period of 2 hours.
2. Leakage, Pressure Loss - Test is acceptable if no loss of pressure is evident during the test period.
3. Leaks - Detect and repair leaks.
4. Retest system until test pressure can be maintained for duration of test.
5. Before final acceptance, pressure supply line shall remain under pressure for a period of 48 hours.
6. Pressure test shall be scheduled and passed prior to scheduling of Substantial Completion Walk-through.

C. Walk-Through for Substantial Completion:

1. Arrange for Consultant's presence 48 hours in advance of walk-through.
2. Entire system shall be completely installed and operational prior to scheduling of walk-through.
3. Operate each zone in its entirety for Consultant at time of walk-through and additionally, open all valve boxes if directed.
4. Generate a list of items to be corrected prior to Final Completion.
5. Furnish all materials and perform all work required to correct all inadequacies of coverage due to deviations from Contract Documents.
6. During walk-through, expose all drip emitters under operations for observation by Consultant to demonstrate that they are performing and installed as designed, prior to placing of all mulch material. Schedule separate walk-through if necessary.
7. Supply Consultant with prints of irrigation as-builds prior to scheduling substantial completion walk-through.

D. Walk-Through for Final Completion:

1. Arrange for Consultant's presence 48 hours in advance of walk-through.
2. Show evidence to Consultant that Owner has received all accessories, charts, record drawings, and equipment as required before Final Completion walk-through is scheduled.
3. Operate each zone, in its entirety for Consultant at time of walk-through to insure correction of all incomplete items.
4. Items deemed not acceptable by Consultant shall be reworked to complete satisfaction of Consultant.
5. If after request to Consultant for walk-through for Final Completion of irrigation system, Consultant finds items during walk-through which have not been properly adjusted, reworked, or replaced as indicated on list of incomplete items from previous walk-through, Contractor shall be charged for all subsequent walk-throughs. Funds will be withheld from final payment and/or retainage to Contractor, in amount equal to additional time and expenses required by Consultant to conduct and document further walk-throughs as deemed necessary to insure compliance with Contract Documents.

3.07 Adjusting - Upon completion of installation, fine-tune entire system by adjusting patterns and break-up pins, and setting pressure reducing valves at proper and similar pressure to provide optimum and efficient coverage. Flush and adjust all sprinkler heads for optimum performance and
to prevent overspray onto walks, roadways, and buildings as much as possible. Heads of same type shall be operating at same pressure +/- 10%.

A. If it is determined that irrigation adjustments will provide proper coverage, and improved water distribution as determined by Consultant, contractor shall make such adjustments prior to Final Acceptance, as directed, at no additional cost to Owner. Adjustments may also include changes in nozzle sizes, degrees of arc, and control valve throttling.

B. All sprinkler heads shall be set perpendicular to finish grade unless otherwise noted on Construction Plans or directed by Consultant.

C. Areas which do not conform to designated operation requirements due to unauthorized changes or poor installation practices shall be immediately corrected at no additional cost to the Owner.

3.08 CLEANING - Maintain continuous cleaning operation throughout duration of work. Dispose of, off-site at no additional cost to Owner, all trash or debris generated by installation of irrigation system.

END OF SECTION
SECTION 32 90 00
FINE GRADING AND SOIL PREPARATION

PART 1 - GENERAL

1.01 SECTION INCLUDES
A. Examination.
B. Preparation.
C. Subsoil Preparation.
D. Placing Topsoil.
E. Soil Tests.
F. Coordination of Soil Amendments.
G. Fine Grading.
H. Tolerances.
I. Field Quality Control
J. Adjusting.
K. Cleaning
L. Protection.

1.02 RELATED SECTIONS
A. Section 01 33 00: Submittal Procedures
B. Section 01 40 00: Quality Requirements
C. Section 31 10 00: Site Clearing
D. Section 31 00 00: Earthwork
E. Section 32 84 00: Irrigation.
F. Section 32 92 00: Turf and Grasses.
G. Section 32 93 00: Planting.
H. Section 32 94 00: Planting Accessories

1.03 REFERENCES
A. Colorado Division of Labor Rules and Regulations: Excavation.
C. ANSI/ASTM D698 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, Using 5.5 lb (2.49 Kg) Rammer and 12 inch (304.8 mm) Drop.
D. ANSI/ASTM D1556 - Test Method for Density of Soil in Place by the Sand-Cone Method.
E. Association of Official Agricultural Chemists: Topsoil Analysis.

1.04 DEFINITIONS

1.05 SUBMITTAL PROCEDURES
A. Comply with Section 01 33 00. All submittals shall be accepted by the Architect in writing before planting commence
B. TOPSOIL TESTING:
   1. After topsoil spreading, submit, for Architect's approval, topsoil samples and test results from:
a. Each off-site topsoil source.

2. Each location submission shall include:
   a. 1 qt. representative sample in air tight container.
   b. Agricultural analysis by recognized laboratory made in accordance with methods established by the Association of Official Agricultural Chemists. Test shall include available nutrients, soil pH, soil texture, salt, and percentage organic matter, and recommended fertilization and amendment rates for plant material types specified.
   c. Location of borrow site, if applicable.

3. Deliver copies of all test reports and samples to landscape contractor and Architect.

C. CERTIFICATES: Submit certificates of inspection as required by governmental authorities.

D. SAMPLES: Comply with paragraph 1.06.B this Section.

1.06 QUALITY REQUIREMENTS

A. Comply with Section 01 40 00.

B. QUALIFICATIONS

1. Installer: Company with minimum five (5) years successful experience in the placing on topsoil similar in scope and size to this project.

2. Testing Agency: Certified soils laboratory with capability to analyze materials for conformance to specification requirements (where applicable).

1.07 DELIVERY, STORAGE AND HANDLING

A. TOPSOIL: Protect materials from erosion, wind, rodents, deterioration and contamination during delivery, installation and site storage.

1.08 PROJECT/SITE CONDITIONS

A. ENVIRONMENTAL REQUIREMENTS

1. Comply with requirements of referenced standards for environmental conditions before, during, and after installation. Maintain environmental conditions and protect work during and after installation to comply with referenced standards.

2. Moisture Content: Topsoil and other materials shall not be placed, backfilled, or spread while in a wet or saturated condition. Moisture content shall not be so great that excessive compaction will occur, nor so low that dust will form in the air or that clods will not break readily. Apply water if necessary to bring soil to optimum moisture content for tilling.

3. Do not work soil when muddy or frozen.

B. EXISTING CONDITIONS

1. Plants: Protect existing plant material. Do not damage any plantings indicated to remain.

2. Utilities: Determine location of underground utilities including irrigation system. Perform work in a manner to avoid possible damage. Hand excavate, as required.
3. **Excavation:** Maintain grade stakes set by others until removal is mutually agreed upon by parties concerned. When conditions detrimental to Work are encountered, such as rubble fill, adverse drainage conditions, noxious materials or obstructions, notify Architect before proceeding.

### 1.09 SEQUENCING AND SCHEDULING

#### A. COORDINATION

1. Coordinate with seeding and landscape Contractor(s) approved schedule. Refer to Division 1. Do not place topsoil more than 3 days prior to commencement of landscaping in the area. Limit fine grading to areas which can be planted within 24 hours after fine grading.

2. Coordinate with Contractors' work requiring access to site over topsoil areas.

3. Coordinate with installation of underground irrigation system and outlets.

### 1.10 MAINTENANCE

#### A. Protect newly topsoiled and fine graded areas from erosion and traffic. Repair and reestablish grades in settled, eroded and disturbed areas to specified tolerances until landscape operations commence.

### PART 2 - PRODUCTS

#### 2.01 TOPSOIL

##### A. ON-SITE TOPSOIL: Fertile sandy loam, taken from a well drained site and free from clay subsoil, stones, lumps, stolons, plants, roots, sticks and seeds, high salt content and other materials/attributes harmful to plant life.

1. **Sieve/Screen Size** | % Passing | % Retaining
--- | --- | ---
1" screen | 100 | 0
1/2" screen | 97-100 | 0-3
#100 mesh sieve | 60-40 | 40-60

2. pH before amendments between 5.5 and 7.5.

3. Refer to Sections 32 92 00, and 32 93 00 for topsoil amendment requirements.

##### B. PRE-AMENDED TOPSOIL: At the contractor's option, pre-amended topsoil may be used in lieu of imported topsoil amended on site.

1. Supplier: A-1 Organics, or approved equal.

#### 2.02 WATER

##### A. Clean, fresh and free of substances or matter which could inhibit vigorous growth of plants.

#### 2.03 HERBICIDE

##### A. **WEED HERBICIDE:** Round-up or approved equal.
PART 3 - EXECUTION

3.01 EXAMINATION

A. VERIFICATION OF CONDITIONS: Examine areas and conditions under which the Work of the Section will be performed. Report unsatisfactory or questionable conditions to the Architect. Do not proceed with the Work until unsatisfactory conditions have been corrected. Commencement of work implies acceptance of all areas and conditions.

1. Verify that during grading, the ground surface was cleaned of materials which might hinder final operations.

3.02 PREPARATION

A. PROTECTION: Protect areas in accordance with paragraph 3.12 this Section.

B. HERBICIDE TREATMENT

1. Confirm Architect’s requirement to proceed with herbicide treatment of on site soil. Herbicide treatment must be completed during the growing season.

2. If plant growth is evident, treat site with Roundup herbicide in accordance with manufacturer’s recommendations.

3. Water subsoil 1/2” per week if natural precipitation does not supply this amount.

4. Ten (10) days after Roundup application, review soil surface for evidence of plant growth.

5. Repeat steps 2, 3 and 4, up to three (3) applications, until there is no evidence of plant growth after 10 day period.

6. Obtain Architect’s approval of soil fourteen (14) days after last herbicide application.

7. Remove plant debris from treated area.

3.03 SUBSOIL PREPARATION

A. Verify subsoil base has been contoured and compacted and is free of contaminated material.

B. Prepare subsoil to eliminate uneven areas and low spots. Maintain lines, levels, profiles, and contours. Make changes in grade gradual. Blend slopes into level areas.

C. Remove foreign materials, stones exceeding 2 inches, weeds and undesirable plants and their roots.

D. Scarify subsoil to a depth of 6 inches where topsoil is to be placed. Repeat cultivation in areas where equipment, used for hauling and spreading topsoil, has compacted subsoil.

E. Remove foreign materials, stones exceeding 2 inches, weeds and undesirable plants and their roots which came to the surface during subsoil scarification.

3.04 PLACING TOPSOIL

A. Place topsoil where seeding, and planting are scheduled and in accordance with paragraph 1.09 this Section.

B. Place topsoil during dry weather and on dry, unfrozen subsoil.

C. Remove vegetative matter and foreign, non-organic material and debris larger than 1.5 inches in diameter at the time of placement.

D. Place topsoil to the following depths:

a. Sod Areas 4"
b. Seed Areas 4"
c. Shrub Beds 6"
d. Flower Beds 6"
e. Planters Full depth, allowing for the addition of soil amendments.
E. Place topsoil eliminating rough or low areas to ensure positive drainage. Maintain profiles and contour of subgrade.
F. Manually place topsoil close to existing trees, shrubs, plants, curbs, new construction, planters and buildings to prevent damage.
G. Coordinate topsoil placement with sub-soil amending in accordance with Section 02950.

3.05 SOIL TESTS
A. Perform soil testing and submission in accordance with paragraph 1.06 this Section.

3.06 COORDINATION OF SOIL AMENDMENTS
A. Coordinate soil amendments with landscape contractor in accordance with Sections 32 92 00, and 32 93 00.

3.07 FINE GRADING
A. Fine grade topsoil to finished elevations with smooth, even surface with loose, uniformly fine texture.
B. Remove foreign materials, stones exceeding 1.5 inches, weeds and undesirable plants and their roots which came to the surface during soil amending.
C. Roll, rake and drag lawn areas, remove ridges and fill depressions, as required to meet finish grades. Limit fine grading to areas which can be planted immediately after grading. Compact seeded areas to 90% in accordance with Earthwork Section 31 00 00.
D. Remove surplus subsoil and topsoil from site.
E. Leave stockpile area and site clean and raked, ready to receive landscaping.

3.08 TOLERANCES
A. TOPSOIL: Topsoil elevations shall be within the following tolerances from elevations indicated on the drawings:
   1. Landscape Areas: ± 0.10’.
   2. Adjacent to Paving and Curbs: ± 0.04’ (1/2”).

3.09 FIELD QUALITY CONTROL
A. REVIEWS: Comply with Contract General Conditions.

3.10 ADJUSTING
A. RECONDITIONING COMPACTED AREAS: When completed topsoil areas are disturbed by subsequent construction operations or adverse weather, scarify surface, reshape, and compact to required density prior to further construction.

3.11 CLEANUP
A. DURING LANDSCAPE INSTALLATION
   1. All areas shall be reasonably clean at the end of each work day. Sidewalks and other paved areas shall be swept or washed down as needed. Keep pavements clean and work area in an orderly condition.
   2. Contractor shall make a reasonable effort to clean up the project on a daily basis to maintain a neat and orderly site.
B. PROJECT COMPLETION
1. All debris, soil and trash resulting from landscape operations shall be removed from the site. Burning of waste material is prohibited. All paved areas shall be washed down.

2. Restore all areas outside the Contract limits which have been disturbed to their original condition at no cost to the Architect.

3.12 PROTECTION

A. Protect landscape work and materials from damage due to landscape operations, operations by other contractors and trades and trespassers.

B. Maintain protection during installation and maintenance periods. Treat, repair or replace damaged landscape work as directed.

C. Protect existing trees, shrubs, groundcovers, perennials and turf areas from damage during construction.

END OF SECTION
SECTION 32 92 00
TURF AND GRASSES

PART 1 - GENERAL

1.01 SECTION INCLUDES
A. Examination.
B. Site Preparation.
C. Soil Preparation for Seeding
D. Seeding
E. Mulching
F. Erosion Control Blankets
G. Areas to be top Dressed
H. Field Quality Control.
I. Clean Up.
J. Protection.
K. Maintenance

1.02 RELATED SECTIONS
A. Section 01 33 00: Submittal Procedures.
B. Section 01 40 00: Quality Requirements.
C. Section 32 84 00: Irrigation.
D. Section 32 90 00: Fine Grading and Soil Preparation.
E. Section 32 93 00: Planting.
F. Section 32 93 50: Landscape Maintenance.
G. Section 32 94 00: Planting Accessories.

