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SECTION 012500 - SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for substitutions.

1.3 DEFINITIONS

- A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.
 1. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
 2. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

1.4 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. Substitution Request Form: Use Form included at end of this Section.
 2. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within seven 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 seven days of receipt of additional information or documentation, whichever is later.
 - a. Forms of Acceptance: Change Order, Construction Change Directive, or Architect's Supplemental Instructions for minor changes in the Work.
 - b. Use product specified if Architect does not issue a decision on use of a proposed substitution within time allocated.

1.5 QUALITY ASSURANCE

- A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage qualified testing agency to perform compatibility tests recommended by manufacturers.

1.6 PROCEDURES

- A. Coordination: Modify or adjust affected work as necessary to integrate work of the approved substitutions.

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

- A. Substitutions for Cause: Submit requests for substitution immediately upon discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.
1. Conditions: 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:
 - a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 - b. Substitution request is fully documented and properly submitted.
 - c. Requested substitution will not adversely affect Contractor's construction schedule.
 - d. Requested substitution has received necessary approvals of authorities having jurisdiction.
 - e. Requested substitution is compatible with other portions of the Work.
 - f. Requested substitution has been coordinated with other portions of the Work.
 - g. Requested substitution provides specified warranty.
 - h. 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.
- B. Substitutions for Convenience: Architect will consider requests for substitution if received within 60 days after the Notice to Proceed. Requests received after that time may be considered or rejected at discretion of Architect.
1. Conditions: 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:
 - a. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume.
 - b. Contractor shall compensate Architect for any costs incurred for redesign and evaluation services related to the request for substitution.
 - c. Requested substitution does not require extensive revisions to the Contract Documents.
 - d. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 - e. Substitution request is fully documented and properly submitted.
 - f. Requested substitution will not adversely affect Contractor's construction schedule.
 - g. Requested substitution has received necessary approvals of authorities having jurisdiction.

- h. Requested substitution is compatible with other portions of the Work.
- i. Requested substitution has been coordinated with other portions of the Work.
- j. Requested substitution provides specified warranty.
- k. 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.

PART 3 - EXECUTION (Not Used)

END OF SECTION 012500

SECTION 012600 - CONTRACT MODIFICATION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section specifies administrative and procedural requirements for handling and processing Contract modifications.

1.3 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 "Architect's Supplemental Instructions" form.

1.4 PROPOSAL REQUESTS

- A. Owner-Initiated Proposal Requests: Architect will issue a detailed description of proposed changes in the Work 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. Proposal Requests 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 Proposal Request after receipt of Proposal Request, submit a quotation 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 Proposals: 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. Proposal Request Form: Use Document for Proposal Requests provided by Architect.

1.5 CHANGE ORDER PROCEDURES

- A. On Owner's approval of a Proposal Request, Architect will issue a Change Order for signatures of Owner and Contractor.

1.6 CONSTRUCTION CHANGE DIRECTIVE

- A. Construction Change Directive: Architect may issue a Construction Change Directive which instructs Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.

1. Construction Change Directive 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. Documentation: Maintain detailed records on a time and material basis of work required by the Construction Change Directive.

1. 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 012600

SECTION 013100 - PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
 - 1. General project coordination procedures.
 - 2. Administrative and supervisory personnel.
 - 3. Coordination drawings.
 - 4. Project meetings.
- B. Each contractor shall participate in coordination requirements. Certain areas of responsibility are assigned to a specific contractor.
- C. Refer to Section 013150 – Requests for Information for procedures involving Contractor information requests.

1.3 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.
 - 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.
- B. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities 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.

1.4 KEY PERSONNEL

- A. 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, office, and cellular telephone numbers and email addresses. Provide names, addresses, and telephone numbers of individuals assigned as standbys in the absence of individuals assigned to Project.
1. Post copies of list in project meeting room, in temporary field office, and by each temporary telephone. Keep list current at all times.

1.5 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: Entity responsible for conducting meeting will record significant discussions and conclusions. Distribute the meeting minutes to everyone concerned, including Owner and Architect, within three days of the meeting.
- B. Preconstruction Conference: Architect will schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner and Architect, but no later than 30 days after execution of the Agreement.
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. 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. Lines of communications.
 - f. Procedures for processing field decisions and Change Orders.
 - g. Procedures for RFIs.
 - h. Procedures for testing and inspecting.
 - i. Procedures for processing Applications for Payment.
 - j. Distribution of the Contract Documents.
 - k. Submittal procedures.
 - l. Sustainable design requirements.
 - m. Preparation of record documents.
 - n. Use of the premises.

- o. Work restrictions.
- p. Working hours.
- q. Owner's occupancy requirements.
- r. Responsibility for temporary facilities and controls.
- s. Procedures for moisture and mold control.
- t. Procedures for disruptions and shutdowns.
- u. Construction waste management and recycling.
- v. Parking availability.
- w. Office, work, and storage areas.
- x. Equipment deliveries and priorities.
- y. First aid.
- z. Security.
- aa. Progress cleaning.

3. Minutes: Entity responsible for conducting meeting will 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:
 - a. Contract Documents.
 - 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 other parties requiring information.
 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.

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 meeting 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) Progress cleaning.
 - 10) Quality and work standards.
 - 11) Status of correction of deficient items.
 - 12) Field observations.
 - 13) Status of RFIs.
 - 14) Status of proposal requests.
 - 15) Pending changes.
 - 16) Status of Change Orders.

17) Documentation of information for payment requests.

3. Minutes: Entity responsible for conducting the meeting will record and distribute the meeting minutes to each party present and to parties requiring information.

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.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013100

SECTION 013150 - REQUESTS FOR INFORMATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative provisions for coordinating Requests for Information by the Contractor, Owner, or Architect.

1.3 DEFINITIONS

- A. Request for Information (RFI): A document submitted by the Contractor requesting information or clarification of a portion of the Contract Documents that is required to properly perform the work.
 - 1. Requests shall clearly and concisely set forth the issue for which clarification or interpretation is sought and why a response is needed from the Architect/Engineer. On the RFI form, the Contractor shall include a detailed description of all information required in Article 1.4 of this Section. The Architect will respond to all Proper RFIs, and will return Improper RFIs and Frivolous RFIs without action unless indicated otherwise.
- B. Proper RFIs:
 - 1. A properly prepared RFI shall include all information identified in Article 1.4 of this Section.
- C. Improper RFIs:
 - 1. RFIs submitted by entities other than Contractor will be returned with no response.
 - 2. An Improper RFI can be identified by its lack of conformance to the requirements of Article 1.4 of this Section. Improper RFIs may be returned without action.
- D. Frivolous RFIs:
 - 1. Frivolous RFIs are those that request information that is clearly shown on the Contract Documents.
 - 2. Frivolous RFIs may be returned without action or may be processed by the Architect with the related time being charged to the Owner at the Architect's contracted hourly rate. All such costs will be withheld from monies due the Contractor. The Contractor and Owner will be notified by the Architect prior to the processing of Frivolous RFIs.

1.4 REQUESTS FOR INFORMATION (RFIs)

A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.

1. RFIs shall originate with Contractor. Architect will return RFIs submitted to Architect by other entities controlled by Contractor with no response. RFIs from subcontractors or material suppliers shall be submitted through, reviewed by, and signed by the Contractor prior to submittal to the Architect.
2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.
3. Wherever possible, such clarification shall be requested at the next appropriate project meeting, with the response entered into the meeting minutes. When clarification at the meeting is not possible, either because of the urgency of the need, or the complexity of the item, Contractor shall prepare and submit an RFI to the Architect.
4. If clarification of an item is required of a document known to have been prepared by a consultant to the Architect, the Contractor may NOT direct the RFI directly to the consultant. Each RFI shall be processed through the Architect.
5. In cases where RFIs are issued to request clarification of coordination issues, for example, pipe and duct routing, clearances, specific locations of work shown diagrammatically and similar items the Contractor shall fully lay out a suggested solution using drawings or sketches drawn to scale and submit same with the RFI. RFIs which fail to include a suggested solution will be returned Unanswered with a requirement that the Contractor submit a complete request.
6. The Architect may opt to retain RFIs for discussion during regularly scheduled project meetings for inclusion of responses in meeting minutes in lieu of responding in written form.
7. Contractor shall endeavor to keep the number of RFI's to a minimum.

B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:

1. Project name.
2. Project number.
3. Date.
4. Name of Contractor.
5. Name of Architect/Engineer.
6. RFI number, numbered sequentially (*Example: RFI #001*).
7. RFI subject.
8. Specification Section number and title and related paragraphs, as appropriate.
9. Drawing Sheet number and detail references, as appropriate.
10. Field dimensions and conditions, as appropriate.
11. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
12. Contractor's signature.
13. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
 - a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.

14. Contractor's requested date/time for response; however, this requested date/time for response is not a guarantee that the RFI will be answered by that date/time if the request is too expeditious.

C. RFI Forms: Contractor's own Software-generated form with substantially the same content as indicated above, acceptable to Architect.

1. Attachments shall be electronic files in Adobe Acrobat PDF format.
2. Identify each page of attachments with the RFI number and sequential page number.
3. RFIs may be submitted by E-Mail. D.

Architect/Engineer's Action:

1. Architect/Engineer will review each RFI, determine action required, and provide a response to the Contractor. Allow seven working days for Architect/Engineer's response for each RFI. RFIs received after 1:00 p.m. will be considered as received the following working day.
2. The Architect/Engineer will endeavor to respond in less time. If additional time is required beyond the maximum number of days specified, the Architect/Engineer will notify the Contractor in writing.
3. Improper RFIs: The following Contractor-generated RFIs will be returned without action:
 - a. Requests for approval of submittals.
 - b. Requests for approval of substitutions.
 - c. Requests for approval of Contractor's means and methods.
 - d. Requests for coordination information already indicated in the Contract Documents.
 - e. Requests for changes that entail additional cost or credit.
 - f. Requests for adjustments in the Contract Time or the Contract Sum.
 - g. Requests for interpretation of Architect/Engineer's actions on submittals. h. Incomplete RFIs or inaccurately prepared RFIs.
4. Architect's action may include a request for additional information, in which case the time for response will date from time of receipt of additional information.
5. 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 Owner and Architect/Engineer in writing within 10 days of receipt of the RFI response.
 - b. Answered RFIs shall not be construed as approval to perform extra work that may involve a change in the Contract Time or the Contract Sum.