1.03 REFERENCES
A. ASPA  (American Sod Producers Association) - Guideline Specifications to Sodding.

1.04 DEFINITIONS

1.05 SUBMITTAL PROCEDURES
A. Comply with Section 01 33 00. All submittals shall be accepted by the Architect in writing before planting commences.
B. TOPSOIL TESTING
   1. Coordinate soil testing with Section 01 40 00.
C. CERTIFICATES
1. Submit two copies of labels or certificates from State Department of Agriculture for grass species and location of sod source.

2. Submit certificates of inspection as required by governmental authorities.

3. Submit manufacturer's certified analysis packaged with standard products.

4. Submit all blue tags which were removed to mix the seed.

5. Submit mix tags showing seed mix, noxious seed and crop seed content, weight, analysis and date of most recent germination test.

6. Submit certificates of inspection certifying that straw for use as mulch is weed free.

D. ANALYSIS AND STANDARDS: Wherever applicable, for non packaged materials, provide two copies of analysis by recognized laboratory made in accordance with methods established by the Association of Official Agriculture Chemists.

E. PLANTING SCHEDULE: Comply with General Contract Conditions.

1.06 QUALITY REQUIREMENTS

A. Comply with Section 01 40 00.

B. QUALIFICATIONS

1. Installer: Company approved by the sod producer or company with minimum five (5) years successful experience in the installation of sodded lawn areas similar in size to this project.

C. REGULATORY REQUIREMENTS

1. Comply with regulatory agencies concerning classification, transportation, handling and storage of sod, seed, fertilizer, herbicide and pesticide materials.

2. Comply with regulatory agencies for fertilizer, herbicide and pesticide composition and application.

1.07 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. SEED

1. Deliver seed mixture in original sealed containers with certificates of inspection required by governing authorities. Labels shall show seed mix, noxious seed and crop seed content, weight, analysis and date of most recent germination test. Certified blue-tagged seed shall be supplied where a named variety is specified. Seed in damaged packaging is not acceptable.

2. Protect materials from weather, moisture, rodents, deterioration and contamination during delivery, installation and site storage. Seed that has become wet or otherwise damaged is not acceptable.

3. Rejection of Materials: Evidence of inadequate or inappropriate transportation or storage of seed or seed not properly identified through blue-tags or mix tags submitted to Architect shall be cause for rejection.

1.08 PROJECT/SITE CONDITIONS

A. ENVIRONMENTAL REQUIREMENTS
1. Seeding Season: Seeding shall occur as specified below. Variance from schedule shall be permitted only with written approval from the Engineer.

<table>
<thead>
<tr>
<th>Seed Type</th>
<th>Irrigated Areas Only</th>
<th>Irrigated and Non-Irrigated Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dryland Grasses</td>
<td>April 15-Sept 1</td>
<td>June 15-July 15</td>
</tr>
<tr>
<td>and Shrubs</td>
<td></td>
<td>Oct 15-April 30</td>
</tr>
</tbody>
</table>

2. Seeding shall occur only when weather and soil conditions permit in accordance with locally accepted practice. Do not seed during periods of prolonged cold or heat, when ground is frozen or too dry, during windy periods, immediately following rain, or during excessively wet or dry periods.

B. EXISTING CONDITIONS

1. Existing Plants: Do not damage any existing plantings indicated to remain. Sod areas after trees are planted and after final grades are established, unless otherwise directed by the Architect.

2. Utilities: Determine location of underground utilities. Perform work in a manner to avoid possible damage. Hand excavate, as required.

3. Excavation: Maintain grade stakes set by others until removal is mutually agreed upon by parties concerned. When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage conditions, noxious materials or obstructions, notify Architect before planting.

1.09 SEQUENCING AND SCHEDULING

A. WORK SCHEDULING: Proceed with and complete landscape work as rapidly as portions of the site become available, working within the specified planting season and approved schedule.

B. COORDINATION

1. Coordinate with Contractors work requiring access to site over lawn areas.

2. Coordinate with installation of underground irrigation system and outlets.

3. Coordinate laying sod and seeding to provide maintenance for 1 year after Final Acceptance in accordance with Paragraph 1.12 this Section.

4. Coordinate with topsoil placing to conform with installation requirements specified in Section 32 90 00.

1.10 WARRANTY AND REPLACEMENT

A. GENERAL: Comply with General Contract Conditions.

B. SEED WARRANTY CONDITIONS: Warranty all seeded areas against defects due to any cause except vandalism and acts of God. The following warranty conditions apply:

1. Reseed all areas when turf is no longer in a satisfactory growing condition as determined by the Engineer for the entire warranty period.
   a. Fescue and Kentucky Bluegrass Mixes Acceptance: 95% of seeded area covered with germinated seed and no bare spots greater than 4 inches square after 90 days.
2. If seeded areas fail after having been replaced previously, area shall be replaced until it is approved. The warranty period begins anew and extends each time an area requires replanting. Replacement seed shall be of the same kind, condition and quality as original seed and subject to all requirements in this specification.

3. All expenses incurred in the replacements shall be borne by the Contractor.

4. Make replacements within seven days of notification by Engineer.

5. If seeded in fall, review for Substantial Completion shall be no later than June 15 the following year.

C. POST CONSTRUCTION INSPECTION (REVIEW FOR FINAL WARRANTY COMPLIANCE): Comply with General Contract Conditions.

1.11 MAINTENANCE (See also Section 32 93 50)

A. GENERAL: Maintain lawns by watering, fertilizing, weeding, mowing, trimming, and other operations such as rolling, regrading and resodding and reseeding as necessary to establish a smooth, acceptable lawn, free of eroded or bare areas or as directed by the Architect.

1. Overwatering of lawns which causes stress to trees is not allowed.

B. MAINTENANCE PERIOD: Begin maintenance immediately after seeding. Maintain seeded areas in accordance with Section 32 93 50. If necessary sub-areas may be deemed to have achieved Substantial Completion to allow maintenance period to begin in that area.

PART 2 - PRODUCTS

2.01 SOIL AMENDMENTS

A. Certification required. Non-sludge Class I compost in compliance with Colorado Department of Public Health and Environment Regulation 64.

2.02 COMMERCIAL FERTILIZER

A. ORGANIC FERTILIZER: Provide fertilizer of neutral character, with some elements derived from organic sources and containing the percentages of available plant nutrients given below. Deliver fertilizers to the site fully labeled according to applicable state fertilizer laws and bearing the name, tradename, trademark and warranty of the supplier. Fertilizers which are mixed into soil shall be:

1. Gro-Power Plus: Granular fertilizer meeting Gro-Power Plus analysis (5-3-1); with 50% humus, 15% humic acids, 1.25% soil penetrant, and bacterial culture included, containing no animal, human, or poultry waste. Submit manufacturer's guaranteed analysis. Guaranteed analysis shall conform to amendment requirements as given in Part 3 of this Section.

   a. Manufacturer: So. California Organic Fertilizer Co., P.O. Box 769, Glendale, CA. 91029; 213-245-6849; 714-750-3830; and as distributed by Direct Landscape Supply, 1501 West Campus Drive, Unit D, Littleton, CO, 80120, 303-797-7733, or approved equal.

B. INORGANIC FERTILIZERS

1. Diammonium Phosphate (DAP) 18-46-0: Soluble mixture in granular form of treated minerals with 16-20% available phosphoric acid.
2. Iron Chelate: Liquid mixture, in acid soils use FeEDTA, in neutral or alkaline soils use FeHEEDTA.

2.03 WATER

A. Clean, fresh and free of substances or matter which could inhibit vigorous growth of grass.
B. Available on-site at no expense to Contractor. Landscape Contractor is responsible for coordination of water needs for watering and irrigation water with the Owner.

2.04 SEED

A. Minimum seed purity shall be 95 percent with a minimum germination of 85 percent. The percentage of material other than grass seed in the mixture, shall not include more than 18 percent non-viable seed, chaff, hulls, live seed of crop plants (other than those specified), or harmless inert matter. Weed shall not exceed 0.50 percent of the total weight of the mixture. Provide seed in labeled, original containers.
B. SUBSTITUTIONS: Do not make substitutions: If specified seed is not obtainable, submit proof of non-availability to Architect together with proposal for use of equivalent material for review and acceptance by Architect.

2.05 SEED MIXTURE

A. DRYLAND GRASS MIX

1. Dryland grass mix seeded at a rate of 30 pounds pure live seed (PLS) per acre.

<table>
<thead>
<tr>
<th>Grass Type</th>
<th>PLS Pounds per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buffalograss</td>
<td>6.4</td>
</tr>
<tr>
<td>Blue Grama Grass</td>
<td>6</td>
</tr>
<tr>
<td>Sideoats Grama Grass</td>
<td>3.6</td>
</tr>
<tr>
<td>Western Wheatgrass</td>
<td>9.6</td>
</tr>
<tr>
<td>Thickspike Wheatgrass</td>
<td>2.2</td>
</tr>
<tr>
<td>Slender Wheatgrass</td>
<td>2.2</td>
</tr>
</tbody>
</table>

2.06 TACKIFIER

A. Plantago-based organic tackifier such as Agri-Tac, M-Binder, AZ/Tac or approved equal.

2.07 MULCH

A. WOOD CELLULOSE: Wood cellulose fiber mulch, dyed green, not containing any substance or factor which might inhibit germination. Mulch shall be supplied dry. Provide certification to Architect that mulch complies with above requirements.
B. STRAW: Small grained straw in 60 pound bales. Apply 1.5 tons of straw per acre. Increase nitrogen fertilizer 20 pounds per ton of straw when applied in accordance with this Specification, to compensate for nitrogen tied up by straw mulch decay.

2.08 ACCESSORIES

A. WOOD PEGS: Softwood, sufficient size and length to anchor sod in swales and on slopes exceeding 3:1.

PART 3 - EXECUTION
3.01  EXAMINATION

A.  VERIFICATION OF CONDITIONS: Examine areas and conditions under which the Work of this Section will be performed. Report unsatisfactory or questionable conditions to the Architect. Do not proceed with the Work until unsatisfactory conditions have been corrected. Commencement of work implies acceptance of all areas and conditions.

1.  Verify that during grading, topsoil spreading and landscape grading operations, the ground surface was be cleaned of materials which might hinder final operations.

3.02  PREPARATION

A.  PROTECTION: Protect areas in accordance with paragraph 3.07 this Section.

3.03  SOIL PREPARATION FOR SEEDING

A.  AMENDMENTS

1.  Apply fertilizer and amendments PRIOR to topsoil spreading. Refer to Section 32 90 00, Fine Grading and Soil Preparation for rates and incorporation method.

B.  FINE GRADING: Coordinate with fine grading in accordance with Section 32 90 00: Fine Grading and Soil Preparation. Compact in accordance with Section 31 00 00: Earthwork.

C.  Restore areas to specified condition if eroded or otherwise disturbed after fine grading and prior to seeding.

D.  Obtain acceptance of final grading by the Architect prior to seeding.

3.04  SEEDING

A.  After soil placement and preparation, roll the area to an evenly compacted, firm soil bed. Rework hard and soft areas.

B.  Refer to Paragraph 2.06 this Section for seeding rates.

C.  APPLICATION

1.  Mechanical Application: Seed by mechanical landscape type drills. Drill seed with approximately 1/2 inch of cover. Seed 50% of seed in one direction and 50% at a 90 degree angle.

2.  Hydroseed or Broadcast Application: Seed by hydroseed or broadcast method only when areas are too small to drill seed. Make 2 passes perpendicular to each other. First pass shall include seed, fertilizer and water. Second pass shall include mulch and tackifier.

D.  Do not seed areas in excess of that which can be mulched on the same day.

E.  PLANTING SEASON: Plant in accordance with paragraph 1.09.A this Section.

F.  Roll seeded area with roller not exceeding 100 lbs.

G.  Apply mulch immediately following seeding and compacting or as part of seeding process, dependent on seeding method.

3.05  MULCHING

A.  GENERAL

1.  Regardless of seeding method, all seeded areas require mulching.
2. Mulch all areas within 24 hours after completion of seeding. Reseeded areas not mulched within 24 hours after seeding with specified seed mix at no cost to the Owner.
3. Areas not properly mulched or areas damaged due to Contractor's negligence shall be repaired and remulched as specified at Contractor's expense.

B. MULCH APPLICATION:
1. Hydromulch
   a. Utilize hydraulic equipment with nozzle adaptable for hydraulic mulching with storage tanks having means of estimating volume used or remaining in tank.
   b. Hydromulch shall consist of tackifier applied at a rate of 100 lbs. per acre and a cellulose fiber mulch mixed to form a homogeneous slurry; spray applied to seeded area at a rate of 2,000 lbs. per acre.

C. WATERING IN: Apply water with a fine spray immediately after each area has been mulched. Saturate to 4 inches of soil.

3.06 FIELD QUALITY CONTROL

A. TESTS: Costs of tests and material analyses made by the testing agency will be borne by the Owner when tests indicate compliance and by the Contractor when test indicated non-compliance.

B. REVIEWS
2. Pre-Planting Review
   a. All finish grading shall be inspected by Architect prior to sodding commencing. Correct any discrepancies prior to sodding.

3. Substantial Completion
   a. Comply with General Contract Conditions.
   b. At the time of this walk-through, the Contractor shall have:
      1.) Established well rooted, thick stand of grass established over 95% of the site's limit of seeding.
      2.) Verified installed irrigation system is fully operational with heads properly adjusted.
      3.) Cleaned all walkways and curbs of debris and litter and shall have cleaned areas of soil and debris left from planting operations.

7. Warranty and Replacement: Comply with General Contract Conditions.

3.07 CLEANUP

A. DURING LANDSCAPE INSTALLATION - All areas shall be reasonably clean at the end of each work day. Sidewalks and other paved areas shall be swept or washed down as needed. Keep pavements clean and work area in an orderly condition.
B. PROJECT COMPLETION: All debris, soil and trash resulting from landscape operations shall be removed from the site. All paved areas shall be washed down.

3.8 PROTECTION

A. Protect landscape work and materials from damage due to landscape operations, operations by other contractors and trades and trespassers.

B. Maintain protection during installation and maintenance periods. Treat, repair or replace damaged landscape work as directed.