- E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log at the time of the construction progress meetings. Software log with not less than the following:
1. Project name.
 2. Name and address of Contractor.
 3. Name and address of Owner
 4. Name and address of Architect/Engineer.
 5. RFI number including RFIs that were returned without action or withdrawn.
 6. RFI description.
 7. Date the RFI was submitted.
 8. Date Architect/Engineer's response was received.
 9. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.
 10. Identification of related Field Order, Work Change Directive, and Proposal Request, as appropriate.
- F. On receipt of Architect/Engineer's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Owner and Architect/Engineer within seven days if Contractor disagrees with response.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013150

SECTION 013200 - CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. 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.
 - 3. Submittals Schedule.
 - 4. Daily construction reports.
 - 5. Material location reports.
 - 6. Field condition reports.
 - 7. Special reports.

1.3 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.
- 1.4 SUBMITTALS
- A. Submittals Schedule: Submit three 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 copies.
1. Approval of cost-loaded preliminary construction schedule will not constitute approval of Schedule of Values for cost-loaded activities.
- C. Contractor's Construction Schedule: Submit two copies of initial schedule, large enough to show entire schedule for entire construction period.
- D. Daily Construction Reports: Submit two copies at monthly intervals.
- E. Material Location Reports: Submit two copies at monthly intervals.
- F. Field Condition Reports: Submit two copies at time of discovery of differing conditions.
- G. Special Reports: Submit two copies at time of unusual event.
- 1.5 COORDINATION
- A. Coordinate preparation and processing of schedules and reports with performance of construction activities and with scheduling and reporting of separate contractors.

- B. 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

2.1 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. Final Submittal: Submit concurrently with the first complete submittal of Contractor's Construction Schedule.

2.2 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 the Notice to Proceed to date of Substantial 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. 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.
 - 2. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Architect's administrative procedures necessary for certification of Substantial 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. Work Restrictions: Show the effect of the following items on the schedule:
 - a. Limitations of continued occupancies.
 - b. Uninterruptible services.

- c. Partial occupancy before Substantial Completion.
 - d. Use of premises restrictions.
 - e. Seasonal variations.
 - f. Environmental control.
- 2. Work Stages: Indicate important stages of construction for each major portion of the Work.
 - 3. 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.
- E. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and Final Completion
 - F. 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.
- 2.3 CONTRACTOR'S CONSTRUCTION SCHEDULE (GANTT CHART)
- A. Gantt-Chart Schedule: Submit a comprehensive, fully developed, horizontal Gantt-chart- type, Contractor's Construction Schedule within 30 days of date established for the Notice of Award. Base schedule on the Preliminary Construction Schedule and whatever updating and feedback was received since the start of Project.
 - B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line.
- 2.4 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.
 - 12. Emergency procedures.
 - 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. Substantial 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 on CSI Form 13.2A. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

2.5 SPECIAL REPORTS

- A. General: Submit special reports directly to Owner within one 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

3.1 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 each regularly scheduled progress meeting.
 - 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 013200

SECTION 013300 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes requirements for the submittal schedule and administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.

1.3 DEFINITIONS

- A. Action Submittals: Written and graphic information and physical samples that require Architect's responsive action. Action submittals are those submittals indicated in individual Specification Sections as action submittals.
- B. Informational Submittals: Written and graphic information and physical samples that do not require Architect's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as informational submittals.
- C. File Transfer Protocol (FTP): Communications protocol that enables transfer of files to and from another computer over a network and that serves as the basis for standard Internet protocols. An FTP site is a portion of a network located outside of network firewalls within which internal and external users are able to access files.
- D. Portable Document Format (PDF): An open standard file format licensed by Adobe Systems used for representing documents in a device-independent and display resolution-independent fixed-layout document format.

1.4 ACTION SUBMITTALS

- A. Submittal Schedule: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or modifications to submittals noted by the Architect and additional time for handling and reviewing submittals required by those corrections.
 - 1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's construction schedule.
 - 2. Final Submittal: Submit concurrently with the first complete submittal of Contractor's construction schedule.
 - a. Submit revised submittal schedule to reflect changes in current status and timing for submittals.
 - 3. Format: Arrange the following information in a tabular format:

- a. Scheduled date for first submittal.
- b. Specification Section number and title.
- c. Submittal category: Action, informational.
- d. Name of subcontractor.
- e. Description of the Work covered.
- f. Scheduled date for Architect's final release or approval.

1.5 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

- A. Architect's Digital Data Files: Electronic copies of CAD Drawings of the Contract Drawings will not 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. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
 - 3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
 - 4. 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. Processing Time: Allow 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.
- D. Identification and Information: Place a permanent label or title block on each paper copy submittal item for identification.
 - 1. Indicate name of firm or entity that prepared each submittal on label or title block.
 - 2. Provide a space approximately 6 by 8 inches (150 by 200 mm) on label or beside title block to record Contractor's review and approval markings and action taken by Architect.

3. Include the following information for processing and recording action taken:
 - a. Project name.
 - b. Date.
 - c. Name of Architect.
 - d. Name of Contractor.
 - e. Name of subcontractor.
 - f. Name 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., 061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., 061000.01.A).
 - i. Number and title of appropriate Specification Section.
 - j. Drawing number and detail references, as appropriate.
 - k. Location(s) where product is to be installed, as appropriate. l. Other necessary identification.
- E. Options: Identify options requiring selection by the Architect.
- F. Deviations: Identify deviations from the Contract Documents on submittals.
- G. Additional Paper 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.
 1. Submit one copy of submittal to concurrent reviewer in addition to specified number of copies to Architect.
- H. Transmittal: Assemble 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. Indication of full or partial submittal.
 - j. Drawing number and detail references, as appropriate.
 - k. Transmittal number, numbered consecutively.
 - l. Submittal and transmittal distribution record.
 - m. Remarks.
 - n. 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 identification 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 with approval notation from Architect's action stamp.
 - 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.
 - K. Use for Construction: Use only final submittals that are marked with approval notation from Architect's action stamp.

PART 2 - PRODUCTS

2.1 SUBMITTAL PROCEDURES

- A. General Submittal Procedure Requirements: Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
 1. Action Submittals: Submit three paper copies of each submittal, unless otherwise indicated. Architect will return two copies.
 2. Informational Submittals: Submit two paper copies of each submittal, unless otherwise indicated. Architect will not return copies.
 3. Closeout Submittals and Maintenance Material Submittals: Comply with requirements specified in Division 01 Section "Closeout Procedures."
 4. Certificates and Certifications Submittals: Provide a 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.
 - a. Provide a notarized statement on original paper copy certificates and certifications where indicated.
 5. Test and Inspection Reports Submittals: Comply with requirements specified in Division 01 Section "Quality Requirements."
- 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 published 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 catalog cuts.
 - b. Manufacturer's product specifications.
 - c. Standard color charts.
 - d. Statement of compliance with specified referenced standards.
 - e. Testing by recognized testing agency.
 - f. Application of testing agency labels and seals.
 - g. Notation of coordination requirements.
 - h. Availability and delivery time information.
 4. For equipment, include the following in addition to the above, as applicable:
 - a. Wiring diagrams showing factory-installed wiring.
 - b. Printed performance curves.
 - c. Operational range diagrams.
 - d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
 5. Submit Product Data before or concurrent with Samples.
 6. Submit Product Data in the following format:
 - a. Three paper copies of Product Data, unless otherwise indicated. Architect will return two copies.
- 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. Identification of products.
 - b. Schedules.
 - c. Compliance with specified standards.
 - d. Notation of coordination requirements.
 - e. Notation of dimensions established by field measurement.
 - f. Relationship and attachment to adjoining construction clearly indicated.
 - g. Seal and signature of professional engineer if specified.
 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 (215 by 280 mm) but no larger than 30 by 42 inches (750 by 1067 mm).
 3. Submit Shop Drawings in the following format:
 - a. Two opaque (bond) copies of each submittal. Architect will return one copy.

- 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 applicable 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. Samples for Verification: 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 three sets of Samples. Architect will retain two Sample sets; remainder 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 three sets of paired units that show approximate limits of variations.
- E. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:
1. Type of product. Include unique identifier for each product.
 2. Manufacturer and product name, and model number if applicable.

3. Number and name of room or space.
 4. Location within room or space.
 5. Submit product schedule in the following format:
 - a. Three paper copies of product schedule or list, unless otherwise indicated. Architect will return two copies.
- F. Contractor's Construction Schedule: Comply with requirements specified in Division 01 Section "Construction Progress Documentation."
- G. Application for Payment: Comply with requirements specified in Division 01 Section "Payment Procedures."
- H. Schedule of Values: Comply with requirements specified in Division 01 Section "Payment Procedures."
- I. 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. 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. Submit subcontract list in the following format:
 - a. Number of Copies: Three paper copies of subcontractor list, unless otherwise indicated. Architect will return two copies.
- J. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.
- K. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on American Welding Society (AWS) forms. Include names of firms and personnel certified.
- L. Installer Certificates: Submit 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.
- M. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
- N. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
- O. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.

- P. Material Test Reports: Submit 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.
- Q. Product Test Reports: Submit 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.
- R. Research Reports: Submit 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.
- S. Schedule of Tests and Inspections: Comply with requirements specified in Division 01 Section "Quality Requirements."
- T. Preconstruction Test Reports: Submit 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.
- U. Compatibility Test Reports: Submit 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.
- V. Field Test Reports: Submit reports 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.
- W. Maintenance Data: Comply with requirements specified in Division 01 Section "Operation and Maintenance Data."
- X. Design Data: Prepare and submit 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.