END OF SECTION
SECTION 32 93 00
PLANTING

PART 1 - GENERAL

1.01 SECTION INCLUDES
A. Examination.
B. Preparation.
C. General Planting Requirements.
D. Trees and Shrubs Planted in Individual Plant Pits or Trenches.
E. Shrubs, Perennials and Groundcovers Planted in Prepared Planting Beds.
F. Clean Up.
G. Field Quality Control.
H. Protection.

1.02 RELATED SECTIONS
A. Section 01 33 00: Submittal Procedures.
B. Section 01 40 00: Quality Requirements.
C. Section 32 84 00: Irrigation.
D. Section 32 90 00: Fine Grading and Soil Preparation.
E. Section 32 92 00: Turf and Grasses.
F. Section 32 94 00: Planting Accessories

1.03 REFERENCE
A. American Standards for Nursery Stock (ANSI Z60.1 - most recent edition), American Association of Nurserymen, Washington D.C.

1.04 DEFINITIONS
B. PLANTS: Trees, shrubs, groundcovers, annuals perennials, and bulbs specified in the plant list.

1.05 SUBMITTAL PROCEDURES
A. Comply with Section 01 33 00. All submittals and plant materials shall be accepted by the Architect in writing before planting commences.
B. TOPSOIL TESTING
   1. Coordinate soil testing with General Conditions.
C. CERTIFICATES
1. Submit certificates of inspection as required by governmental authorities.
3. Submit manufacturer’s certified analysis packaged with standard products.

D. ANALYSIS AND STANDARDS: Wherever applicable, for non packaged materials, provide analysis by recognized laboratory made in accordance with methods established by the Association of Official Agriculture Chemists.

E. PLANTING SCHEDULE: Submit in accordance with paragraph 1.05B Section 01011.

F. PLANT PHOTOGRAPHS: Submit one color photograph or 35 mm color transparency of all trees over 2 inch caliper or 7 foot height for any plant materials which are located outside of 30 mile radius of Denver for approval by Architect prior to shipment to the site or the contractor’ holding yard.

G. TREE PLANTING MATERIAL SUBMITTAL: Submit 1 tree collar and 1 sample of tree wrap.

H. SAMPLES: Submit 1 quart sample of wood chips for acceptance by Architect.

I. CONTRACTOR QUALIFICATIONS: Submit nursery and installation company qualifications in accordance with paragraph 1.06.B this Section for acceptance by Architect.

1.06 QUALITY REQUIREMENTS

A. Comply with Section 01 44 00

B. QUALIFICATIONS

1. Nursery: Company specializing in growing and cultivating the plants with minimum five (5) years experience, and certified by the State of Colorado Department of Agriculture.

2. Installer: Company with minimum five (5) years successful experience in the installation of landscape areas similar in size and complexity to this project. Company shall be a member in good standing of one of the following organizations:

   a. Associated Landscape Contractors of America.
   b. American Association of Nurserymen.
   c. A member of the Nurserymen’s Association of the state in which the work is being performed.

C. REGULATORY REQUIREMENTS

1. Comply with regulatory agencies concerning classification, transportation, handling and storage of plants, fertilizer, herbicide and pesticide materials.

2. Comply with regulatory agencies for fertilizer, herbicide and pesticide composition and application.

D. REJECTION OF MATERIALS

1. Evidence of inadequate or inappropriate protection after digging, transportation, or improper handling or storage, shall be cause for rejection.

2. Architect will inspect plants for proper shipping procedures upon arrival at the temporary storage location or the site. The Architect will reject injured plants including those with dried out roots, broken large branches, broken, or loosened balls or earth, split trunks or torn areas of bark.

3. The Contractor shall immediately removed and replace rejected plants.

E. PLANT LIST: Plant quantities are provided for the Contractor’s convenience only. The Contractor shall provide all plants in quantities as shown on Drawings despite any discrepancies which may exist with quantities called for on the plant list.
1.07 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. SHIPPING OF PLANTS

1. Plant Names and Labeling: Botanic and common names given in the plant list are in conformance with standard horticultural practice in the area. Deliver all plants to the site with tags bearing the botanical name and size as indicated in the plant list.

2. Nursery Harvesting: Provide freshly dug trees and shrubs. Do not prune prior to delivery unless otherwise approved by Architect. Plants shall be dug and prepared for shipment in a manner that will not cause damage to branches, shape and future development after planting. Trunks shall be wrapped for added protection. All balled and burlapped trees are to be dug during the appropriate time of year for the species listed, but in no case after buds have opened or prior to fall leaf drop. Do not bend or bind-tie trees or shrubs in such manner as to damage bark, break branches or destroy natural shape. Wounds, scars or damage shall be grounds for rejection. Do not drop balled and burlapped stock during delivery.

   a. If necessary obtain Architect’s approval to dig plants in full leaf. Spray foliage with antidessicant such as Wilt-proof or approved equal.

3. Transportation

   a. Open vehicles used to transport plants to the project shall be covered with tarpaulins or other suitable covers securely fastened to the vehicle to prevent damage to the plants. Closed vehicles shall be adequately ventilated to prevent overheating of the plants. Do not remove plants from refrigerated trucks into hot weather without allowing time for plants to adjust to heat.

   b. Ship landscape materials with certificates of inspection required by governing authorities. Comply with regulations applicable to landscape materials.

   c. Keep plants moist fresh and protected at all times.

4. Contractor shall exercise care in the handling of plant materials to avoid damage or stress.

C. ACCEPTANCE OF PLANTS AT SITE: Unless otherwise authorized by the Architect, the Contractor shall notify the Architect at least two working days in advance of the anticipated delivery date of any plant material. A legible copy of the bill of lading, showing the quantities, kinds, and sizes of materials included for each shipment shall be furnished to the Architect.

D. STORAGE AND PROTECTION OF PLANTS

1. Keep plants moist fresh and protected at all times, including entire period of transit, handling, and temporary storage.

2. Deliver trees and shrubs after preparations for planting have been completed and plant immediately. If planting is delayed more than 6 hours after delivery, set trees and shrubs in shade, protect from weather and mechanical damage, and keep roots moist by covering with mulch, burlap or other acceptable means of retaining moisture. Duration and method of storage are subject to Architect's
approval. Plants shall not remain on the site more than 3 days prior to planting unless specific authorization is obtained by the Architect.

1.08 PROJECT/SITE CONDITIONS

A. ENVIRONMENTAL REQUIREMENTS

1. Planting Season: Planting shall occur only after April 15 and before October 1 or as specified on the Drawings without written approval from Architect. Northern Red Oaks (Quercus rubra) shall be planted no later than May 31.

2. Planting shall occur only when weather and soil conditions permit in accordance with locally accepted practice. Do not plant during periods of prolonged cold or heat, or during excessively wet or dry periods.

B. EXISTING CONDITIONS

1. Existing Plants: Do not damage any existing plantings indicated to remain. Plant areas after final grades are established in accordance with Section 02923, unless otherwise directed by the Architect.

2. Utilities: Determine location of underground utilities. Perform work in a manner to avoid possible damage. Hand excavate, as required.

3. Excavation: Maintain grade stakes set by others until removal is mutually agreed upon by parties concerned. When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage conditions, noxious materials or obstructions, notify Architect before planting.

1.09 SEQUENCING AND SCHEDULING

A. WORK SCHEDULING: Proceed with and complete landscape work as rapidly as portions of the site become available, working within the specified planting season and approved schedule.

B. COORDINATION

1. Coordinate with Contractor's work requiring access to site through planting areas.

2. Coordinate with installation of underground irrigation system and outlets.

3. Coordinate Planting with Seeded and Sodded Areas: Plant trees and shrubs after final grades are established and prior to seeding and sodding, unless otherwise acceptable to Architect. If planting occurs after seeding or sodding, protect areas and promptly repair damage resulting from planting operations.

4. Coordinate planting to provide maintenance up to date of Substantial Completion in accordance with Paragraph 1.12 this Section.

1.10 WARRANTY AND REPLACEMENT

A. GENERAL: Refer to Division 1.

B. PLANT WARRANTY CONDITIONS: Warranty all plants against defects due to any cause except vandalism and acts of God. The following warranty conditions apply:

1. Replant when plants are no longer in a satisfactory growing condition as determined by the Architect for the entire warranty period.

2. If plants fail after having been replaced previously, plant shall be replaced until it is approved. Replacement plants shall be of the same kind, condition and quality as original plants and subject to all requirements in this specification.
3. Plants shall be healthy, and in flourishing condition at the end of the warranty period. Plants shall be free of dying branches and branch tips, and shall bear foliage of normal density, size and color.

4. All expenses incurred in the replacements shall be borne by the Contractor.

5. Make replacements within seven days of notification by Architect.

C. POST CONSTRUCTION INSPECTION (REVIEW FOR FINAL WARRANTY COMPLIANCE): Comply with Division 1 requirements.

1.11 MAINTENANCE

A. GENERAL: Maintain plants by watering, fertilizing, pruning, restoring planting saucers, tightening and repairing stake supports, resetting trees and shrubs to proper grades or vertical position as required, spraying as required to keep trees and shrubs free of insects and disease, cultivating and weeding as required for healthy growth or as directed by the Architect.

1. Monitor watering of plants and lawns to verify overwatering is not causing stress to trees.

2. Tree Wrap
   a. Apply a coating of insecticide and fungicide to the tree trunk area to be wrapped.
   b. Apply wrap to overlap 1 1/2” from ground line up to the lowest branch. Wrap trunks in late fall (approximately November 15).
   c. Tie securely in at least five places with jute twine, placed at least 12” apart.
   d. Remove tree wrap the beginning of the growing season (approximately April 15).
   e. Do not wrap cottonwoods (Populus spp.).

B. MAINTENANCE PERIOD: Begin maintenance immediately after planting. Maintain plants in accordance with Section 32 93 50. If necessary sub-areas may be deemed to have achieved Substantial Completion to allow maintenance period to begin in that area.

PART 2 – PRODUCTS

2.01 SOIL AMENDMENTS

A. COMPOST: Non-sludge Class 1 Compost in compliance with Colorado Department of Public Health and Environment Regulation 64.

2.02 COMMERCIAL FERTILIZER

A. ORGANIC FERTILIZER: Provide fertilizer of neutral character, with some elements derived from organic sources and containing the percentages of available plant nutrients given below. Deliver fertilizers to the site fully labeled according to applicable state fertilizer laws and bearing the name, tradename, trademark and warranty of the supplier. Fertilizers which are mixed into soil shall be:

1. Gro-Power Plus: Granular fertilizer meeting Gro-Power Plus analysis (5-3-1); with 50% humus, 15% humic acids, 1.25% soil penetrant, and bacterial culture included, containing no animal, human, or poultry waste. Submit manufacturer's guaranteed analysis. Guaranteed analysis shall conform to amendment requirements as given in Part 3 of this Section.
a. Manufacturer: So. California Organic Fertilizer Co., P.O. Box 769, Glendale, CA. 91209, 213-245-6849; 714-750-3830; and as distributed by Direct Landscape Supply, 1501 West Campus Drive, Unit D, Littleton, CO, 80120, 303-797-7733, or approved equal.

2. Fertilizer Tablets: Provide tablets of Gro-Power 12/8/8 analysis with 20% humus, 4% humic acid, in 7 gram tablet, or approved equal.
3. Bone Meal: Commercial, raw, finely ground; 4% nitrogen and 20% phosphoric acid.

B. INORGANIC FERTILIZERS: None.

2.03 WATER

A. Clean, potable and free of substances or matter which could inhibit vigorous growth of plants.
B. Available on-site at no expense to Contractor. Landscape Contractor is responsible for coordination of water needs for watering and irrigation water with the Owner.

2.04 GENERAL PLANT REQUIREMENTS

A. HEALTH: Plant materials provided shall:
1. Be healthy and vigorous.
2. Be free from disease, injury, insects and their eggs, larvae.
3. Have a well developed fibrous root system.
4. Be free of physical damage such as scrapes, broken or split branches, scars, bark abrasions, sun scalds, fresh limb cuts, disfiguring knots, or other defects.
5. Be free of weed roots.

B. SIZE AND FORM: Plant materials provided shall:
1. Meet the sizes indicated on the Plant List. Where a size or caliper range is stated, at least 50% of the plants shall be closer in size to the top of the stated range. Plants larger or smaller than specified may be used only if accepted by the Architect.
2. Meet the requirements of the reference standards for size, branching, condition, ball size, number of canes and all other conditions particular to each species.
3. Be well branched and proportioned with respect to height and width relationships, and characteristic of the exact type called for in the plant list.

C. BALLENGED AND BURLAPPED PLANTS: Nursery grown stock adequately balled with firm, natural balls of soil in sizes and ratios in accordance with the reference standards. Balls shall be firmly wrapped with non-treated burlap, secured with wire or jute. Broken balls will not be accepted.

D. CONTAINER GROWN PLANTS: Nursery grown in fibrous, plastic or metal containers and shall have sufficient roots to hold the entire soil mass together after container removal without being root-bound.

E. COLLECTED PLANTS: Plants collected from native stands or established plantings which have a root system greater than roots of nursery grown plants. Collected plants require a larger root ball than recommended for transplanted nursery stock as specified in reference standards. Collection tags shall be attached to each plant as required by regulatory agencies.

F. SPADED PLANTS: Plants shall be dug with tree spade and directly planted on site, or temporarily burlapped and placed in a wire basket while plant pit is hand dug on site. Size of tree spade in proportion to plant shall be as specified in reference standard for collected plants.
G. **OPTIONS:** If all other requirements are met, a balled and burlapped plant may be substituted for a container grown plant of the same or larger size at the Contractor's option upon acceptance of the Architect.

H. **Architect shall inspect and tag all deciduous and evergreen trees at tree sources, within 30 miles of Denver, prior to digging and shipment to site. Approval of plant material from sources outside the 30 mile radius shall be reviewed in accordance with paragraph 1.05.F this Section.**

I. **SUBSTITUTIONS:** Do not make substitutions: If specified landscape material is not obtainable, submit proof of non-availability to Architect together with proposal for use of equivalent material for review and acceptance by Architect.

2.05 **DECIDUOUS TREES AND SHRUBS**

A. Provide plants of height, size, condition and recommended branching configuration scheduled. Trees shall be uniformly shaped, quality plants with single leader, and evenly distributed branching in all directions.

B. If in leaf, trees shall be fully leafed-out with healthy, full and vigorous growth. Leaf damage caused by insects, hail and/or transplant shock shall be cause for rejection. If dormant, tree shall have pliable, green twigs and viable buds to indicate the healthy condition of plants, as appropriate to the species.