2.2 DELEGATED-DESIGN SERVICES

- 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.

- B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit three paper copies of certificate, 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.
 - 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

3.1 CONTRACTOR'S REVIEW

- A. Action and Informational Submittals: 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. Project Closeout and Maintenance/Material Submittals: Refer to requirements in Division 01 Section "Closeout Procedures."
- C. 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.

3.2 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.
- 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 prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Architect.
- E. Incomplete submittals are not acceptable, will be considered nonresponsive, and will be returned without review.
- F. Submittals not required by the Contract Documents may not be reviewed and may be discarded.

END OF SECTION 013300

SECTION 014000 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes 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 Owner or authorities having jurisdiction are not limited by provisions of this Section.
 - 4. Specific test and inspection requirements are not specified in this Section, but in the sections where they are applicable.

1.3 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 the Architect/Engineer.
- C. Mockups: Full-size physical assemblies that are constructed on-site. Mockups are constructed to verify selections made under Sample submittals; to demonstrate aesthetic effects and, where indicated, qualities of materials and execution; to review coordination, testing, or operation; to show interface between dissimilar materials; and to demonstrate compliance with specified installation tolerances. Mockups are not Samples. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.
- D. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria.

- E. Product Testing: Tests and inspections that are performed by a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.
- F. Source Quality-Control Testing: Tests and inspections that are performed at the source, e.g., plant, mill, factory, or shop.
- G. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
- H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.
- I. 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. Use of trade-specific terminology (such as “carpentry”) in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals (such as a “carpenter”), or that requirements specified apply exclusively to specific trade(s).
- J. Experienced: When used with an entity or individual, "experienced" means having successfully completed previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction. Individual specification sections may designate a required minimum period of experience for select building components, systems, or assemblies.

1.4 CONFLICTING REQUIREMENTS

- A. Referenced Standards: 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 conflicting requirements that are different, but apparently equal, to Architect/Engineer 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/Engineer for a decision before proceeding.

1.5 ACTION SUBMITTALS

- A. Shop Drawings: For mockups, provide plans, sections, and elevations, indicating materials and size of mockup construction.
 - 1. Indicate manufacturer and model number of individual components.
 - 2. Provide axonometric drawings for conditions difficult to illustrate in two dimensions.

1.6 INFORMATIONAL SUBMITTALS

- A. Contractor's Quality-Control Plan: For quality-assurance and quality-control activities and responsibilities.
- B. Qualification Data: For Contractor's quality-control personnel.
- C. Testing Agency Qualifications: 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.
- D. Schedule of Tests and Inspections: Prepare in tabular form and include the following :
 - 1. Specification Section number and title.
 - 2. Entity responsible for performing tests and inspections.
 - 3. Description of test and inspection.
 - 4. Identification of applicable standards.
 - 5. Identification of test and inspection methods.
 - 6. Number of tests and inspections required.
 - 7. Time schedule or time span for tests and inspections.
 - 8. Requirements for obtaining samples.
 - 9. Unique characteristics of each quality-control service.

E. Contractor's Quality-Control Plan:

- 1. Quality-Control Plan, General: Submit quality-control plan within time period designated in the General Conditions and not less than five days prior to preconstruction conference. Submit in format acceptable to Owner. Identify personnel, procedures, controls, instructions, tests, records, and forms to be used to carry out Contractor's quality-assurance and quality-control responsibilities. Coordinate with Contractor's construction schedule.
- 2. Quality-Control Personnel Qualifications: Engage qualified full-time personnel trained and experienced in managing and executing quality-assurance and quality-control procedures similar in nature and extent to those required for Project.
 - a. Project quality-control manager may also serve as Project superintendent.
- 3. Submittal Procedure: Describe procedures for ensuring compliance with requirements through review and management of submittal process. Indicate qualifications of personnel responsible for submittal review.
- 4. Testing and Inspection: In quality-control plan, include a comprehensive schedule of Work requiring testing or inspection, including the following:
 - a. Contractor-performed tests and inspections including subcontractor-performed tests and inspections. Include required tests and inspections and Contractor-elected tests and inspections.
 - b. Special inspections required by authorities having jurisdiction and indicated on the "Statement of Special Inspections."
 - c. Owner-performed tests and inspections indicated in the Contract Documents.

5. Continuous Inspection of Workmanship: Describe process for continuous inspection during construction to identify and correct deficiencies in workmanship in addition to testing and inspection specified. Indicate types of corrective actions to be required to bring work into compliance with standards of workmanship established by Contract requirements and approved mockups.
6. Monitoring and Documentation: Maintain testing and inspection reports including log of approved and rejected results. Include work Architect/Engineer or Owner has indicated as nonconforming or defective. Indicate corrective actions taken to bring nonconforming work into compliance with requirements. Comply with requirements of authorities having jurisdiction.

F. Reports and Documents

1. Reports for Testing and Inspection: Prepare and submit certified written reports specified in other Sections. Include the following:
 - a. Date of issue.
 - b. Project title and number.
 - c. Name, address, and telephone number of testing agency.
 - d. Dates and locations of samples and tests or inspections.
 - e. Names of individuals making tests and inspections.
 - f. Description of the Work and test and inspection method.
 - g. Identification of product and Specification Section.
 - h. Complete test or inspection data.
 - i. Test and inspection results and an interpretation of test results.
 - j. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
 - k. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
 - l. Name and signature of laboratory inspector.
 - m. Recommendations on retesting and reinspecting.
2. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:
 - a. Name, address, and telephone number of technical representative making report.
 - b. Statement on condition of substrates and their acceptability for installation of product.
 - c. Statement that products at Project site comply with requirements.
 - d. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
 - e. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 - f. Statement whether conditions, products, and installation will affect warranty.
 - g. Other required items indicated in individual Specification Sections.
3. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service

representative's tests and inspections specified in other Sections. Include the following:

- a. Name, address, and telephone number of factory-authorized service representative making report.
 - b. Statement that equipment complies with requirements.
 - c. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 - d. Statement whether conditions, products, and installation will affect warranty.
 - e. Other required items indicated in individual Specification Sections.
4. 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.

1.7 QUALITY ASSURANCE

- A. General: Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.
- B. 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.
- C. 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.
- D. 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.
- 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 in material, design, and extent to those indicated for this Project.
- F. Specialists: Certain Specification Sections 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. Requirements of authorities having jurisdiction shall supersede requirements for specialists.
- G. Testing Agency Qualifications: An independent agency with the experience and capability to conduct testing and inspecting indicated, as documented according to ASTM E 329, ASTM E 548 or other referenced standard; and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is

acceptable to authorities, such as:

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. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- I. 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.
- J. 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, and 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/Engineer, 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.
- K. 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/Engineer.
 2. Notify Architect/Engineer 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/Engineer'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.
- L. Integrated Exterior Mockups: Construct integrated exterior mockup according to approved Shop Drawings and as indicated on Drawings. Coordinate installation of exterior envelope materials and products for which mockups are required in individual Specification Sections, along with supporting materials.

1.8 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, and the Contract Sum will be adjusted by Change Order.
- B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities required to verify that the Work complies with requirements, whether specified or not.
1. 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.
 2. 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.
 3. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
 4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
 5. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
 6. 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 Section 013300 "Submittal Procedures."

- D. **Manufacturer's Technical Services:** Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.
- E. **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.
- F. **Testing Agency Responsibilities:** Cooperate with Owner and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
1. Notify Owner, Architect/Engineer 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.
- G. **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. Delivery of samples to testing agencies.
 6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
 7. Security and protection for samples and for testing and inspecting equipment at Project site.
- H. **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.
- I. **Schedule of Tests and Inspections:** Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents as a component of Contractor's quality-control plan. Coordinate and submit concurrently with Contractor's construction schedule. Update as the Work progresses.

1. Distribution: Distribute schedule to Owner, Architect/Engineer, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

1.9 SPECIAL TESTS AND INSPECTIONS

- A. Special Tests and Inspections: Owner will engage a qualified testing agency to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of Owner, and as follows:
 1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviews the completeness and adequacy of those procedures to perform the Work.
 2. Notifying Owner 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 Owner, 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

3.1 TEST AND INSPECTION LOG

- A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:
 1. Date test or inspection was conducted.
 2. Description of the Work tested or inspected.
 3. Date test or inspection results were transmitted to Owner and Architect/Engineer.
 4. Identification of testing agency or special inspector conducting test or inspection.
- B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Owner and Architect/Engineer's reference during normal working hours.

3.2 REPAIR AND PROTECTION

- A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
 1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible.

- 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 014000

SECTION 017300 - EXECUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes general administrative and procedural requirements governing execution of the work including, but not limited to, the following:

1. Construction layout.
2. Field engineering and surveying.
3. Installation of the Work.
4. Cutting and patching.
5. Progress cleaning.
6. Starting and adjusting.
7. Protection of installed construction.
8. Correction of the Work.

1.3 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 construction to original conditions after installation of other work.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For land surveyor.
- B. Certificates: Submit certificate signed by land surveyor certifying that location and elevation of improvements comply with requirements.

1.5 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.
- B. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of products and equipment.

1.6 WARRANTY

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

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: Comply with requirements specified in other Sections.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Existing Conditions: 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, mechanical and electrical systems, 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; underground electrical services, and other utilities.
 - 2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.
- B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, 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.

3.2 PREPARATION

- A. Existing Utility Information: Furnish information to local utility and 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.
- D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for

clarification of the Contract Documents caused by differing field conditions outside the control of the Contractor, submit a request for information to Architect according to requirements in Division 01 Section "Project Management and Coordination."

3.3 CONSTRUCTION LAYOUT

- A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the project horizontal control 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 rim 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.
- E. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Architect.

3.4 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.

3.5 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 96 inches (2440 mm) in occupied spaces and 90 inches (2300 mm) in unoccupied spaces.
- 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 Substantial 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. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions.
 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.