C. Adjacent plants of the same variety and size shall be consistent in size, shape, and overall appearance. Particular emphasis will be placed on this requirement for trees which occur in a straight row or otherwise formal relationship.

D. Trees with included bark will not be accepted.

E. *Gleditsia triacanthos inermis* ‘Skyline’, *Tilia Cordata* ‘Greenspire’, *Acer fremanii* ‘Autumn Blaze’, *Malus* ‘Spring Snow’, *Crataegus crus-galli* v. inermis must be matching “specimen” trees. *Gleditsia* ‘Skyline Malus’ ‘Spring Snow’ and *Tilia* ‘Greenspire’ must be high branching and limbed up a height of 6 feet. All trees must be from same stock with consistent size, color and shape.

2.06 **EVERGREEN TREES AND SHRUBS**

A. Provide plants of height, size, condition and recommended branching configuration scheduled. Trees shall be uniformly shaped, quality plants with single leader and evenly distributed branching in all directions.

B. Coniferous trees shall be heavily branched, full needled, low branching, specimen quality plants. Evidence of dormant buds and secondary needles shall be present. Damage caused by excessive pruning, insect infestation, galls or other plant disorders or damage shall be cause for rejection. Container grown evergreens will be acceptable subject to paragraph 2.04.D this Section.

C. Adjacent plants of the same variety and size shall be consistent in size, shape, and overall appearance. Particular emphasis will be placed on this requirement for trees which occur in a straight row or otherwise formal relationship.

2.07 **GROUND COVERS, VINES AND PERENNIALS**

A. Provide plants established and well-rooted in removable containers or integral peat pots with not less than minimum number and length of canes, runners or blades as required by the reference standard.

2.08 **ACCESSORIES**

A. **TREE STAKES:** Two-inch diameter lodgepole stake, straight and true, treated for resistance to rot, 8 foot length. Or Metal T-stakes, 8 foot length.

B. **STAKING WIRE:** Annealed, galvanized steel, 12 gauge wire.

C. **TREE COLLAR:** Non-stretch fabric with grommets, 1.5 inch wide by 12 inches length.
1. Supplier: Central Bag and Burlap Co., 2715 Blake Street, Denver, CO 80205, (303)297-9955, or approved equal.

D. WRAPPING MATERIAL: First quality 4 inch wide, bituminous impregnated tape, corrugated or crepe paper, specifically manufactured for tree wrapping and having qualities to resist insect infestation.

E. PVC: 1/2" diameter PVC pipe.

PART 3 - EXECUTION

3.01 EXAMINATION

A. VERIFICATION OF CONDITIONS: Examine areas and conditions under which the Work of this Section will be performed. Report unsatisfactory or questionable conditions to the Architect. Do not proceed with the Work until unsatisfactory conditions have been corrected. Commencement of Work implies acceptance of all areas and conditions.

1. Verify that during grading, topsoil spreading and landscape grading operations, the ground surface was cleaned of materials which might hinder final operations.

3.02 PREPARATION

A. PROTECTION: Protect areas in accordance with paragraph 3.08 this Section.

B. LAYOUT: Stake locations of individual plants and outline areas for multiple plantings. Secure Architect's approval prior to starting Work.

3.03 GENERAL PLANTING REQUIREMENTS

A. PLANTING SEASON: Plant in accordance with paragraph 1.08.A this Section.

3.04 TREES AND SHRUBS PLANTED IN INDIVIDUAL PLANT PITS OR TRENCHES

A. EXCAVATION FOR TREES AND SHRUBS IN INDIVIDUAL PLANT PITS OR TRENCHES

1. Excavate pits, beds and trenches with sides shaped and sized as detailed. Scarify subsoil on bottom and sides of excavation.

2. In tree pits without tree pit drains, fill each pit with water to test drainage. Pits shall drain within 24 hours.

   a. In the event non-draining soil are encountered, recommend to the Architect method to achieve subsurface drainage from details on the Drawings.

   b. Drainage system shall be approved by Architect prior to installation.

   c. Payment for subsurface drainage not included in the original Drawings shall be in accordance with the unit price submitted during base bid.

3. For balled and burlapped and container grown stock, excavate as shown on the Drawings. Adjust excavation to size of container width and depth, shaping excavation as indicated.

4. Preserve soil removed from tree and shrub planting excavations for reuse as tree and shrub planting soil.
B. SOIL PREPARATION FOR TREES AND SHRUBS IN INDIVIDUAL PLANT PITS

1. Clean soil in plant pits of roots, plants, sods, stones over 1.5 inches, clay lumps, asphaltic materials, concrete, metal and wire fragments and other extraneous materials harmful or toxic to plant growth. Remove contaminated subsoil.

2. Mix soil amendments with soil from pit at rates specified below:
   - 70% soil from pit by volume
   - 30% compost by volume

3. Uniformly mix planting soil mix, turning several times to achieve a uniform, evenly blended consistency, free of all pockets of unblended materials and any clods or stones greater than 1.5 inches in their greatest dimension.

C. PLANTING TREES AND SHRUBS IN INDIVIDUAL PLANT PITS

1. Plant container grown and balled and burlapped (B&B) material in same manner except where noted.

2. Place planting soil mix in pit and compact to depth which will place top of rootball at specified height above surrounding grade. Set plants slightly high, as detailed and accepted by the Architect.

3. Set plant on layer of compacted planting soil mix, plumb and in center of pit or trench with top of ball at required elevation.

4. Place plant for best appearance for review and final orientation by the Architect.

5. Remove non-biodegradable root containers.
   a. Wire Baskets: Cut and remove wire baskets.
   b. Containers: Cut container cans on 2 sides with an approved can cutter; remove container so as not to damage root balls; A spade shall not be used.

6. Space fertilizer tablets evenly around root ball no higher than 1/3 of the way up the root ball. Place approximately 2 inches away from root tips for container stock, and adjacent to ball for B&B stock. Use the following number of tablets:
   - 3 for 1 gallon containers.
   - 9 for 5 gallon containers.
   - 13 for balled and burlapped stock.

7. When set, place additional backfill around base and sides of root ball, and work each layer to settle backfill and eliminate voids and air pockets. When excavation is approximately 2/3 full, water thoroughly. Repeat watering until no more is absorbed.

8. Place remaining planting soil mix and tamp firmly. Water again after placing final layer of planting soil mix.

9. Dish top of backfill to allow for mulching as indicated.

10. Unless otherwise directed by Architect, do not cut tree leaders and remove only injured or dead branches from trees and shrubs, if any. Make flush cuts perpendicular to the secondary branches being removed in accordance with the References.

11. Remove and replace excessively pruned or stock.

12. Stake trees immediately after planting, as detailed using stakes or guying as noted on planting plan. Set trees plumb. Wrap only trees noted on plant list.
3.05 TREES, SHRUBS, PERENNIALS GROUNDCOVERS AND BULBS PLANTED IN PREPARED PLANTING BEDS AND PLANTERS

A. SOIL PREPARATION FOR SHRUBS, PERENNIALS AND GROUNDCOVERS PLANTED IN AT GRADE PREPARED PLANTING BEDS

1. Prior to placing imported topsoil mix, disc or scarify existing subsoil in planting beds to a minimum depth of 6 inches or to a depth as indicated in drawings using a cultimulcher or similar equipment. Remove roots, plants, sods, stones over 1.5 inches, clay lumps, asphaltic materials, concrete, metal and wire fragments and other extraneous materials harmful or toxic to plant growth. Remove contaminated subsoil.

2. Soil Preparation for Planting Beds
   a. 1.) Organics: Apply 5 cubic yards per 1,000 square feet of compost by volume.
      2.) Fertilizer: Apply 150 pounds of Gro-Power Plus per 1,000 square feet. Verify application rate after reviewing soils analysis.
      3.) Substantiate quantities with delivery tickets and empty manufacturer's bags on a daily basis to Architect.
   b. Incorporate 50% of the required organic amendments and fertilizer. Thoroughly rototill into existing subsoil to a depth of 5 inches to achieve a uniform, evenly blended consistency free of all pockets of unblended materials and any clods or stones greater than 1.5 inches.
   c. Spread imported topsoil mix in accordance with Section 02923 over amended subsoil in all planting bed areas. Remove roots, plants, sods, stones over 1.5 inches, clay lumps, asphaltic materials, concrete, metal and wire fragments and other extraneous materials harmful or toxic to plant growth.
   d. Incorporate remaining 50% of the required organic amendments and fertilizer with topsoil mix. Rototill to a depth of 7 inches. Apply and rototill in fertilizer no more than 48 hours before planting.
   e. Fill prepared planting bed with water and allow to percolate out before planting. If water does not drain out in 24 hours, notify Architect.
      1.) In the event non-draining soil are encountered, recommend to Architect method to achieve subsurface drainage.
      2.) Drainage system shall be approved by Architect prior to installation.
   f. Total depth of soil mixture shall be a uniform 10 inches in all planting beds after light rolling and natural settlement or as indicated in drawings. Compact soil in planting beds to 90% in accordance with Section 02200.

3. Soil Preparation for Planters
   a. Soil Mix for Planters
      1.) Imported topsoil mix
      2.) Fertilizer: Apply Gro-Power planting tablets per manufacturer's recommendations for each plant type. Verify application rate after reviewing soils analysis.
      3.) Soil pH range: 5.5 to 7. Add amendments if necessary.
      4.) Substantiate quantities with delivery tickets and empty manufacturer's bags on a daily basis to Architect.
b. Fill planters in accordance with the Drawings. Fill planters no more than 48 hours before planting. Compact soil in planters to 90% in accordance with Section 02200.

C. PLANTING SHRUBS, GROUND COVERS, VINES, AND PERENNIALS IN PREPARED PLANTING BEDS AND PLANTERS

1. Plant container grown and balled and burlapped (B&B) material in same manner except where noted.
2. Space plants as shown on the Drawings.
3. Place plant for best appearance for review and final orientation by the Architect.
4. Remove non-biodegradable root containers, including wire baskets. Cut container cans on 2 sides with an approved can cutter; remove stock so as not to damage root balls. A spade shall not be used.
5. Dig holes large enough to allow for rootball container and backfill with amended soil in the plant beds or soil mix in planters.
6. Space fertilizer tablets evenly around root ball no higher than 1/3 of the way up the root ball. Place approximately 2 inches away from root tips for container stock, and adjacent to ball for B&B stock. Use the following number of tablets:

   3 for 1 gallon containers.
   9 for 5 gallon containers.
   13 for balled and burlapped stock.
7. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water. Water thoroughly after planting, taking care not to cover crowns of plants with wet soils.
8. Dish top of backfill to allow for mulching as indicated.
9. Unless otherwise directed by Architect, remove only injured or dead branches from shrubs, if any. Make flush cuts perpendicular to the secondary branches being removed.
10. Remove and replace excessively pruned or stock.

3.06 FIELD QUALITY CONTROL

A. TESTS: Costs of tests and material analyses made by the testing agency will be borne by the Owner when tests indicate compliance and by the Contractor when test indicated non-compliance.

B. REVIEWS

1. General: Comply with Division 1.
2. Pre-Planting Review

   a. Plant Procurement Inspection

      1.) Contractor shall notify Architect upon selection of all trees and shall designate source and location for inspection. Proposed materials shall be flagged by the Contractor to facilitate inspection.

      2.) Architect may choose to attach his seal to each tree or to representative samples. Inspection and/or sealing of plants by the Architect at the source does not preclude his rejection of trees for improper handling, transportation, storage, damage, insects or disease or otherwise not meeting this specification at the site of planting.

      3.) Do not ship trees to site without the Architect's approval.
b. Plant Inspection

1.) All plant materials must be inspected by the Architect at supplier's or contractor's nursery and at the site before planting commences. Tag acceptable plant material with Contractor's numbered tag and verify upon arrival at the project site. Notify Architect 48 in advance to request inspection of plant material. Any materials planted prior to acceptance are subject to rejection. Inspection of plant materials may be sequenced by major planting areas to accommodate efficient planting operations. All rejected materials must be removed from the site, replaced and reinspected before any additional inspections are made.

2.) The Architect may elect to inspect trees and shrubs at place of growth before planting, for compliance with requirements for genus, species, variety, size and quality. Architect retains the right to further inspect trees and shrubs for size and conditions of balls and root systems, insects, injuries and latent defects, and to reject unsatisfactory or defective material at any time during progress of work.

3.) If, in the opinion of the Architect, there is probable cause to suspect root damage, root binding, or disease conditions in the container stock plants, the Contractor will remove the container for the Architect's inspection before planting.

c. Grading: All finish grading shall be inspected by Architect prior to planting commencing. Correct any discrepancies prior to planting.

d. Staking: Stake all tree and shrub locations with flags. Architect shall inspect the staked locations before digging shall occur. The Contractor shall give the Architect 48 hours notice to request inspection of staked locations.

3. Substantial Completion

a. Comply with General Conditions.

b. At the time of this walk-through, the Contractor shall have:

1.) Established all planted areas free of weeds, and neatly cultivated. All plant basins shall be in good repair. Pruning shall be completed.

2.) Verified installed irrigation system is fully operational with heads properly adjusted.

3.) Cleaned all walkways and curbs of debris and litter and shall have cleaned areas of soil and debris left from planting operations.

4. Final Completion: Comply with General Conditions.

5. Closeout Documents: Comply with General Conditions.

6. Start Up and Instructions: Comply with General Conditions.

7. Warranty and Replacement: Comply with General Conditions.

8. Post Construction Inspection: Comply with General Conditions.

3.07 CLEANUP

A. DURING LANDSCAPE INSTALLATION - All areas shall be reasonably clean at the end of each work day. Sidewalks and other paved areas shall be swept or washed down as needed. Keep pavements clean and work area in an orderly condition.
B. PROJECT COMPLETION: All debris, soil and trash resulting from landscape operations shall be removed from the site. All paved areas shall be washed down. All tags shall be removed from plant material.

3.08 PROTECTION

A. Protect landscape work and materials from damage due to landscape operations, operations by other contractors and trades and trespassers.
B. Maintain protection during installation and maintenance periods. Treat, repair or replace damaged landscape work as directed.

END OF SECTION
SECTION 32 93 50

LANDSCAPE MAINTENANCE

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Tree and Plant Maintenance.
B. Irrigation System Maintenance.
C. Clean Up.
D. Protection.