3.6 CUTTING AND PATCHING

- A. Cutting and Patching, 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. Temporary Support: Provide temporary support of work to be cut.
- C. 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.
- 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 prevent interruption to occupied areas.
- E. 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 neatly to minimum 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. Proceed with patching after construction operations requiring cutting are complete.
- F. 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 practicable. Provide materials and comply with installation requirements specified in other Sections, where applicable.
 - 1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical 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 minimize 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, prepare substrate and apply primer and intermediate paint coats appropriate for substrate 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. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition.
- G. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.7 PROGRESS CLEANING

- A. General: Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.
1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
 2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F (27 deg C).
 3. Containerize hazardous and unsanitary waste materials separately from other waste.
 - a. Utilize containers intended for holding waste materials of type to be stored.
- 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 Substantial Completion.

- G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Comply with waste disposal requirements in Division 01 Section "Construction Waste Management and Disposal."
- 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 Substantial 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.

3.8 STARTING AND ADJUSTING

- A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- B. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.
- 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: Comply with qualification requirements in Division 01 Section "Quality Requirements."

3.9 PROTECTION OF INSTALLED CONSTRUCTION

- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
- B. Comply with manufacturer's written instructions for temperature and relative humidity.

3.10 CORRECTION OF THE WORK

- A. Repair or remove and replace defective construction. Restore damaged substrates and finishes.
 - 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 017300

SECTION 017700 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 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.

1.2 SUBSTANTIAL COMPLETION

- A. Preliminary Procedures: Before requesting inspection for determining date of Substantial Completion, complete the following. List items below that are incomplete in request.
 - 1. Prepare a list of items to be completed and corrected (punch list), 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. Prepare and submit Project Record Documents, operation and maintenance manuals, Final Completion construction photographs, damage or settlement surveys, property surveys, and similar final record information.
 - 6. Deliver tools, spare parts, extra materials, and similar items to location designated by the Owner. Label with manufacturer's name and model number where applicable.
 - 7. Make final changeover of permanent locks and deliver keys to Owner. Advise of changeover in security provisions.
 - 8. Complete startup testing of systems.
 - 9. Submit test/adjust/balance records.
 - 10. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
 - 11. Advise Owner of changeover in heat and other utilities.
 - 12. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
 - 13. Complete final cleaning requirements, including touchup painting.
 - 14. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.
- B. Inspection: Submit a written request for inspection for Substantial Completion (or Partial Substantial Completion). On receipt of request, Owner and Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare the

Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items 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.
2. Results of completed inspection will form the basis of requirements for Final Completion.

1.3 FINAL COMPLETION

A. Preliminary Procedures: Before requesting final inspection for determining date of Final Completion, complete the following:

1. Submit copy of Substantial Completion inspection list of items to be completed or corrected (Substantial Completion Inspection list). The copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
2. Submit evidence of final, continuing insurance coverage complying with insurance requirements.
3. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems.

B. Inspection: Submit a written request for final inspection for acceptance. On receipt of request, Owner and 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.

1.4 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

A. Preparation: Submit list of incomplete items. 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, starting with exterior areas first and proceeding from lowest floor to highest floor.
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 Contractor. d. Page number.

1.5 WARRANTIES

- A. Submittal Time: Submit written warranties on request of Owner for designated portions of the Work where commencement of warranties other than date of Substantial 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

2.1 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

3.1 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 Substantial 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.
- l. 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 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. Comply with safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on Government'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 017700

SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.
- B. Related Requirements:
 - 1. Section 312000 "Earth Moving" for drainage fill under slabs-on-grade.

1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.
- B. W/C Ratio: The ratio by weight of water to cementitious materials.

1.4 ACTION SUBMITTALS

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

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer and testing agency.
- B. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.
2. Admixtures.
3. Steel reinforcement and accessories.
4. Curing compounds.
5. Floor and slab treatments.

C. Material Test Reports: For the following, from a qualified testing agency:

D. Floor surface flatness and levelness measurements indicating compliance with specified tolerances.

1.6 QUALITY ASSURANCE

A. 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."

B. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

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

1.7 DELIVERY, STORAGE, AND HANDLING

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

1.8 FIELD CONDITIONS

A. 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.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

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

1. ACI 301.
2. ACI 117.

2.2 FORM-FACING MATERIALS

- A. Smooth-Formed Finished Concrete: Form-facing panels that 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.
- 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. Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.
1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
- D. Form Ties: Factory-fabricated, removable or snap-off glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

2.3 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
- B. Plain-Steel Wire: ASTM A 1064/A 1064M, as drawn.
- C. Deformed-Steel Wire: ASTM A 1064/A 1064M.

2.4 REINFORCEMENT ACCESSORIES

- A. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs.
- B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

2.5 CONCRETE MATERIALS

- A. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.
- B. Cementitious Materials:
 - 1. Portland Cement: ASTM C 150/C 150M, Type I, gray.
 - 2. Fly Ash: ASTM C 618, Class F or C.
 - 3. Slag Cement: ASTM C 989/C 989M, Grade 100 or 120.
- C. Normal-Weight Aggregates: ASTM C 33/C 33M, Class 3S coarse aggregate or better, graded. Provide aggregates from a single source.
 - 1. Maximum Coarse-Aggregate Size: 3/4 inch nominal.
- D. Air-Entraining Admixture: ASTM C 260/C 260M.
- E. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and that do 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.
- F. Water: ASTM C 94/C 94M and potable.

2.6 CURING MATERIALS

- A. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. BASF Corporation-Construction Systems.
 - b. ChemMasters, Inc.
 - c. Dayton Superior.
 - d. Euclid Chemical Company (The); an RPM company.

2.7 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.

- B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, aromatic polyurea with a Type A shore durometer hardness range of 90 to 95 according to ASTM D 2240.
- C. Bonding Agent: ASTM C 1059/C 1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.

2.8 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/C 150M, 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 1/4 inch and that can be filled in over a scarified surface to match adjacent floor elevations.
 - 1. Cement Binder: ASTM C 150/C 150M, 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.

2.9 CONCRETE MIXTURES, GENERAL

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
 - 1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.
- B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
 - 1. Fly Ash: 25 percent.
 - 2. Combined Fly Ash and Pozzolan: 25 percent.
 - 3. Slag Cement: 50 percent.

4. Combined Fly Ash or Pozzolan and Slag Cement: 50 percent portland cement minimum, with fly ash or pozzolan not exceeding 25 percent.
 5. Silica Fume: 10 percent.
 6. Combined Fly Ash, Pozzolans, and Silica Fume: 35 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.
 7. Combined Fly Ash or Pozzolans, Slag Cement, and Silica Fume: 50 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.
- C. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
- D. Admixtures: Use admixtures according to manufacturer's written instructions.
1. Use water-reducing 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 w/c ratio below 0.50.

2.10 CONCRETE MIXTURES FOR BUILDING ELEMENTS

A. Footings: Normal-weight concrete.

1. Minimum Compressive Strength: 4000 psi at 28 days.
2. Maximum W/C Ratio: 0.50.
3. Slump Limit: 4 inches, plus or minus 1 inch.

B. Foundation Walls: Normal-weight concrete.

1. Minimum Compressive Strength: 4000 psi at 28 days.
2. Maximum W/C Ratio: 0.50.
3. Slump Limit: 4 inches, plus or minus 1 inch.
4. Air Content: 6 percent +/- 1.0%.

C. Slabs-on-Grade: Normal-weight concrete.

1. Minimum Compressive Strength: 4000 psi at 28 days.
2. Maximum W/C Ratio: 0.50.
3. Minimum Cementitious Materials Content: 540 lb/cu. yd..
4. Slump Limit: 4 inches, plus or minus 1 inch.
5. Air Content: 6 percent +/- 1.0%.
6. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.

2.11 FABRICATING REINFORCEMENT

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

2.12 CONCRETE MIXING

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

PART 3 - EXECUTION

3.1 FORMWORK INSTALLATION

- 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.
- C. Limit concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:
 - 1. Class A, 1/8 inch for smooth-formed finished surfaces.
 - 2. Class B, 1/4 inch for rough-formed finished surfaces.
- D. Construct forms tight enough to prevent loss of concrete mortar.
- E. Construct 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, 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. Do not chamfer exterior corners and edges of permanently exposed concrete.
- I. Form openings, chases, offsets, sinkages, keyways, 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.

3.2 EMBEDDED ITEM INSTALLATION

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 303.

3.3 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. Concrete has to be hard enough to not be damaged by form-removal operations, and curing and protection operations need to be maintained.

B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material are not 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.

3.4 STEEL REINFORCEMENT INSTALLATION

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting 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 reduce bond to concrete.

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

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

- E. Install welded-wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

3.5 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. Do not continue reinforcement through sides of strip placements of floors and slabs.
 - 2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
 - 3. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:
 - 1. 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 does not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.
- D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
 - 1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated.
 - 2. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.
- E. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.6 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections are completed.
- B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect.
- C. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is 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 not to 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.
2. Maintain reinforcement in position on chairs during concrete placement.
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.

3.7 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, or 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.

3.8 FINISHING FLOORS AND SLABS

- A. General: Comply with ACI 302.1R recommendations for screeding, restraighening, 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 restraighening until surface is left with a uniform, smooth, granular texture.
- 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. Finish surfaces to the following tolerances, according to ASTM E 1155, for a randomly trafficked floor surface:
 - a. Specified overall values of flatness, F(F) 45; and of levelness, F(L) 35; with minimum local values of flatness, F(F) 30; and of levelness, F(L) 24.
 - 2. Finish and measure surface, so gap at any point between concrete surface and an unlevelled, freestanding, 10-ft.- long straightedge resting on two high spots and placed anywhere on the surface does not exceed 1/8 inch.
- D. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and elsewhere as indicated.
 - 1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

3.9 MISCELLANEOUS CONCRETE ITEM INSTALLATION

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

3.10 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 remainder of 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. 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.