1.02 RELATED SECTIONS

A. Section 01 33 00: Submittal Procedures
B. Section 01 40 00: Quality Requirements
C. Section 32 84 00: Irrigation.
D. Section 32 90 00: Fine Grading and Soil Preparation.
E. Section 32 92 00: Turf and Grasses.
F. Section 32 93 00: Planting.
G. Section 32 94 00: Planting Accessories

1.03 REFERENCE

A. American Standards for Nursery Stock (ANSI Z60.1 - most recent edition), American Association of Nursemymen, Washington D.C.
G. ASPA (American Sod Producers Association) - Guideline Specifications to Sodding.

1.04 DEFINITIONS

B. PLANTS: Trees, shrubs, groundcovers, annuals, perennials, and bulbs specified in the plant list.

1.05 SUBMITTAL PROCEDURES

A. Comply with Section 01 33 00.
B. Submit in typewritten form:

1. Maintenance company qualification for acceptance by Architect and Owner prior to commencing Work. Include hourly rates for maintenance personnel. Submit 2 weeks prior to Final Acceptance walk-through.
2. Procedures which Contractor shall complete during the maintenance period.
a. Include proposed herbicide, insecticides, fertilizers, and any other chemical treatment to the Architect for review and approval prior to commencing Work.

3. Procedures to be established by the Owner, upon completion of maintenance period, for one year maintenance of landscape. Submit 3 months prior to the expiration of the maintenance period.

1.06 QUALITY REQUIREMENTS

A. Comply with Section 01 40 00.

B. QUALIFICATIONS

1. Maintenance Company: The work of this Section shall be the responsibility of the landscape subcontractors ONLY. This Section may be performed by the landscape subcontractor or his sub-subcontractor. Company shall be a member in good standing of one of the following organizations:

   a. Associated Landscape Contractors of America.
   b. American Association of Nurserymen.
   c. A member of the Nurserymen's Association of the state in which the work is being performed.

2. Work Force: Contractor's representative shall be experienced in the maintenance and repair of all types of plantings and irrigation systems which are part of this Contract.

C. REGULATORY REQUIREMENTS

1. Comply with regulatory agencies concerning classification, transportation, handling and storage of plants, fertilizer, herbicide and pesticide materials.

2. Comply with regulatory agencies for fertilizer, herbicide and pesticide composition and application.

3. Licenses and Taxes:

   a. Licenses: Contractor shall obtain and pay for all licenses required by city, county, state and federal governments that are necessary for the legal conduct of his business.
   b. Taxes: Contractor shall pay all applicable taxes, including sales taxes on materials supplied.

PART 2 - PRODUCTS

2.01 MATERIALS

A. MATERIALS: All materials used in maintenance and repair shall conform to these Specifications or shall be otherwise accepted by the Owner.
an attractive, healthy, operable condition for a period of one-year from the date of final acceptance including spring start-up of the irrigation system and coordination with the Owner. Contractor shall be responsible for all maintenance and shall provide winter watering as needed to insure healthy, vigorous plant growth.

B. PRE-MAINTENANCE INSPECTION: Schedule pre-maintenance inspection prior to the beginning of the warranty period in accordance with Sections 32 84 00, 32 92 00, and 32 93 00.

3.02 TREE AND PLANT MAINTENANCE

A. WATERING: Maintain large enough water basin around plants so that enough water can be applied to establish moisture through the major root zone. When hand watering, use a water wand to break the water force. Utilize mulches to reduce evaporation and watering frequency. Contractor is responsible for all winter water requirements.

B. PRUNING: None required except at time of planting and as needed to correct damage.

C. STAKES AND GUYS: Inspect regularly to prevent girdling of trunks or branches and to prevent rubbing which might cause bark wounds. Remove and replace stakes and guys as directed by the Owner's Representative.

D. WEED CONTROL: Maintain tree and shrub basins free of weeds and grasses on a weekly basis using a pre-approved herbicide. Frequent soil cultivation which might destroy shallow roots is not permitted. Apply approved pre-emergent herbicide to shrub beds in the spring. Use of mulches to prevent seed germination is permitted.

E. INSECTS AND DISEASE CONTROL: Control insects and disease as necessary to prevent damage to the health or appearance of plants. Use only approved materials and methods.

F. FERTILIZATION: Fertilize trees and shrubs by means of foliar application of an approved water soluble fertilizer. Submit fertilizer specifications to Architect for approval. Fertilize trees and shrubs at the following times when they occur during the maintenance period:

1. Early April.
2. June.
3. Early August.

G. REPLACEMENT OF PLANTS: Replace plant material during the warranty period in accordance with Sections 32 92 00, and 32 93 00. Remove dead and dying plants and replace with plants of equal size, condition and variety of original planting. Make replacements within 7 days of notification from Owner except as prohibited by season and authorized by the Owner, and remove rejected plants within 7 days of notice.

H. TREE PROTECTION: Remove and/or apply tree wrap starting wrap from the bottom up. Wraps all trees, except for Cottonwoods (Populus spp.).

1. Apply a coating of insecticide and fungicide to the tree trunk area to be wrapped.
2. Apply wrap to overlap 1 1/2" from ground line up to the lowest branch. Wrap trunks in late fall (approximately November 15).
3. Tie securely in at least five places with jute twine, placed at least 12" apart.
4. Remove tree wrap the beginning of the growing season (approximately April 15).

I. EMERGENCY REPAIRS: Contractor shall be available to the Owner at any time during the maintenance period to perform emergency repairs that may be necessary. Costs will be negotiated by the Owner and the Contractor at the time based on Contractor's submitted hourly rates.

3.03 IRRIGATION SYSTEM MAINTENANCE

LANDSCAPE MAINTENANCE
32 93 50 - 3
A. REVIEWS AND REPAIRS: Check all systems for proper operation after each mowing. Make all repairs before the next watering cycle. Any damage caused to the system by Contractor's operations shall be repaired at no cost to the Owner.

1. Correct any repairs needed as a result of improper winterization or negligence due to the Contractor at no additional cost to the Owner.

B. CONTROLLER PROGRAMMING: Program the irrigation controller including schedule, cycles, amount of water, etc. Review watering schedule with Owner.

1. Take extra care to balance the requirements of trees, shrubs and lawns which are in the same vicinity. Adjust watering timing and rates frequently to insure the health of each type of plant material. Adjust sprinkler nozzle settings and sizes to refine application rates in specific areas as necessary.

C. WINTERIZATION: Under the maintenance period, drain the system in preparation for the winters of 2007, 2008 after construction. Remove all water from the system using compressed air.

D. SPRING START-UP: Under the maintenance period, Contractor shall be responsible for starting up the irrigation system in the spring (April of 2008). Activate the system and demonstrate that it is in full working order. Repairs needed as a result of improper winterization or negligence due to the Contractor shall be corrected by the Contractor at no additional cost to the Owner.

3.04 CLEANUP

A. DURING LANDSCAPE MAINTENANCE: All areas shall be reasonably clean at the end of each work day. Sidewalks and other paved areas shall be swept or washed down as needed. Keep pavements clean and work area in an orderly condition.

3.05 PROTECTION

A. Protect landscape work and materials from damage due to landscape operations, operations by other contractors and trades and trespassers.

B. Treat, repair or replace damaged landscape work as directed.

C. Protect adjacent pavements from fertilizer staining.

END OF SECTION
SECTION 32 94 00
PLANTING ACCESSORIES

PART 1 - GENERAL

1.01 SECTION INCLUDES
A. Examination.
B. Preparation.
C. Wood Mulch.
D. Landscape Edging.
E. Weed Barrier Fabric
F. Field Quality Control.
G. Clean Up.
H. Protection.

1.02 RELATED SECTIONS
A. Section 01 33 00: Submittal Procedures.
B. Section 01 40 00: Quality Requirements.
C. Section 32 84 00: Irrigation.
D. Section 32 90 00: Fine Grading and Soil Preparation.
E. Section 32 92 00: Turf and Grasses.
F. Section 32 93 00: Planting.

1.03 REFERENCES

1.04 DEFINITIONS

1.05 SUBMITTAL PROCEDURES
A. Comply with Section 01 33 00. All submittals shall be accepted by the Architect in writing before planting commences.
B. DESCRIPTIVE PRODUCT DATA: Submit catalog cuts, brochures, and analyses of any manufactured items.
C. CERTIFICATES
1. Submit certificates of inspection as required by governmental authorities.
2. Submit manufacturer’s certified analysis packaged with standard products.
D. ANALYSIS AND STANDARDS: Wherever applicable, for non packaged materials, provide analysis by recognized laboratory made in accordance with methods established by the Association of Official Agriculture Chemists.

E. MULCH AND SQUEEGEE SUBMITTAL: Submit 1 quart sample of each mulch type to be installed, full color range. Obtain Architect's approval prior to bulk delivery to site.

1.06 QUALITY REQUIREMENTS

A. Comply with Section 01 40 00.

B. REGULATORY REQUIREMENTS: Comply with regulatory agencies concerning classification, transportation, handling and storage of landscape materials.

1.07 DELIVERY, STORAGE AND HANDLING

A. Comply with Section 01 40 00.

B. 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.

C. MULCH: Exercise care in the storage of mulches on site to avoid mixing soil with mulch.

D. WEED BARRIER FABRIC: Exercise care in the storage of fabric on site to prevent damage to fabric prior to and during installation.

E. REJECTION OF MATERIAL

1. Evidence of inadequate protection or improper handling or storage, shall be cause for rejection.

2. Any product or material exhibiting signs of damage due to nonconformity to specifications or due to delivery, storage or handling shall be rejected by the Architect. Contractor shall be responsible for hauling off-site and disposing of according to general conditions and codes of the governing jurisdiction.

1.08 PROJECT/SITE CONDITIONS

A. ENVIRONMENTAL REQUIREMENTS: Work shall occur only when weather and soil conditions permit in accordance with locally accepted practice.

B. EXISTING CONDITIONS

1. Existing Plants: Do not damage any existing plantings indicated to remain.

2. Utilities: Determine location of underground utilities. Perform work in a manner to avoid possible damage. Hand excavate, as required.

3. Excavation: Maintain grade stakes set by others until removal is mutually agreed upon by parties concerned.

1.09 SEQUENCING AND SCHEDULING

A. WORK SCHEDULING: Proceed with and complete landscape work as rapidly as portions of the site become available, working within the specified planting season and approved schedule.

1.10 WARRANTY AND REPLACEMENT

A. GENERAL: Refer to General Conditions.

1.11 MAINTENANCE

A. GENERAL: Maintain Work in accordance with standard industry practice or as directed by the Architect.
B. MAINTENANCE PERIOD: Begin maintenance immediately after Work is completed. Maintain areas until Final Acceptance.

PART 2 - PRODUCTS

2.01 WATER
A. Clean, potable and free of substances or matter which could inhibit vigorous growth of plant material.
B. Available on-site at no expense to Contractor. Landscape Contractor is responsible for coordination of water needs for watering and irrigation water with the Owner.

2.02 WOOD MULCH
A. Shredded bark mulch, free from deleterious materials and suitable for top dressing of trees, shrubs and ground covers. Mulch shall be of a long fibrous nature capable of matting together and interlocking when moistened and settled. Shredded cedar bark mulch or accepted substitute.
B. Submit samples prior to delivery to the site in accordance with paragraph 1.06.E this Section.
C. SUBSTITUTIONS: Do not make substitutions: If specified wood mulch is not obtainable, submit proof of non-availability to Architect together with proposal for use of equivalent material for review and acceptance by Architect.

2.03 LANDSCAPE EDGING
A. STEEL EDGING: 3/16 inch thick x 4 inches deep roll-top steel edging with stakes placed 3 feet on center. Provide steel edging in all locations shown on the drawings.
   1. Where metal edging surrounds stone mulch adjacent to building walls provide ½” diameter holes 12” o.c. located at mid-height of edging to provide drainage.
B. MANUFACTURER: Ryerson Steel, Box 16445, Denver, CO, 80216, (303)287-0101, or approved equal.
C. PLASTIC EDGING: Oly Ola Super-Edg, or approved equal. Oly-Ola Edgings, Inc., 124, E. St. Charles Road, Villa Park, IL 60181. (800)334-4647

2.04 WEED BARRIER FABRIC
B. MANUFACTURER: Dupont, Reemay, P.O. Box 511, Old Hickory, TN, 37138, (800)321-6271 or approved equal.

PART 3 - EXECUTION

3.01 EXAMINATION
A. VERIFICATION OF CONDITIONS: Examine areas and conditions under which the Work of this Section will be performed. Report unsatisfactory or questionable conditions to the Architect. Do not proceed with the Work until unsatisfactory conditions have been corrected. Commencement of work implies acceptance of all areas and conditions.
   1. Verify that during grading, topsoil spreading and landscape grading operations, the ground surface was cleaned of materials which might hinder final operations.
3.02 PREPARATION
A. PROTECTION: Protect areas in accordance with paragraph 3.08 this Section.
B. All areas within the limits of planting shall be seeded, sodded, planted with trees, shrubs, groundcovers, perennials or mulched as indicated on the Drawings and Specifications.

3.03 WOOD MULCH
A. TREES IN LAWN: Mulch areas area around trees in accordance with drawings. Place 3 inches thick.

3.04 LANDSCAPE EDGING
A. GENERAL: Install steel edging at locations indicated in the Drawings. Where required, cut edging square and accurately to required length.
B. INSTALLATION
   1. Secure edging at beginning and end points to adjacent structure where this is possible as shown on Drawings. Repair damage to concrete or other structures if damage occurs. Repairs shall be in accordance with Section 01045.
   2. Securely stake edging in required position and in accordance with manufacturer’s instructions
   3. Butt adjacent ends and lock together with a widened stake.
   4. Set edging plumb and vertical at required line and grade. Straight sections shall not be wavy; curved sections shall be smooth and shall have no kinks or sharp bends.
   5. For steel edging bend angles using a jig.
   6. For steel edging weld together cut pieces if unable to lock together with stakes.