3.11 JOINT FILLING

- A. Prepare, clean, and install joint filler according to manufacturer's written instructions.
 - 1. Defer joint filling until concrete has aged at least one month. Do not fill joints until construction traffic has permanently ceased.
- B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joints clean and dry.
- C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.12 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 1 part portland cement to 2-1/2 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.
 - 1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete. Limit cut depth to 3/4 inch. 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 matches 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.
1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
 2. After concrete has cured at least 14 days, correct high areas by grinding.
 3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
 4. Correct other low areas scheduled to 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.
 5. 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.
 6. 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.

3.13 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

- C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172/C 172M shall be performed according to the following requirements:
1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.
 2. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.
 - a. When frequency of testing provides 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.
 3. 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.
 4. Air Content: ASTM C 231/C 231M, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 5. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below or 80 deg F and above, and one test for each composite sample.
 6. Compression Test Specimens: ASTM C 31/C 31M.
 - a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.
 - b. Cast and field cure two sets of two standard cylinder specimens for each composite sample.
 7. Compressive-Strength Tests: ASTM C 39/C 39M; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.
 - a. Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days.
 - b. 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. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
 9. 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.
 10. Test results shall be reported in writing to Architect, concrete manufacturer, 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.

11. 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.
 12. 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.
 13. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
 14. 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 033000

SECTION 055000 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Metal bollards.

- B. Related Requirements:

- 1. Section 033000 "Cast-in-Place Concrete" for installing anchor bolts, steel pipe sleeves, slotted-channel inserts, wedge-type inserts, and other items cast into concrete.

1.3 COORDINATION

- 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 metal fabrications that are anchored to or that receive other work. 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.

1.4 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.1 METALS

- A. 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.

- B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- C. Steel Pipe: ASTM A 53/A 53M, Standard Weight (Schedule 40) unless otherwise indicated.

2.2 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 or ASTM F 1941, Class Fe/Zn 5, at exterior walls. 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. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563; and, where indicated, flat washers.
 - 1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.
- D. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; 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, all hot-dip galvanized per ASTM F 2329.
- E. Post-Installed Anchors: chemical anchors.
 - 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.

2.3 MISCELLANEOUS MATERIALS

- A. Shop Primers: Provide primers that comply with Section 099123 Interior Painting."
- B. Concrete: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained, concrete with a minimum 28-day compressive strength of 3000 psi.

2.4 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 exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

- D. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- E. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- F. 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.
- G. 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.

2.5 METAL BOLLARDS

- A. Fabricate metal bollards from Schedule 40 steel pipe.
 - 1. Cap bollards with 1/4-inch-thick steel plate.
- B. Fabricate bollards with 3/8-inch-thick steel baseplates for bolting to concrete slab. Drill baseplates at all four corners for 3/4-inch anchor bolts.
 - 1. Where bollards are to be anchored to sloping concrete slabs, angle baseplates for plumb alignment of bollards.
- C. Prime bollards with zinc-rich primer.

2.6 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 no fewer than two integrally welded steel strap anchors for embedding in concrete.

2.7 FINISHES, GENERAL

- A. Finish metal fabrications after assembly.
- B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.8 STEEL AND IRON FINISHES

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.
 - 1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

- B. Preparation for Shop Priming Galvanized Items: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.
- C. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.
 - 1. Shop prime with primers specified in Section 099123 "Interior Painting" unless indicated.
- D. Preparation for Shop Priming: Prepare surfaces to comply with SSPC-SP 3, "Power Tool Cleaning."

PART 3 - EXECUTION

3.1 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 screws, 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.

3.2 INSTALLING METAL BOLLARDS

- A. Fill metal-capped bollards solidly with concrete and allow concrete to cure seven days before installing.
 - 1. Do not fill removable bollards with concrete.

- B. Anchor bollards to existing construction with expansion anchors. Provide four 3/4-inch bolts at each bollard unless otherwise indicated.
 - 1. Embed anchor bolts at least 4 inches in concrete.
- C. Fill bollards solidly with concrete, mounding top surface to shed water.
 - 1. Do not fill removable bollards with concrete.

3.3 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 Section 099123 "Interior Painting."
- C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780/A 780M.

END OF SECTION 055000

SECTION 061000 - ROUGH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Wood blocking and nailers.
 - 2. Plywood backing panels.

1.3 DEFINITIONS

- A. Lumber grading agencies, and the abbreviations used to reference them, include the following:
 - 1. NLGA: National Lumber Grades Authority.

1.4 DELIVERY, STORAGE, AND HANDLING

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

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

- A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
 - 1. Factory mark each piece of lumber with grade stamp of grading agency.
 - 2. Provide dressed lumber, S4S, unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED LUMBER

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

2.3 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. Furring.
 - 4. Grounds.
- B. For items of dimension lumber size, provide Construction or No. 2 grade lumber and the following species:
 - 1. Northern species; NLGA.
- C. 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.

2.4 PLYWOOD BACKING PANELS

- A. Equipment Backing Panels: DOC PS 1, Exposure 1, C-D Plugged, in thickness indicated or, if not indicated, not less than 1/2-inch nominal thickness.

2.5 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.
- C. Power-Driven Fasteners: NES NER-272.
- 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. Adhesive Anchors: Anchor bolt and adhesive of material indicated below with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry assemblies and equal to four times the load imposed when installed in concrete as determined by testing per ASTM conducted by a qualified independent testing and inspecting agency.
 - 1. Material: Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.

2.6 MISCELLANEOUS MATERIALS

- A. Sill-Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to suit width of sill members indicated.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry to other construction; scribe and cope as needed for accurate fit. Locate furring, nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.
- B. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.
- C. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels.
- D. Install sill sealer gasket to form continuous seal between sill plates and foundation walls.
- E. Do not splice structural members between supports unless otherwise indicated.
- F. 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.
- G. 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.
- H. Comply with AWP A M4 for applying field treatment to cut surfaces of preservative-treated lumber.
- I. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 1. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
- J. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.

3.2 WOOD GROUND, SLEEPER, BLOCKING, AND NAILER INSTALLATION

- A. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
- B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.
- C. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.
- D. 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.

3.3 WOOD FURRING INSTALLATION

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

END OF SECTION 061000

SECTION 077253 - SNOW GUARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Rail-type, Seam-mounted snow guards.

1.3 ACTION SUBMITTALS

- A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for snow guards.
- B. Shop Drawings: Include roof plans showing layouts and attachment details of snow guards.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Performance Requirements: Provide snow guards that withstand exposure to weather and resist thermally induced movement without failure, rattling, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.
- B. Structural Performance:
 - 1. Snow Loads: As indicated on Drawings.

2.2 RAIL-TYPE SNOW GUARDS

- A. Seam-Mounted, Rail-Type Snow Guards:
 - 1. Description: Snow guard rails fabricated from metal pipes, bars, or extrusions, anchored to brackets and equipped with two rails.
 - 2. Material and Finish: Aluminum; mill.
 - 3. Material and Finish: Stainless steel; mill.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, snow guard attachment, and other conditions affecting performance of the Work.
 - 1. Verify compatibility with and suitability of substrates including compatibility with existing finishes or primers.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean and prepare substrates for bonding snow guards.
- B. Prime substrates according to snow guard manufacturer's written instructions.

3.3 INSTALLATION

- A. Install snow guards according to manufacturer's written instructions. Space rows as recommended by manufacturer.
- B. Attachment for Standing-Seam Metal Roofing:
 - 1. Do not use fasteners that will penetrate metal roofing, or fastening methods that void metal roofing finish warranty.
 - 2. Seam-Mounted, Rail-Type Snow Guards: Stainless-steel clamps attached to vertical ribs of standing-seam metal roof panels.

END OF SECTION 077253

SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Silicone joint sealants.
 - 2. Nonstaining silicone joint sealants.
 - 3. Urethane joint sealants.
 - 4. Immersible joint sealants.
 - 5. Silyl-terminated polyether joint sealants.
 - 6. Mildew-resistant joint sealants.
 - 7. Polysulfide joint sealants.
 - 8. Butyl joint sealants.
 - 9. Latex joint sealants.

1.3 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
- B. Product Testing: Test joint sealants using a qualified testing agency.
 - 1. Testing Agency Qualifications: Qualified according to ASTM C 1021 to conduct the testing indicated.
- C. Mockups: Install sealant in mockups of assemblies specified in other Sections that are indicated to receive joint sealants specified in this Section. Use materials and installation methods specified in this Section.

1.4 FIELD 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. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.5 WARRANTY

- A. Special Installer's Warranty: Installer agrees to repair or replace 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 agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
 1. Warranty Period: Five years from date of Substantial Completion.
- C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:
 1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
 2. Disintegration of joint substrates from causes exceeding design specifications.
 3. Mechanical damage caused by individuals, tools, or other outside agents.
 4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 JOINT SEALANTS, 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 joint-sealant manufacturer, based on testing and field experience.
- B. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 SILICONE JOINT SEALANTS

- A. Silicone, S, NS, 50, NT: Single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 50, Use NT.
 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. **Dow Corning Corporation.**

- b. **GE Construction Sealants; Momentive Performance Materials Inc.**
- c. **Pecora Corporation.**

2.3 URETHANE JOINT SEALANTS

- A. Urethane, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C 920, Type S, Grade P, Class 25, Uses T and NT.
 - 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. **BASF Corporation-Construction Systems.**
 - b. **Pecora Corporation.**
 - c. **Polymeric Systems, Inc.**
- B. Urethane, M, P, 50, T, NT: Multicomponent, pourable, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C 920, Type M, Grade P, Class 50, Uses T and NT.

2.4 MILDEW-RESISTANT JOINT SEALANTS

- A. Mildew-Resistant Joint Sealants: Formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth.
- B. Silicone, Mildew Resistant, Acid Curing, S, NS, 25, NT: Mildew-resistant, single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Use NT.
 - 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. **Dow Corning Corporation.**
 - b. **GE Construction Sealants; Momentive Performance Materials Inc.**

2.5 LATEX JOINT SEALANTS

- A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.
 - 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. **BASF Corporation-Construction Systems.**
 - b. **May National Associates, Inc.; a subsidiary of Sika Corporation.**
 - c. **Pecora Corporation.**

2.6 JOINT-SEALANT BACKING

- A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and 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), 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. Provide self-adhesive tape where applicable.