3.05 FIELD QUALITY CONTROL
A. TESTS: Costs of tests and material analyses made by the testing agency will be borne by the Owner when tests indicate compliance and by the Contractor when test indicated non-compliance.
B. REVIEWS
   1. General: Comply with General Conditions.
   2. Pre-Planting Review
      a. All mulches and edging shall be inspected and accepted at the site by the Architect before they are used in planting operations.
   3. Substantial Completion
      a. Comply with General Conditions.
      b. At the time of this walk-through, the Contractor shall have:
         1.) Installed all items in accordance with this Section.
         2.) Cleared all walkways and curbs of debris and litter and shall have cleaned areas of soil and debris left from planting operations.
   4. Final Completion: Comply with Section General Conditions.
   5. Closeout Documents: Comply with Section General Conditions.
   6. Start Up and Instructions: Comply with Section General Conditions.
   7. Warranty and Replacement: Comply with Section General Conditions.
   8. Post Construction Inspection: Comply with Section General Conditions.
3.06 CLEANUP

A. DURING LANDSCAPE INSTALLATION: All areas shall be reasonably clean at the end of each work day. Sidewalks and other paved areas shall be swept or washed down as needed. Keep pavements clean and work area in an orderly condition.

B. PROJECT COMPLETION: All debris, soil, trash, and excavated and/or stripped material resulting from landscape operations and unsuitable for or in excess of requirements for completing work of this Section shall be disposed of off-site. All paved areas shall be washed down.

3.07 PROTECTION

A. Protect landscape work and materials from damage due to landscape operations, operations by other contractors and trades and trespassers.

B. Maintain protection during installation and maintenance periods. Treat, repair or replace damaged landscape work as directed.

END OF SECTION
SECTION 33 11 00

WATER DISTRIBUTION SYSTEMS

PART 1 - GENERAL

1.01 GENERAL

A. Work Included:
   1. The CONTRACTOR shall provide all labor, materials, tools, supervision, etc., and unless otherwise specified or shown on the Drawings, all equipment, fixtures, devices, accessories, and appurtenances required to make an installation completely operative in accordance with the International Plumbing Code, local regulations, the Drawings, and the Specifications.
   2. Additionally, the Work includes, but is not necessarily limited to the following.
      a. Water service, extending from existing water main as shown on the Drawings. Route new service as shown on the Drawings.
      b. All piping and specialties; including fittings, valves, supports, sleeves, thrust blocks, anchors and all necessary appurtenances.

B. Related Work Specified Elsewhere:
   1. Division 1: General Requirements of Work.
   2. Section 02 30 00: Earthwork.
   3. Division 15: Mechanical Specifications.
   4. Division 16: Electrical Specifications.

C. Codes, Regulations and Standards
   All work shall conform to the following codes, regulations and standards:
   1. The International Plumbing Code.
   2. The International Association of Plumbing and Mechanical Officials (IAPMO Standards).
   3. American Water Works Association (AWWA) Standards

1.02 QUALITY ASSURANCE

A. CONTRACTOR: The CONTRACTOR shall be regularly engaged in the full practice of construction, renovation, and installation of site utilities.

1.03 SUBMITTALS

A. Comply with the requirements of Section 01 33 00.

B. Submit shop drawings and product data for major manufactured products and assemblies required for this product.

C. Include component capacities, sizes, rough-in requirements, service sizes, and finishes. Include product description, model, and dimensions.

D. Submit manufacturer's installation instructions.
E. Operation and Maintenance Data:
1. Submit operation and maintenance data under provisions of Division One.
2. Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.04 HANDLING OF MATERIALS/PRODUCTS
A. Ship and store all products and materials in a manner which will protect them from damage. Damaged items shall be replaced at the CONTRACTOR's expense.

1.05 GUARANTEE/WARRANTY
A. All material, equipment, and workmanship installed and/or furnished under this section of the Specifications shall be guaranteed against defects in accordance with the General Provisions of the contract (Doc 80). Any defects or faulty workmanship shall be this CONTRACTOR's responsibility and shall be corrected entirely at his expense.

PART 2 - PRODUCTS
A. Submittal Requirements
1. Material submittals shall include a complete list of equipment and products and manufacturer's design information catalog sheets for each item.
2. Shop drawings shall include pipe size and routing, valves, thrust blocks with bearing surface area indicated, rodding with diameter indicated, trench and bedding section detail indicating depth of cover, post-indicator valve detail, plan and section detail of vault, and connection to existing mains.

2.02 WATER SERVICE PIPING AND MATERIALS
A. Piping and Fittings
1. Distribution mains shall be Ductile iron ANSI/AWWA C-151/A21.51 Class 50 and shall be cement lined per ANSI/AWWA C-104/A21.4. Bituminous coating shall be per ANSI/AWWA A21.51.
2. Fittings shall be class 350 ductile iron manufactured in conformance with ANSI/AWWA C153/A21.53 with cement lining and bituminous coating per AWWA C104-A21.4.
3. Jackets: ANSI/AWWA C105 polyethylene jacket/encasement material shall have a minimum wall thickness of eight mils.
4. Mechanical joint restraints shall incorporate the following design: Gland shall be ductile iron conforming to ASTM A 53860. Dimensions of the gland shall conform to AWWA C111 and C153 for connections to joint bell pipe. EBBA Iron, Inc Megalug 11000 Series. Working pressure of 250 psi with a minimum safety factor of 2:1.
5. Valves shall be mechanical joint, iron body, iron wedge, non-rising stem; ANSI/AWWA C509 standard. 250 psi working pressure. Mueller A-2360 resilient wedge gate valve, open left, or approved equal.
6. Valves shall be installed vertically in level lines and shall meet AWWA C500 specifications.
7. Post Indicator Valves (PIV): Inside screw, non-rising stem, adjustable indicator post type, 175 lb. working pressure., 350 lb. hydrostatic test pressure, UL and FM approved. Mueller Fig. A-20801 and non-rising stem resilient gate valve Fig. A-2075-20 with mechanical joint ends, or approved equal.
8. OS&Y Valves (Located Within Vaults): Outside screw and yoke, bronze mounted, iron body, minimum 8" diameter handwheel, double disk; 175 lb. wp, 300 lb. hydrostatic test pressure, UL and FM approved. Mueller A-2073-
6 or approved equal. Flanges shall be faced and drilled, per ANSI B16.1 class 125.

9. Restraints devices: Restraining of joint may be accomplished by either the use of clamps and rods or by use of mechanical joint restraint systems per the latest edition of the Denver Water Department Engineering Standards. All restraining rods, nuts, and hardware shall be stainless steel.

10. Wet taps may be used where shown on the Drawings. Coordinate work with THE CORPORATION’s Construction Administrator. Sleeves, shells, lugs, bolts, washers, and nuts shall be type 304 stainless steel; flanges, type 304 stainless steel or ductile iron, ASTM 536-80, test rated at 200 psi.

11. Buried isolation valves shall have Tyler Pipe cast iron valve box with oval base and lid.

C. Tape wrap shall comply with the Standard PS 22-71.

D. Bedding Materials: Refer to section 02 30 00.

E. Thrust Blocks: Shall be sized for internal static pressure of 150 psi plus transient pressures and the soil bearing capacity. Refer to NFPA 24 and Denver Water Department “Concrete Kickblock Details” for specific requirements.


PART 3 - EXECUTION

3.01 PREPARATION

A. Before assembly of equipment with flanges and unions, remove scale and dirt on inside and outside.

B. Mains shall be properly bedded.

C. Domestic water mains shall be buried a minimum of 5'-0" below finished grade or as indicated on the Drawings. Fire mains shall be buried a minimum of 7'-0" below finished grade.

D. Installation work shall be done by persons fully experienced in underground service mains.

E. Protect open piping by keeping pipes capped during suspended work on systems.

3.02 EXCAVATION

A. Underground piping shall not be installed where new excavation occurs until after earth has been filled, tamped, and compacted to rough grade by the CONTRACTOR.

B. After compacting and rough grading have been completed, new trenches shall be dug down to required levels for the installation of new underground piping by the General CONTRACTOR. Where no new excavation occurs, trenches may be dug at the time installation of the piping is ready to occur. Comply with Section 02 30 00 for trenching and shoring requirements.

C. The CONTRACTOR shall provide depressions in bedding materials under all pipe bells to ensure uniform bearing.
D. Where rock is encountered, excavate to 6" below bell of pipe and provide bed for refilling with bedding materials to common level of pipe. Bed shall be compacted per Section 02 30 00.

E. Remove all surplus material removed from excavation.

F. Dewater trenches while piping is being laid. Dewatering of the trenches shall be accomplished by the Contractor upon notification to the Owner’s Representative.

3.03 BACKFILLING

A. Trenches shall be backfilled only after underground piping has been tested, inspected, and approved. Backfill trenches as specified in Section 02 30 00.

B. This CONTRACTOR shall ensure permanent stability of the piping installed and that sufficient compacting has been accomplished to ensure elimination of ground movement as specified.

C. Any existing finish material such as concrete, asphalt, etc., that has been removed due to trenching, shall be replaced to finish grade and shall match existing finishes by the CONTRACTOR.

D. The CONTRACTOR shall comply with all additional requirements specified in Section 02 30 00 Earthwork.

3.04 BURIED PIPING IDENTIFICATION

A. Provide a continuous plastic warning tape (3" minimum width) above all underground utility piping. Tape shall be located 12" below finished grade, installed directly above the buried piping and shall identify in large block letters the type of piping below grade.

B. Provide a copper or galvanized steel tracer wire (12-gage minimum) wrapped or taped on all buried piping.

C. Provide test stations for access to tracer wires, located adjacent to each valve box or PIV and as needed to accomplish an allowable maximum distance between test stations of 300 feet.

3.05 PROTECTIVELY COATED BURIED PIPING

A. Installation and material of protective pipe coatings shall comply with IAPMO IS 13-75 installation standard.

B. Piping shall be coated in accordance with IAPMO Materials and Property Standard PS 22-71.

C. Install tape wrap per AWWA requirements.

D. Primer for field application shall be compatible with the tape and be as recommended by the tape manufacturer.

3.06 TESTING

A. Shall be conducted per NFPA 24 requirements.
B. All lines shall be hydrostatic pressure tested after laying and blocking and prior to joint backfilling.

C. Test pressure shall not be less than 50 psi above static, but no less than 200 psi or more than 200% of the working pressure for the class and size of pipe tested.

D. The line shall be filled between test valves with all air expelled at high points. Test pressure shall then be applied and maintained, for at least 2 hours. Test pressure must be maintained for 5 minutes without pumping.

E. All lines shall be flushed thoroughly before connection is made to system piping. The minimum rate of flow shall be not less than the water demand rate of the system, or 10 ft/sec, whichever is greater.

F. THE OWNER's Construction Administrator shall witness and approve tests.

G. Provide a completed CONTRACTOR's Material and Test Certificate for Underground Piping to Owner.

3.07 CLEANING

A. Bacteriological testing shall be conducted by the CONTRACTOR per AWWA Standard C601.

B. After hydrostatic testing the lines shall be thoroughly flushed (not less than 2-1/2 ft./sec. Velocity), drained and refilled. In refilling, care must be taken to avoid trapping or entraining air within the pipe to prevent direct contact between the pipe and its disinfectant.

C. Apply the disinfectant from one end of the pipe only and bleed from the other end until traces show in the waste stream. Calcium hypochlorite, in a 1% solution may be used to bring the chlorine dosage up to a concentration of 50-100 parts per million within the pipe and the solution shall then be held not less than 24 hours until the residue stabilizes at not less than 10 ppm.

D. During this period all valves and similar appurtenances shall be opened and closed to assure adequate and complete contact.

E. Following test acceptance the line shall be drained, flushed and refilled. The CONTRACTOR shall collect samples of water in properly sterilized containers for bacteriological testing in accordance with paragraph 4.4.3 of AWWA C652. Samples shall be given to THE CORPORATION's Administrator to be tested and approve bacteriological testing. The entire process will be repeated until satisfactory bacteriological test results are obtained and the line placed in service.

F. THE OWNER's Construction Administrator will make all necessary test arrangements with the CONTRACTOR and notify the following as to date and time of flushing and hydrostatic and bacteriological testing:

   1. THE UNIVERSITY's Plant Engineering and Construction Department.
   2. THE UNIVERSITY's Environmental Management Department.
   3. THE UNIVERSITY's Industrial Hygiene Department.

3.08 AS-BUILT DRAWINGS

A. At the completion of the project, include a set of such drawings with each set of as-
built drawings. Drawings shall clearly show the Work and its relation to the work of other trades.

B. Drawings shall include all existing conditions including existing utilities and invert elevations.

END OF SECTION
SECTION 33 30 00
SANITARY SEWER SYSTEMS

PART 1 – GENERAL

1.01 DESCRIPTION
A. The scope of this section includes the labor, materials, and equipment to provide and install sanitary sewerage piping, fittings, and accessories, connection of building sanitary drainage system to municipal sewers, cleanouts, connections to manholes, and sewer taps.
B. Related Work Specified Elsewhere
   1. Section 02 30 00: Earthwork
   2. Section 03 30 00: Cast In Place Concrete

1.02 REFERENCES
A. American Society for Testing and Materials - (ASTM):
C. ASTM D 3034-89 Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
E. ASTM F 679-86 Specification for Poly Vinyl Chloride (PVC) Large Diameter Plastic Gravity Sewer Pipe and Fittings
F. ASTM F477-76 Specification for Elastomeric Seals (Gaskets) for joining Plastic Pipe

1.03 DEFINITIONS
A. Bedding: Fill placed under, beside and directly over the pipe, prior to subsequent backfill operations.

1.04 SUBMITTALS
A. Product Data: Provide data indicating pipe, pipe accessories, and cleanout plug and cover. Submit shop drawing for fittings, restraint, and connections to existing system.
B. Manufacturer’s Installation Instructions: Indicate special procedures required to install products specified.
C. Manufacturer’s Certificate: Certify that products meet or exceed specified requirements.

1.05 PRODUCT HANDLING
A. Handle pipe carefully to avoid damage to pipe, joints, and coatings. The Owner will reject all damaged pipe. The manufacturer shall package the pipe in a manner designed to deliver the pipe to the project neatly, intact, and without physical damage. The transportation carrier shall use appropriate method and intermittent checks to insure the pipe is properly...
supported, stacked, and restrained during transport such that the pipe is not physically damaged.

B. Pipe shall be stored on a clean, level location. Materials may not be stored directly on ground. If necessary, the pipe may be stacked in accordance with the pipe manufacturer’s recommendations. The handling of the pipe shall be done in such a manner that it is not damaged by dragging over sharp objects or cut by chokers or lifting equipment.

C. PVC pipe shall not be exposed to ultraviolet light longer than six (6) months. Any discoloration of the pipe material will be evidence of ultraviolet damage and shall be reason for rejection and removal from the project.

PART 2 - PRODUCTS

2.01 PVC PIPE

A. Polyvinyl chloride (PVC) pipe shall be unplasticized polyvinyl chloride manufactured specifically for sanitary sewage and with an integral bell. PVC pipe for diameters not exceeding fifteen inches (15") will conform to ASTM D 3034 Standard Specifications. A minimum wall dimension ratio (ratio of the average specified outside diameter to the minimum specified wall thickness) shall be SDR 35. PVC pipe for diameters eighteen inches (18") through twenty-seven inches (27") shall conform to ASTM F679 Standard Specifications. A minimum wall dimension ratio will be SDR 35 (minimum wall thickness T-1, Table 1, ASTM F679).

B. The bell end of all main line pipe shall contain a confined Elastometric gasket conforming to ASTM F477 and will be tested in accordance with ASTM D3212 Standard Specifications.

C. All PVC sewer pipe shall be an integral green tint in color. Lightly tinted pipe will not be acceptable. All pipe shall have a home mark on the spigot to indicate proper penetration when the joint is made.

2.02 BEDDING: Refer to Section 02 30 00.

2.03 CONCRETE: For Concrete for encasement and collars refer to Section 03 30 00.

PART 3 - EXECUTION

3.01 PREPARATION

A. Remove dirt on inside and outside before assembly.

B. Remove any seal or protective coating devices on the pipe before assembly of the pipe. Inspect inside of each pipe length to ensure that no debris, dirt, or remnants of manufacturing process are present.

3.02 BEDDING

A. Excavate pipe trench in accordance with Section 02 30 00 Earthwork for work of this Section. Hand trim excavation for accurate placement of pipe to elevations indicated.

B. Maintain optimum moisture content of bedding material to attain required compaction density in accordance with Section 02 30 00.
3.03 PVC PIPE LAYING

A. Pipe shall be protected during installation against impact shocks and free fall to avoid spalling or breaking and to avoid unnecessary disturbance of the bedding surface in the trench bottom. Pipe shall be kept clean at all times. Pipes shall be laid to a true line and at uniform rates of grade between manholes as shown on the plans. Contractors shall install all PVC pipe with the identification markings on top so as to be visible from above.

B. The Contractor shall take every precaution necessary to prevent dirt, debris or surface water from entering existing lines or new construction. No pipe shall be laid in water or when trench conditions are unsuitable for such work. At no time shall sewage be allowed to run in the trench during construction. All bypass pumping, temporary connections or other work needed to comply with this requirement shall be considered incidental to the sanitary sewer pipe and all costs in connection therewith shall be included in the unit price for the pipe.

C. The laying of the pipe in prepared trenches shall commence at the lowest point with the spigot ends pointing in the direction of flow. Install pipe with a joint within 18-inches maximum of all wall perforations, ends of concrete encasements, and manholes with cast in place bases. For manholes with precast bases the resilient rubber connector specified in Section 03 43 00 will suffice.

D. Service line wyes shall be placed on the sewer main at points shown on the plans or where directed by the Owner. The service lines shall be extended to the extent shown on the construction drawings.

E. All pipe shall be carefully centered, and shall not deviate more than one inch (1") from line so that when laid will form a sanitary sewer with a uniform invert and a straight alignment with an unobstructed line of site unless a curvilinear alignment is shown on the plans.

F. The grade of the pipe shall be obtained by the use of batter boards and a "top line," batter boards with a double string line having a minimum of four feet (4') separation, a laser beam, or by the use of surveying instruments approved by the Owner. The grade shall not be obtained by placing a carpenter’s level on individual pipes.

G. If batter boards are used, the Contractor shall at all times where pipe laying is in progress, maintain batter boards for a distance covering at least three grade stakes. The elevation of the batter boards shall be determined from the depth of cut as given by the Owner, and the Contractor shall keep on each crew a man whose duty it shall be to see that the batter boards are in proper place at all times. It is not intended that these requirements shall make it necessary for the Contractor to keep a man especially for this purpose, but to provide that a competent man shall be with each crew at all times whose duty it shall be to attend to the placing of the batter boards and the giving of grades to the pipe layer.

H. If a method other than batter boards is used, the instrument used shall be operated continuously under the supervision of a qualified foreman or superintendent. The pipe grade shall be checked by an alternate method at fifty foot (50') intervals and upon request of the Owner.

I. Connections to an existing PVC pipe, for extensions or repairs, shall be made with a double bell coupling when a bell end does not exist, (i.e. plain end to plain end connection).

J. In no case shall a section of pipe be accepted if it does not possess a positive grade (i.e.,
- no flat or adverse sections).

K. All pipe shall be installed within the following range of tolerances. Any pipe not within the specified spot elevation tolerance shall be relaid.

**PIECE GRADE TOLERANCE TABLE**

<table>
<thead>
<tr>
<th>PIPE DIAMETER (inches)</th>
<th>GRADE(S) in PERCENT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>S&lt;0.50</td>
</tr>
<tr>
<td>8</td>
<td>±0.02 Ft.</td>
</tr>
<tr>
<td>10 - 15</td>
<td>±0.03 Ft.</td>
</tr>
<tr>
<td>18 or larger</td>
<td>±0.04 Ft.</td>
</tr>
</tbody>
</table>

L. After it has been laid and backfilled, and prior to the placing of surface improvements, all PVC pipe shall be tested by the Contractor by means of an approved mandrel prior to construction of surface improvements. The deflection shall not exceed 5-percent of the pipe diameter.

M. All pipe joints shall be made in the manner and under the conditions described under the various types of joints for the work. Preparatory to making pipe joints, all surfaces of the portion of the pipe to be jointed shall be cleaned.

3.04 ELASTOMERIC GASKET JOINTS

A. The assembly of the gasketed joint shall be performed as recommended by the pipe manufacturer. The Contractor shall provide a suitable method of installation to insure the pipe being entered is true and concentric with the previously laid pipe so as to prevent injury to the Elastometric gasket.

B. Mechanical methods shall be employed, if necessary, to pull or push the pipe together with sufficient force to compress the gasket sufficiently to make a watertight joint.

C. If any other type of joint is proposed to be used, it shall conform to the requirements of these specifications that apply, and the Contractor shall obtain written approval of the Owner for its use.

3.05 FIELD QUALITY CONTROL

A. Request inspection prior to and immediately after placing bedding.

B. Compaction testing will be performed in accordance with Section 02 30 00 Earthwork.

C. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no additional cost to Owner.

3.06 PROTECTION

A. Protect finished installation from damage during construction activities.

B. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

3.07 TESTING AND INSPECTION

A. General:
1. No surface improvements shall be constructed over the new sanitary sewer until all testing and televised inspection of the pipe are accepted by the Owner. The Contractor shall conduct the testing and be responsible for furnishing all equipment and labor for testing. The Owner shall verify the accuracy and acceptability of the equipment used and witness all tests.

2. The Contractor shall measure the rate of exfiltration of all sanitary sewer lines by either a Hydrostatic Pressure Test or a Pneumatic Pressure Test, except in areas where excessive amounts of groundwater are encountered.

3. In areas where excessive groundwater is encountered, a pneumatic pressure test will be required. An excessive amount of groundwater for testing purposes is defined as the amount of groundwater needed to produce in excess of two feet (2') of hydrostatic pressure on the crown of the pipe along the entire test section. The Contractor will be required to prove this by installing manometer tubes at the ends of the test section in the manholes. The determination of groundwater elevation (installation of manometer tubes) shall be in accordance with Section 8, of the Uni-Bell Plastic Pipe Association - Recommended Practice for Low-Pressure Air Testing of Installed Sewer Pipe.

4. Tests shall also be conducted at any time during the course of construction that the quality of the workmanship is questionable in the opinion of the Owner. The type of test conducted shall be at the Owner's option. Whenever the rate of infiltration, exfiltration or deflection is found to exceed the allowable amounts, the Contractor shall stop construction. The Contractor may then be required to provide at his own expense, televised or photographic visual inspection of the interior of the pipe to help determine the reason for failing the testing. The Contractor shall make appropriate repairs by methods approved by the Owner, and shall retest the sewer until it is satisfactory. No compensation shall be paid to the Contractor for testing, televising, photographing, repairing, delays, or reconstruction to comply with the allowable leakage amounts.

5. At the option of the Owner, the section between the first two (2) manholes of all projects may be tested before further construction to permit initial observation of the quality of the construction workmanship.

6. Work accomplished under this sub-section will not be measured, nor will it be paid for directly. This work will be considered as incidental to the sanitary sewer pipe and all costs in connection therewith shall be included in the unit price for the pipe.

B. Hydrostatic Pressure Test

1. The section to be tested shall be prepared by plugging the lower end of the section and the inlet sewer or sewers of the upper manholes and filling the pipe and the upstream manhole with water to a depth of two feet (2') above the top of pipe at the upstream manhole of the test section or two feet (2') above the normal ground water level at the upstream manhole of the test section, whichever is higher. The maximum internal pipe pressure at the lowest end shall not exceed twenty-five feet (25') of head of water or 10.8 psi. Only after the test section has been acceptably isolated and filled with water can the test period begin. The period shall be two hours in duration. Leakage by exfiltration shall be determined by measuring the drop in the water level in the upstream manhole at the end of the test period. The exfiltration test time period may be extended beyond the minimum two-hour period when necessary to effectively determine the source of leakage when test results are unsatisfactory.

2. Any sanitary sewer line where the Hydrostatic Pressure Test shows leakage in the sewer line and manholes exceeding fifty (50) gallons per inch of diameter, per mile, per day or will not be accepted. After acceptable backfilling tests shall be run to determine whether these limits are exceeded.
C. Pneumatic Pressure Test

1. In preparation for a pipe acceptance test using low pressure air, all pneumatic plugs shall be seal tested before being used in the actual test installation. One length of pipe shall be sealed at both ends with the pneumatic plugs to be checked. The plugs, installed in accordance with manufacturer’s recommendations, shall hold against a pressure of 5 psig without bracing and without movement of the plugs out of the pipe. However, during actual testing, the Contractor should internally or externally brace the plugs as an added safety precaution. Plugs found acceptable by this testing shall be placed in the test installation and low pressure air introduced into the sealed lien until the internal air pressure reaches 4 psig greater than the average back pressure of any groundwater that may be over the pipe, but not greater than 9 psig. The level of groundwater back pressure shall be determined by averaging the reading of groundwater manometer tubes installed at the manholes of the section of pipe being tested. The air pressure correction, which must be added to a 3.5 psig test starting pressure, shall be calculated by dividing the average vertical height, in feet of groundwater above the invert of the pipe to be tested by 2.31. At least two (2) minutes shall be allowed for the air pressure to stabilize. After the stabilization period the air hose from the control panel to the air supply shall be disconnected and the pressure shall be decreased to 3.5 psig (plus any required air pressure correction) before the start of timing. The portion of line being tested shall be termed “Acceptable” if the time shown, for the given diameters in the following table, elapses before the air pressure drops 0.5 psig from the test starting pressure.

2. The Contractor's testing equipment shall have a regulator or a relief valve set no higher than 9 psig to avoid over-pressurizing.

<table>
<thead>
<tr>
<th>Pipe Diameter (Inches)</th>
<th>Minimum Time (Min:Sec)</th>
<th>Length (L) for Minimum Time (Feet)</th>
<th>Time for Longer Length (Seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>3:47</td>
<td>298</td>
<td>0.760L</td>
</tr>
<tr>
<td>10</td>
<td>4:43</td>
<td>239</td>
<td>1.187L</td>
</tr>
<tr>
<td>12</td>
<td>5:40</td>
<td>199</td>
<td>1.709L</td>
</tr>
<tr>
<td>15</td>
<td>7:05</td>
<td>159</td>
<td>2.671L</td>
</tr>
<tr>
<td>18</td>
<td>8:30</td>
<td>133</td>
<td>3.846L</td>
</tr>
<tr>
<td>21</td>
<td>9:55</td>
<td>114</td>
<td>5.235L</td>
</tr>
<tr>
<td>24</td>
<td>11:20</td>
<td>99</td>
<td>6.837L</td>
</tr>
<tr>
<td>27</td>
<td>12:45</td>
<td>88</td>
<td>8.653L</td>
</tr>
</tbody>
</table>

3.08 ACCEPTANCE, FINISHING, AND CLEANUP

A. Acceptance of the pipe in the tested section will be granted by the Owner only after all defects such as poor alignment, misplaced pipe, and broken pipe have been remedied, and prescribed testing satisfactorily completed. Acceptance of the pipe does not relieve the Contractor of responsibilities imposed by all other sections of these specifications.

B. The sewers and appurtenances shall be thoroughly cleaned at the Contractors expense to the satisfaction of the Owner before final acceptance of the work. In the event the Owner has to perform any cleaning, the Contractor will be charged for the actual cost of labor, equipment and materials.
END OF SECTION 33 30 00
SECTION 33 40 00
SITE DRAINAGE

PART 1 - GENERAL

1.01 GENERAL

A. Work Included: Items of Work included under this section of the Specifications shall consist of, but are not necessarily limited to the following.
   1. Storm drainage systems.
   2. Drainage inlets and outlets.
   3. Rip-rap, grouted and non-grouted.
   4. Identification of new buried piping, including warning tape, tracer wire, and tracer wire test stations.
   5. All other items of site drainage indicated and/or called for on the Drawings or specified herein.

B. Related Work Specified Elsewhere
   1. Division 1: General Requirements of Work.
   2. Section 02 30 00: Earthwork.
   3. Section 03 30 00: Concrete Cast-In-Place.

1.2 QUALITY ASSURANCE

A. Standards: Comply with standards specified in this section of the Specifications.

B. Qualifications of Installers: Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the requirements and the methods needed for proper performance of the Work of this section of the Specifications.

1.3 SUBMITTALS

A. Comply with the provisions of Section 01 33 00, "Submittals."

B. Product Data: Submit the following for approval by the OWNER.
   1. Complete materials list of all items proposed to be furnished and installed under this section of the Specifications.
   2. Manufacturers' specifications and other data required to demonstrate compliance with the specified requirements.
   3. Manufacturers' recommended installation procedures which, when approved by the OWNER, shall become the basis for inspecting and accepting or rejecting actual installation procedures used on the Work.