2.7 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

3.1 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 performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 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. Remove laitance and form-release agents from concrete.
 3. Clean nonporous joint substrate 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.
- B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by 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 or primer 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.

3.3 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. Install sealant backings of kind 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.
- D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- E. 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.
- F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs 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 profile per Figure 8A in ASTM C 1193 unless otherwise indicated.

3.4 FIELD QUALITY CONTROL

A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:

1. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.
 - a. 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.
2. Inspect tested joints and report on the following:
 - a. Whether sealants filled joint cavities and are free of voids.
 - b. Whether sealant dimensions and configurations comply with specified requirements.
 - c. 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 kind of product and joint substrate. Compare these results to determine if adhesion complies with sealant manufacturer's field-adhesion hand-pull test criteria.
3. 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-Adhesion-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.

3.5 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.

3.6 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, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.7 JOINT-SEALANT SCHEDULE

- A. Joint-Sealant Application: Exterior joints in horizontal traffic surfaces.
 - 1. Joint Locations:
 - a. Isolation and contraction joints in cast-in-place concrete slabs.
 - b. Joints between different materials listed above.
 - 2. Joint Sealant: Urethane, M, P, 50, T, NT.
 - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- B. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces.
 - 1. Joint Locations:
 - a. Construction joints in cast-in-place concrete.
 - b. Joints between metal panels.
 - c. Joints between different materials listed above.
 - d. Perimeter joints between materials listed above and frames of doors.
 - 2. Joint Sealant: Silicone, nonstaining, S, NS, 50, NT.
 - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- C. Joint-Sealant Application: Interior joints in horizontal traffic surfaces.
 - 1. Joint Locations:
 - a. Isolation joints in cast-in-place concrete slabs.
 - 2. Joint Sealant: Urethane, S, P, 25, T, NT.
 - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- D. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces not subject to significant movement.
 - 1. Joint Locations:
 - a. Control joints on exposed interior surfaces of exterior walls.
 - b. Perimeter joints between interior wall surfaces and frames of interior doors windows.
 - 2. Joint Sealant: Acrylic latex.
 - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- E. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces.

1. Joint Locations:
 - a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
2. Joint Sealant: Silicone, mildew resistant, acid curing, S, NS, 25, NT.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

END OF SECTION 079200

SECTION 081113 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes hollow-metal work.
- B. Related Requirements:
 - 1. Section 087100 "Door Hardware" for door hardware for hollow-metal doors.

1.3 DEFINITIONS

- A. **Minimum Thickness:** Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or SDI A250.8.

1.4 COORDINATION

- A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

1.5 ACTION SUBMITTALS

- A. Shop Drawings: Include the following:
 - 1. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
 - 2. Frame details for each frame type, including dimensioned profiles and metal thicknesses.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver hollow-metal work palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.
 - 1. Provide additional protection to prevent damage to 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 vertically under cover at Project site with head up. Place on minimum 4-inch-high wood blocking. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. **Ceco Door; ASSA ABLOY.**
 - 2. **Curries Company; ASSA ABLOY.**
 - 3. **Republic Doors and Frames.**
 - 4. **Steelcraft; an Allegion brand.**

2.2 INTERIOR DOORS AND FRAMES

- A. Construct interior doors and frames to comply with the standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
- B. Commercial Doors and Frames: NAAMM-HMMA 861..
 - 1. Physical Performance: Level A according to SDI A250.4.
 - 2. Doors:
 - a. Type: As indicated in the Door and Frame Schedule.
 - b. Thickness: 1-3/4 inches
 - c. Face: Uncoated, cold-rolled steel sheet, minimum thickness of 0.042 inch.
 - d. Edge Construction: Continuously welded with no visible seam.
 - e. Core: Steel stiffened.
 - 3. Frames:
 - a. Materials: Uncoated steel sheet, minimum thickness of 0.053 inch.
 - b. Construction: Full profile welded.
 - 4. Exposed Finish: Prime.

2.3 EXTERIOR HOLLOW-METAL DOORS AND FRAMES

- A. Construct exterior doors and frames to comply with the standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
- B. Commercial Doors and Frames: NAAMM-HMMA 861..
 - 1. Physical Performance: Level A according to SDI A250.4.

2. Doors:
 - a. Type: As indicated in the Door and Frame Schedule.
 - b. Thickness: 1-3/4 inches
 - c. Face: Metallic-coated steel sheet, minimum thickness of 0.053 inch, with minimum G60A60 coating.
 - d. Edge Construction: Continuously welded with no visible seam.
 - e. Core: Steel stiffened.
 - 1) Thermal-Rated Doors: Provide doors fabricated with thermal-resistance value (R-value) of not less than 2.1 deg F x h x sq. ft./Btu when tested according to ASTM C 1363.
3. Frames:
 - a. Materials: Metallic-coated steel sheet, minimum thickness of 0.067 inch, with minimum G60A60 coating.
 - b. Construction: Full profile welded.
4. Exposed Finish: Prime.

2.4 FRAME ANCHORS

- A. Jamb Anchors:
 1. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.042 inch thick.
- B. Floor Anchors: Formed from same material as frames, minimum thickness of 0.042 inch, and as follows:
 1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.

2.5 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
- C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B.
- D. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.
- E. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.

- F. Grout: ASTM C 476, except with a maximum slump of 4 inches, as measured according to ASTM C 143/C 143M.
- G. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.
- H. Glazing: Comply with requirements in Section 088000 "Glazing."
- I. Bituminous Coating: Cold-applied asphalt mastic, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.6 FABRICATION

- A. Fabricate hollow-metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for metal thickness. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.
- B. Hollow-Metal Doors:
 - 1. Steel-Stiffened Door Cores: Provide minimum thickness 0.026 inch, steel vertical stiffeners of same material as face sheets extending full-door height, with vertical webs spaced not more than 6 inches apart. Spot weld to face sheets no more than 5 inches o.c. Fill spaces between stiffeners with glass- or mineral-fiber insulation.
 - 2. Vertical Edges for Single-Acting Doors: Bevel edges 1/8 inch in 2 inches.
 - 3. Top Edge Closures: Close top edges of doors with inverted closures, except provide flush closures at exterior doors of same material as face sheets.
 - 4. Bottom Edge Closures: Close bottom edges of doors where required for attachment of weather stripping with end closures or channels of same material as face sheets.
 - 5. Exterior Doors: Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.
- C. Fabricate concealed stiffeners and edge channels from either cold- or hot-rolled steel sheet.
- D. Hardware Preparation: Factory prepare hollow-metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to SDI A250.6, the Door Hardware Schedule, and templates.
 - 1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
 - 2. Comply with applicable requirements in SDI A250.6 and BHMA A156.115 for preparation of hollow-metal work for hardware.

2.7 STEEL FINISHES

- A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.

1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

PART 3 - EXECUTION

3.1 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.

3.2 PREPARATION

- A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.
- B. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.3 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 Doors: Fit hollow-metal doors accurately in frames, within clearances specified below. Shim as necessary.
- C. Glazing: Comply with installation requirements in Section 088000 "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.

3.4 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. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION 081113

SECTION 083430 – HANGAR DOORS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Bi-fold hangar door with structured-polycarbonate panel facing.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's Spec Sheets for each Bi-fold Door, plus product data and installation instructions. Include details of construction relative to materials, dimensions of individual components, profiles, and finishes. Provide roughing-in diagrams, include the following:

- 1. Summary of forces and loads on walls and jambs.
 - 2. Setting drawings, templates, and installation instructions for built-in or embedded anchor devices.

- B. Shop Drawings: Submit shop drawings for approval prior to fabrication. Include detailed plans, elevations, and details of framing members, required clearance, anchors and accessories. Include relationship with adjacent materials. The make and type of door, operators and controls shall be clearly shown. Door weight, method of suspension, operation, and all fastenings shall be indicated.

- C. Submit 2 copies each of the following manufacturer's Manuals / Diagrams:

- 1. Hangar Door Literature
 - 2. Installation Manual
 - 3. Operating Instructions
 - 4. Maintenance data/manual
 - 5. Safety Decal Placement Guide Manual / Warning Labels
 - 6. Electrical System Manual for the bi-fold door system
 - 7. Electrical Schematics
 - 8. Electrical Wiring Diagram
 - 9. Diagrams of potentially hazardous locations related to the operation of the door

- D. Samples: For each type of exposed finish required.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Engage a firm experienced in manufacturing hangar doors similar to those indicated for this Project and with a record of successful in-service performance.

- B. Installer Qualifications: Engage an experienced installer who has three or more years of

experience for both installation and maintenance of units required for this Project.

- C. Preinstallation Conference: Conduct a pre-installation conference at Project site prior to commencement of field operations that might affect installation of hangar door to establish procedures for maintaining optimum working conditions, and to coordinate this work with related and adjacent work.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials and products in manufacturer's labeled protective packages. Store and handle in strict compliance with manufacturer's written instructions and recommendations. Protect from damage from weather, excessive temperatures and constructions operations.
- B. Inspect vertical bi-fold doors upon delivery for damage. Minor damages may be repaired provided refinished items are equal in all respects to new work and acceptable to Architect. Otherwise, remove and replace damaged items as directed.
- C. Place bi-fold door frame units on minimum 4" high wood blocking. Store doors components & packages at building site under cover. Avoid use of non-vented plastic or canvas shelters which could create humidity chamber. If cardboard wrapper on door becomes wet, remove carton immediately.
- D. The contractor shall store the sheet, panels, components and other manufactured items so that they will not be damaged or deformed. Store metal sheets or panels so that water accumulations will drain freely. Do not store sheets or panels in contact with other materials which might cause staining.