1.4 HANDLING

A. Protection: Use all means necessary to protect the materials used in the Work before, during, and after installation and to protect the work and materials of all other trades.

B. Protection of Utilities: Protect existing utilities as specified in Section 02 30 00.
C. Delivery and Storage: Deliver all materials to the Work site in their original containers with labels intact and legible at time of use. Store in strict accordance with the manufacturers’ recommendations and as approved by the OWNER.

D. Replacements: In the event of damage, immediately make all repairs and replacements necessary to the approval of the OWNER and at no additional cost to the OWNER.

PART 2 - PRODUCTS

2.1 PIPE MATERIALS

A. General: Provide pipe sizes as indicated on the Drawings and as follows.

B. Concrete, Reinforcing, Etc.: Comply with Section 03 30 00, "Concrete Cast-In-Place".

C. High Density Polyethylene (HDPE) Pipe: ADS N12 ProLink Ultra, manufactured by Advanced Drainage Systems, Inc. Provide all necessary couplers, fittings, etc. required for a complete installation.

2.2 RIPRAPH MATERIALS


B. Nongrouted Riprap: Type M riprap in accordance with Urban Storm Drainage Criteria Manual, Urban Drainage and Flood Control District, conforming to the following gradation:

<table>
<thead>
<tr>
<th>Intermediate Rock Dimension (inches)</th>
<th>Percent Smaller Than Given Size By Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>70 - 100%</td>
</tr>
<tr>
<td>18</td>
<td>50 - 70%</td>
</tr>
<tr>
<td>12</td>
<td>35 - 50%</td>
</tr>
<tr>
<td>4</td>
<td>2 - 10%</td>
</tr>
</tbody>
</table>

C. Grouted Riprap: Type M riprap in accordance with Urban Storm Drainage Criteria Manual, Urban Drainage and Flood Control District, with the smallest rock fraction eliminated from the gradation, conforming to the following gradation:

<table>
<thead>
<tr>
<th>Intermediate Rock Dimension (inches)</th>
<th>Percent Smaller Than Given Size By Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>70 - 100%</td>
</tr>
<tr>
<td>18</td>
<td>50 - 70%</td>
</tr>
<tr>
<td>12</td>
<td>35 - 50%</td>
</tr>
</tbody>
</table>
D. Grout: Grout for grouted riprap shall be a mixture of cement, fine aggregate, and water in a consistency which is flowable enough to completely fill all voids between riprap. Submit design mix for approval which conforms with the following requirements:

- Compressive Strength: 2,500 psi (minimum) at 28 days
- Cement: Type II, 564 lbs. per cu. yd.
- Aggregate: 30% 3/8 inch coarse rock, 70% sand
- Slump: 7" ± 2"
- Air Entrainment: 7.5% ± 1.5%
- Fiber Reinforcement: 1.5 lbs. per cu. yd. Fibermesh®

2.3 ACCESSORIES


PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions under which the Work of this section of the Specifications will be performed.

B. Correct conditions detrimental to the timely and proper completion of the Work. Do not proceed until unsatisfactory conditions have been corrected.

3.2 EXCAVATING, TRENCHING, AND BEDDING FOR PIPES

A. Movement of Construction Machinery: Use all means necessary to avoid displacement of, and injury to, the pipe and structures while compacting by rolling or operating equipment parallel with the pipe. Movement of equipment over a culvert or storm drain at any stage of construction is solely at the risk of the CONTRACTOR.

B. Bedding: Provide bedding for the pipe as indicated on the Drawings and in accordance with Section 02 30 00, Earthwork.

3.3 PLACING PIPE

A. Carefully examine each pipe prior to placing. Promptly set aside all defective pipe and all damaged pipe. Clearly identify all defects. Do not install defective pipe or damaged pipe.

B. Place all pipe to the grades and alignment shown.

C. Provide all required equipment for lowering pipe safely into the trenches.

D. Do not place pipe in water, nor place pipe when trench or weather is unsuitable for such work.

E. Install pipe in accordance with the requirements of ASTM D2321 and per manufacturers' instructions.

F. Buried Piping Identification:
   1. Provide a continuous plastic warning tape (3" minimum width) above all underground utility piping. Tape shall be located 12" below finished grade, installed directly above the buried piping and shall identify in large block letters the type of piping below grade.
2. Provide a copper or galvanized steel tracer wire (12-gage minimum) wrapped or taped on all buried piping.
3. Provide test stations for access to tracer wires, located adjacent to each valve box or PIV, and at a maximum spacing of 300 feet.

3.4 BACKFILLING

A. General
   1. Backfill in accordance with the provisions of Section 02300, and as specified herein. Take all necessary care to ensure thorough compaction of fill under haunches of the pipe, without damage or misalignment of the pipe.
   2. Anchor pipe as required to prevent "floating" during backfilling operations.

B. Backfilling Pipe in Fill Sections: For pipe placed in fill sections, after the backfill has reached at least 12" above the top of the pipe, place the remainder of the fill by compacting in layers not exceeding 8" in uncompacted depth in accordance with Section 02 30 00, Earthwork.

C. Compaction: Backfill over and around the pipe, backfill around and adjacent to all other drainage structures, and compact to the minimum densities specified in Section 02 30 00.

3.5 PLACING GROUTED RIPRAP

A. Prepare, shape, compact subgrade in accordance with Section 02 30 00.
B. Place riprap to the required thickness.
C. Just prior to grout placement, spray riprap with clean water. Remove all dirt and other materials from rock surfaces that could prevent the grout from bonding to rock.
D. Place grout using a low pressure (less than 10 psi) grout pump with a 2 inch maximum diameter hose.
E. Vibrate grout with a pencil vibrator. Ensure complete grout penetration between rocks and filling of all voids.
F. Smooth grout surface with a small broom or gloved hand. Remove any excess grout from rock as necessary to provide specified depth from riprap surface to grout surface.
G. Clean excess grout from all exposed surfaces. Apply curing and sealing compound.

3.6 PLACING NON-GROUTED RIPRAP

A. Prepare, shape, compact subgrade in accordance with Section 02 30 00.
B. Carefully place riprap over geotextile to the required thickness, taking necessary precautions to prevent tearing or puncturing geotextile.
C. Hand place top layer of riprap, shape as required to ensure uniform thickness, etc.

3.7 TESTING AND INSPECTING

A. Provide all equipment and personnel necessary, and make all tests required to demonstrate that the Work of this section of the Specifications has been completed in strict accordance with the design and the specified requirements.
B. Closing In Uninspected Work: Do not allow any of the Work of this section of the Specifications to be covered up or enclosed until after it has been completely tested, inspected, and approved by the OWNER.

END OF SECTION
PART 1  GENERAL

1.01  SUMMARY

A. The CONTRACTOR shall provide all labor, materials, tools, supervision, etc.; and unless otherwise specified or shown on the Drawings, all equipment, fixtures, devices, accessories, and appurtenances required to make an installation completely operative in accordance with applicable environmental rules and regulations, the Drawings and the Specifications.

B. Section Includes:
   1. Perforated Drain Tile
   2. Geotextile Fabric
   3. Granular Filter Material

C. Related Sections:
   1. Section 02 30 00 - Earthwork
   2. Section 03 30 00 - Cast-in-Place Concrete

1.02  REFERENCES

A. ASTM:
   1. D2311 - Perforated Bituminous Fiber Pipe
   2. D2321 - Installation of Thermoplastic Drain Pipe
   3. D2665 - PVC Schedule 40
   4. D2729 - Standard for PVC Sewer Pipe and Fittings
   5. D3034 - PVC PSM Sewer Pipe, SDR 35
   6. F891 - Cellular Core PVC Pipe
   7. F1732 - PVC Sewer and Drain Pipe Materials Containing Recycled PVC

1.03  DEFINITIONS

A. PVC: Polyvinyl Chloride.

1.04  SUBMITTALS

A. Reference: See Section 01 33 00.

B. Product Data: For the following:
   1. Perforated-wall pipe and fittings.
   2. Drainage conduits.
   3. Drainage panels.
1.05 QUALITY ASSURANCE

A. Qualifications: One person, thoroughly trained and experienced in skills required, completely familiar with requirements of Work described in this Section, present at all times to direct progress of Work.

PART 2 PRODUCTS

2.01 MANUFACTURER

A. Acceptable Manufacturers: Subject to compliance with specified requirements, acceptable manufacturers and products are:
2. Manufacturer of comparable products.

2.02 MATERIALS

A. Perforated-Wall Pipe:
1. Size 4-inch diameter.
2. Perforations: 2 rows of 5-inch on center, 120 degrees apart at 10 and 2 clock positions, 1/2" diameter.
3. Type: Rigid only.
4. Acceptable Materials:
   a) PVC Plastic 6B.1 or 6C.1:
      (1) SDR 35 per ASTM D2665.
B. Geotextile Fabric: Typar Type 3341 fabric, or equal.
C. Granular Filter Material: 3/4-inch to No. 4 size clean gravel or crushed stone.
D. Prefabricated Drainage Structures: Use “Miradrain 6000” as manufactured by Mirafi/Nicolon Corporation; Nudrain WD/15 as manufactured by Nilex Corporation; or equal as approved by THE CORPORATION.
E. Other Materials: All other materials not specifically described, but required for complete and proper installation as selected by Contractor, subject to acceptance of Owner.

2.03 ACCESSORIES

A. Connectors, Corners and other Accessories: As manufactured by or recommended by manufacturer of pipe.

PART 3 EXECUTION

3.01 EXAMINATION

A. Work of Other Trades: Prior to commencing Work, carefully inspect and verify that work is complete to point where this installation may properly commence.
B. Verification of Conditions: Verify that foundation drainage may be installed in accordance with original design, pertinent codes and regulations, and pertinent portions of referenced standards.

C. If subdrainage is required for landscaping, locate and mark existing utilities, underground structures, and above-ground obstructions before beginning installation, and avoid disruption and damage of services.

D. Discrepancies:
   1. Immediately notify Owner.
   2. Do not proceed with installation in areas of discrepancy until fully resolved.

### 3.02 INSTALLATION OF FILTERING MATERIAL

A. Installation of Granular Filtering Material: Place to depth indicated or, if not indicated, to compacted depth of not less than 4 inches.

B. Installation of Geotextile Fabric: Place over compacted subgrade where drainage pipe is to be laid.

C. Installation of Supporting Layer of Granular Filtering Material: Place on geotextile fabric to depth indicated or, if not indicated, to compacted depth of not less than 4 inches.

### 3.03 INSTALLATION OF PIPE

A. Laying Drain Pipe:
   1. Solidly bedded in filtering material on continuous granular bed.
   2. Provide full bearing for each pipe section throughout its length, to true grades and alignment, and continuous slope in direction of flow as shown on the drawings.

B. Perforated Pipe: Lay with perforations down and joints tightly closed in accordance with pipe manufacturer’s recommendations.

C. Collars and Couplings: Provide as required.

D. Tracer wire shall be provided for all foundation and roof drainage outfall pipes. Wire to be provided as detailed on the drawings from the point of connection at the building to the point of outfall.

### 3.04 FIELD QUALITY CONTROL

A. Testing Drain Lines:
   1. Test or check lines before backfilling to assure free flow.
   2. Remove obstructions, replace damaged components, and retest system until satisfactory.

### 3.05 BACKFILL AND COMPACTION

A. Additional Filtering and Wrapping: After successfully testing drain lines, place additional granular filtering material to 4-inch depth around sides and top of drains.

B. Carefully backfill above cover sheet with clean granular material.
C. Compact: In accordance with Section 02 30 00.

3.06 IDENTIFICATION

A. Install PE warning tape or detectable warning tape over ferrous piping.

B. Install detectable warning tape over nonferrous piping and over edges of underground structures.

3.07 ADJUSTING

A. Upon direction of Owner, remove, reconstruct, and/or reinstall components of drainage system not meeting requirements of this Section.

3.08 CLEANING

A. Maintain swab or drag in piping and pull past each joint as it is completed.

B. Place plugs in ends of uncompleted pipe at end of each day or when work stops.

C. Leave all components of drain system completely free from silt, debris, and obstructions.

D. Restore all surfaces to previous condition at start of Work.
PART 1 - GENERAL

1.01 SUMMARY

A. The CONTRACTOR shall provide all labor, materials, tools, supervision, etc.; and unless otherwise specified or shown on the Drawings, all equipment, fixtures, devices, accessories, and appurtenances required to make an installation completely operative in accordance with applicable environmental rules and regulations, the Drawings and the Specifications.

B. Section Includes:
   1. Excavation or enlargement of ponding areas within the designated construction limits.
   2. Placement of topsoil for turf establishment.

C. Related Sections:
   1. Section 02 42 00 - Site Drainage

1.02 SUBMITTALS

A. LEED Submittal
   1. Contractor shall submit as-constructed survey data for the ponds and storm sewer structures for verification of required elevation versus storage volumes in each pond.

1.03 DEFINITIONS

A. Excavation items will be classified in accordance with Section 02 30 00 Earthwork.

1.04 SEQUENCING AND SCHEDULING

A. Complete pond grading prior to construction of associated intake and discharge sewers.

PART 2 PRODUCTS

2.01 MATERIALS

A. Topsoil borrow materials shall be in accordance with Section 02 10 50 Topsoil, Stripping, Storing & Replacement.

B. Geotextile for use in PLD’s shall meet ASTM D-4751 –
   1. AOS U.S. Standard Sieve #50 to #70
   2. D-4632 - Grab Strength > 100 lbs.
   3. D-4491 - Permitting > 1.8/sec.
PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

A. If present, remove ice and snow prior to grading operations.
B. All grading shall conform to the planned grades, cross-sections and stakes.
C. Confine operations to established limits.
D. Provide temporary drainage facilities to maintain existing drainage courses until permanent facilities are operative.

3.02 EXCAVATING OPERATIONS

A. Conform to lines, grades and slopes staked.
B. Excavate all suitable topsoil material separately and stockpile for salvage.

3.03 DISPOSAL OF EXCAVATED MATERIAL

A. Use suitable excavated materials for embankment construction as required.
B. Construct embankment layers from uniform materials.
C. All surplus excavated materials shall become the property of the Contractor for disposal.

3.04 FINISHING OPERATIONS

A. Finish all earthwork to within 0.1 foot of the staked grade.
B. Conduct finishing and topsoiling concurrent with the grading operations to provide for erosion control.
C. Place 6 inches salvage topsoil in the locations shown on the Drawings.

END OF SECTION