1.6 WARRANTY

- A. The Contractor shall warrant the door to be free of defects in accordance with the General Conditions, except the warranty shall be extended by manufacturer's 2 - year written warranty against defects in materials and workmanship, against problems which arise through normal anticipated usage of the door during the warranty period. The warranty shall be signed by the manufacturer.
- B. Special Structured-Polycarbonate-Panel Warranty: Manufacturer's standard form in which manufacturer agrees to replace panels that exhibit defects in materials or workmanship..
 - 1. Defects include, but are not limited to, the following:
 - a. Delamination.
 - b. Color changes exceeding requirements.
 - c. Losses in light transmission beyond 6 percent from original when measured per ASTM D 1003.
 - 2. Warranty Period: 10 years from date of Substantial Completion.

PART 2 – PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structured Polycarbonate Panel Assemblies:

1. General Performance: Structured-polycarbonate-panel assemblies shall withstand the effects of the following forces without failure due to defective manufacture, fabrication, installation, or other defects in construction:
 - a. Structural loads.
 - b. Thermal movements.
 - c. Movements of supporting structure.
 - d. Dimensional tolerances of building frame and other adjacent construction. e. Failure includes, but is not limited to, the following:
 - 1) Deflection exceeding specified limits.
 - 2) Water leakage.
 - 3) Thermal stresses transferred to building structure.
 - 4) Noise or vibration created by wind, thermal, or structural movements.
 - 5) Loosening or weakening of fasteners, attachments, and other components.
2. Structural Loads:
 - a. Wind Loads: As indicated on Drawings.
 - 1) Basic Wind Speed: 90 mph (40 m/s).
 - 2) Exposure Category: C.
3. Deflection Limits:
 - a. Overhead Panel Assemblies: Limited to 1/100 of clear span for each assembly component.
4. Structural-Test Performance: Provide panel assemblies tested according to ASTM E 330, as follows:
 - a. When tested at positive and negative wind-load design pressures, assemblies do not show evidence of deflection exceeding specified limits.
5. Water Penetration under Static Pressure: Provide panel assemblies 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 7 lbf/sq. ft..
6. Thermal Movements: Allow for thermal movements from ambient- and surface-temperature changes. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - a. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 HANGAR DOOR

- A. Manufacturers General: The bi-fold doors supplied by a manufacturer who is regularly engaged in the manufacture of aircraft hangar doors for a minimum of ten years, and upon request from the Owner provide a list of completed projects.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide Schweiss Bi-Fold Doors product or comparable products by qualified manufacturer.

2.3 FREE STANDING HEADER

- A. The free standing header shall consist of two side columns and the main header frame attached to the existing building's structure and capable of supporting all the imposed loads that the bi-fold door exerts.
- B. Columns shall be attached to the new concrete foundation.
- C. The header framework shall consist of jig welded steel tube sections engineered by the door manufacturer to resist all anticipated loads without sagging, bowing or conflicting with the door's smooth operation.
- D. Structural steel framing members shall be ASTM A500 Grade B square structural welded steel tubing.
- E. Shop connections shall be welded.

2.4 BI-FOLD DOOR CONSTRUCTION REQUIREMENTS

- A. Hangar doors shall be of the electrically operated bi-fold canopy type.
- B. When in the open position the doors shall have a slight slope to direct drainage away from the building.
- C. Door shall be hinged horizontally at the top and center, and be arranged to open by moving frame out & up.
- D. Door frames shall have prelocated top hinges to align with the header framing members. E.
Door shall be self-contained with only the top hinges, bottom door rollers and column followers/ wind rails.
- F. The door framework shall consist of jig welded steel tube sections engineered by the door manufacturer to resist all anticipated loads without sagging, bowing or conflicting with its smooth operation.
- G. Structural steel door framing members shall be ASTM A500 Grade B square structural welded steel tubing.
- H. Shop connections shall be welded.

2.5 DRIVESHAFT / LIFT DRUMS

- A. The solid steel driveshaft with lift drums mounted on bottom cord of door shall run continuously along entire door width providing an even lift of the door at all times.
- B. The drive shaft shall be attached to the door frame with (greaseable) bearing mounts wherever there is a cable drum installed, to minimize stress on the shaft.
- C. Solid Driveshaft and lift drums shall be in sufficient amount to give 5:1 safety factor.

2.6 LIFTING METHODS

- A. The door power unit shall be operated by a system of lifting straps, lifting drums and drive shafts.
- B. Lift Straps shall be attached to a retainer on the upper door frame passing through a strap guide attached at the top chord of the door frame, thereby transmitting forces directly to header of building & relieving door of unnecessary stresses.
- C. The Lift Straps shall have adjustable slack take-up device to keep proper tension on each Lift Strap.
- D. The lift drums must be properly shielded to avoid any potential hazards to people.
- E. Lift Straps and Lift Drums shall be manufacturer's standard adequately sized in sufficient amount to give 5:1 safety factor.

2.7 HEAVY DUTY HINGES

- A. Heavy Duty Steel Hinges furnished complete. Each Hinge set shall be 10.50" wide; pins shall be 11/16" diameter minimum.

2.8 DOOR INTERNAL TRUSS

- A. An extra heavy duty center truss shall be installed in the center of the interior side and at the base of the door to provide extra strength.

2.9 HEAVY DUTY SIDE ROLLERS

- A. The bi-fold hangar doors shall include 3" Heavy Duty minimum guide rollers with sealed bearings on bottom of door at jamb location.

2.10 COLUMN FOLLOWERS

- A. System provided by the door manufacture to hold the base of the door securely against the building when the door is in the closed position.
- B. I - Beam columns secure the door in all positions.

2.11 WIND PINS

- A. Center wind pins 1" diameter minimum - provide a sturdy installation - Must automatically engage/ disengage with auto latching system.

2.12 PAINT

- A. Frame members and parts shall be factory primer finished with primer specified in Division 9 – Interior Painting.

2.13 TOP & BOTTOM RUBBER SEALS

- A. Provide manufacturer's standard seal continuous at top, bottom of each door.
- B. The door shall be equipped with neoprene weather stripping at heads and jambs to prevent flow of moisture into the door installation. Sills shall have a special fabric reinforced high grade rubber astragal. The entire door perimeter shall be weather tight.

2.14 WEATHER SEAL

- A. The sides and center of each bi-fold shall be sealed off with a special weather stripping. The center of the door shall have a self-sticking foam cushion seal. The entire door perimeter must be weather tight.

2.15 STRUCTURED POLYCARBONATE PANEL FACINGS

- A. Install door skins to completely clad the door frames, use noncorrosive fasteners.
- B. Description: Translucent, extruded-polycarbonate sheet with cellular cross section that provides isolated airspaces and that is coextruded with a UV-protective layer.
 - 1. Plastic Self-Ignition Temperature: 650 deg F (343 deg C) or more per ASTM D 1929.
 - 2. Smoke-Developed Index: 450 or less per ASTM E 84, or 75 or less per ASTM D 2843.
 - 3. Flame-Spread Index: Not more than 25 per ASTM E 84.
 - 4. Combustibility Classification: Class CC1 per ASTM D 635.
 - 5. Color Change: Not more than 3.0 units Delta E when measured according to ASTM D 2244 after outdoor weathering compliant with procedures in ASTM D 1435.
 - a. Outdoor Weathering Conditions: 60 months in Arizona or 120 months in a moderate North American climate.
 - 6. Impact Resistance: No failure at impact of 200 ft. x lbf (271 J) according ASTM D-384/SPI.
- C. Panel Thickness: As determined by manufacturer to meet structural load requirements but not less than 16mm.
- D. Panel Color: Clear.
- E. Install the door skin and all trims according to the bi-fold door recommendations.

2.16 ELECTRIC MOTOR / VOLTAGE / PHASE

- A. Service: 60 amp, 208 volt, three phase three wire.
- B. Motors shall be totally enclosed.

C. The size of the motor shall be as recommended by the manufacturer.

D. Door operator shall be pre-wired at factory.

2.17 GEAR MOTOR

A. The gear motor shall be equipped with an electric brake, which stops and holds the door in any position of door travel.

B. Provide high starting torque, reversible, continuous duty, class A insulated, electric motors complying with NEMA MG 1, with overload protection, sized to start, accelerate, and operate door in either direction, from any position.

C. Provide magnetic starter with control unit.

D. Design operator so motor may be removed without disturbing limit switch adjustment and without affecting emergency auxiliary operator.

2.18 CONTROL STATION

A. Button Constant Hold Control Station

1. 2-button constant contact dead man switch, to prevent operator from leaving control panel while door is in motion, either up or down.

2. When the operator takes his hand off the up /down button, the door shall immediately stop regardless of its opening / closing position.

3. The motor shall automatically stop when the door reaches either the full open or closed position.

B. HVAC Controls Interface: Provide contacts in the door control panel to output the door position (for door in the open position and door in the closed position). Contacts will be used by the HVAC system to shut down the infrared heaters when the door is open, and to start the infrared heaters when the door is closed. Contacts to be field changeable to NO or NC.

2.19 LIMIT SWITCHES

A. Heavy duty limit switch box shall be weatherproof.

B. Heavy duty limit switch box shall provide adjustable switches interlocked with motor controls and set to automatically stop door at fully opened and fully closed positions.

C. Safety edges shall not be used as limit switches.

2.20 ELECTRICAL DISCONNECT

A. Provide Electrical Disconnect to completely disable the door, for service, maintenance, emergency backup operations.

B. Mount disconnect so it is accessible from floor level.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine wall and overhead areas, including opening framing and blocking, with Installer present,

for compliance with requirements for installation tolerances, clearances, and other conditions affecting performance of Work of this section.

- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General:

1. Door manufacturer is required to coordinate with the structured polycarbonate panel manufacturer in the development of the exact installation details.
2. Install columns and support header, and attach to existing structure.
3. Install door and operating equipment complete with necessary hardware, jamb and head mold strips, anchors, inserts, hangers, and equipment supports according to Shop Drawing, manufacturer's written instructions, and as specified.
4. Fasten vertical track assembly to framing at not less than 24 inches o.c. Hang horizontal track, hinges from structural overhead framing with angle or channel hangers welded and/or bolt fastened in place. Provide sway bracing, diagonal bracing, and reinforcement as required for rigid installation of track, hinges and door-operating equipment.

B. Top and Bottom Limits Settings

1. Each bi-fold door has a recommended clear opening setting, specified by the manufacture. Do not over travel the door beyond the recommended setting.

C. Exterior panels

1. Structured polycarbonate panel installer to install the panels with the proper trims that are recommended by the manufacturer for a weathertight seal.

D. Apply Proper Safety Markings

1. Apply proper markings for any potentially hazardous locations related to the operation of the door.
2. Follow the pictorial diagram included in the door installation manual. E.

Installing Warning Labels

1. Furnish warning labels for any potentially hazardous locations related to the operation of the door.
2. Fasten warning labels to the bi-fold door frame and by the operator's station in accordance with manufacturer's instructions, NO EXCEPTIONS.

3.3 DEMONSTRATION

A. Startup Services: Engage a qualified -authorized service representative to perform startup services and to train Owner's maintenance personnel as specified below:

1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls & equipment.
2. Train Owner's maintenance personnel on procedures and schedules related to startup and shut down, operating, troubleshooting, servicing, and preventative maintenance.
3. Review data in the installation & maintenance manuals.
4. Schedule training with Owner at least 7 days advance notice.

END OF SECTION 083430

SECTION 083613 - SECTIONAL DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes electrically operated sectional doors.
- B. Related Requirements:
 - 1. Section 133419 "Metal Building Systems" for miscellaneous steel supports.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type and size of sectional door and accessory.
 - 1. Include construction details, material descriptions, dimensions of individual components, profile door sections, and finishes.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished accessories.
- B. Samples for Initial Selection: For units with factory-applied finishes.
 - 1. Include Samples of accessories involving color selection.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For sectional doors to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer for both installation and maintenance of units required for this Project.

1.6 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of sectional doors 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. Failure of components or operators before reaching required number of operation cycles.
 - c. Faulty operation of hardware.
 - d. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use; rust through.
 - e. Delamination of exterior or interior facing materials.
2. Warranty Period: Ten years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Sectional doors shall comply with performance requirements specified without failure due to defective manufacture, fabrication, installation, or other defects in construction.
- B. Structural Performance, Exterior Doors: Capable of withstanding the design wind loads.
 1. Design Wind Load: As indicated on Drawings.
 2. Testing: According to ASTM E 330.
 3. Deflection Limits: Design sectional doors to withstand design wind loads without evidencing permanent deformation or disengagement of door components.
 - a. Deflection of door sections in horizontal position (open) shall not exceed 1/120 of the door width.
 - b. Deflection of horizontal track assembly shall not exceed 1/240 of the door height.

2.2 DOOR ASSEMBLY

- A. Steel Sectional Door: Sectional door formed with hinged sections and fabricated according to DASMA 102 unless otherwise indicated.
- B. Operation Cycles: Door components and operators capable of operating for not less than 10,000. One operation cycle is complete when a door is opened from the closed position to the fully open position and returned to the closed position.
- C. Air Infiltration: Maximum rate of 0.08 cfm/sq. ft. at 15 and 25 mph when tested according to ASTM E 283.
- D. Installed R-Value: 17.5 deg F x h x sq. ft./Btu.
- E. Steel Sections: Zinc-coated (galvanized) steel sheet with G60 zinc coating.
 1. Section Thickness: 1-3/4 inches.
 2. Exterior-Face, Steel Sheet Thickness: 0.019-inch- nominal coated thickness.

- a. Surface: Flat.
 - 3. Insulation: CFC-free and HCFC-free polyurethane, fully encapsulated.
 - 4. Interior Facing Material: Zinc-coated (galvanized) steel sheet with a nominal coated thickness of 0.019 inch or manufacturer's recommended dimension to comply with performance requirements.
- F. Track Configuration: Standard-lift track.
 - G. Weatherseals: Fitted to bottom and top and around entire perimeter of door.
 - H. Roller-Tire Material: Case-hardened steel.
 - I. Locking Devices: Equip door with locking device assembly.
 - 1. Locking Device Assembly: Cremone type, both jamb sides, locking bars, operable from outside with cylinder.
 - J. Counterbalance Type: Torsion spring.
 - K. Electric Door Operator:
 - 1. Usage Classification: Heavy duty, 25 or more cycles per hour and more than 90 cycles per day.
 - 2. Operator Type: Jackshaft, side mounted.
 - 3. Safety: Listed according to UL 325 by a qualified testing agency for commercial or industrial use.
 - 4. Motor Exposure: Interior, clean, and dry.
 - 5. Emergency Manual Operation: Chain type.
 - 6. Obstruction-Detection Device: Automatic photoelectric sensor.
 - 7. Control Station: Interior-side mounted.
 - L. Door Finish:
 - 1. Baked-Enamel or Powder-Coat Finish: Color and gloss as selected by Architect from manufacturer's full range.
 - 2. Finish of Interior Facing Material: Finish as selected by Architect from manufacturer's full range.

2.3 STEEL DOOR SECTIONS

- A. Exterior Section Faces and Frames: Zinc-coated (galvanized), cold-rolled, commercial steel (CS) sheet, complying with ASTM A 653/A 653M, with indicated zinc coating and thickness.
 - 1. Fabricate section faces from single sheets to provide sections not more than 24 inches high and of indicated thickness. Roll horizontal meeting edges to a continuous, interlocking, keyed, rabbeted, shiplap, or tongue-in-groove weather-resistant seal, with a reinforcing flange return.
 - 2. For insulated doors, provide sections with continuous thermal-break construction, separating the exterior and interior faces of door.

- B. Section Ends and Intermediate Stiles: Enclose open ends of sections with channel end stiles formed from galvanized-steel sheet not less than 0.064-inch-nominal coated thickness and welded to door section. Provide intermediate stiles formed from not less than 0.064-inch-thick galvanized-steel sheet, cut to door section profile, and welded in place. Space stiles not more than 48 inches apart.
- C. Reinforce bottom section with a continuous channel or angle conforming to bottom-section profile.
- D. Reinforce sections with continuous horizontal and diagonal reinforcement, as required to stiffen door and for wind loading. Provide galvanized-steel bars, struts, trusses, or strip steel, formed to depth and bolted or welded in place.
- E. Provide reinforcement for hardware attachment.
- F. Board Thermal Insulation: Insulate interior of steel sections with door manufacturer's standard CFC-free polystyrene or polyurethane board insulation, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E 84; or with glass-fiber-board insulation. Secure insulation to exterior face sheet. Enclose insulation completely within steel sections and the interior facing material, with no exposed insulation.
- G. Interior Facing Material: Zinc-coated (galvanized), cold-rolled, commercial steel (CS) sheet, complying with ASTM A 653/A 653M, with indicated thickness.
- H. Fabricate sections so finished door assembly is rigid and aligned, with tight hairline joints and free of warp, twist, and deformation.

2.4 TRACKS, SUPPORTS, AND ACCESSORIES

- A. Tracks: Manufacturer's standard, galvanized-steel track system of configuration indicated, sized for door size and weight, designed for lift type indicated and clearances indicated on Drawings, Provide complete system including brackets, bracing, and reinforcement to ensure rigid support of ball-bearing roller guides for required door type, size, weight, and loading.
 - 1. Galvanized Steel: ASTM A 653/A 653M, minimum G60 zinc coating.
 - 2. Slope tracks at an angle from vertical or design tracks to ensure tight closure at jams when door unit is closed.
 - 3. Track Reinforcement and Supports: Galvanized-steel members to support track without sag, sway, and vibration during opening and closing of doors.
 - a. For Vertical Track: Intermittent, jamb brackets attached to track and attached to wall.
 - b. For Horizontal Track: Continuous reinforcing angle from curve in track to end of track, attached to track and supported at points by laterally braced attachments to overhead structural members.
- B. General: Provide miscellaneous lumber indicated and lumber for support or attachment of construction. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.

- C. Weatherseals: Replaceable, adjustable, continuous, compressible weather-stripping gaskets of flexible vinyl, rubber, or neoprene fitted to bottom and top of sectional door unless otherwise indicated.

2.5 HARDWARE

- A. General: Heavy-duty, corrosion-resistant hardware, with hot-dip galvanized, stainless-steel, or other corrosion-resistant fasteners, to suit door type.
- B. Hinges: Heavy-duty, galvanized-steel hinges of not less than 0.079-inch-nominal coated thickness at each end stile and at each intermediate stile, according to manufacturer's written recommendations for door size. Attach hinges to door sections through stiles and rails with bolts and lock nuts or lock washers and nuts. Use rivets or self-tapping fasteners where access to nuts is impossible. Provide double-end hinges where required, for doors more than 16 feet wide unless otherwise recommended by door manufacturer.
- C. Rollers: Heavy-duty rollers with steel ball-bearings in case-hardened steel races, mounted with varying projections to suit slope of track. Extend roller shaft through both hinges where double hinges are required. Provide 3-inch-diameter roller tires for 3-inch-wide track and 2-inch-diameter roller tires for 2-inch-wide track.
- D. Push/Pull Handles: Equip each push-up operated or emergency-operated door with galvanized-steel lifting handles on each side of door, finished to match door.

2.6 LOCKING DEVICES

- A. Locking Device Assembly: Fabricate with cylinder lock, spring-loaded deadbolt, operating handle, cam plate, and adjustable locking bars to engage through slots in tracks. Operable from interior and exterior.
 - 1. Lock Cylinders: Cylinders standard with manufacturer and keyed to building keying system.
 - 2. Keys: Three for each cylinder.

2.7 COUNTERBALANCE MECHANISM

- A. Torsion Spring: Counterbalance mechanism consisting of adjustable-tension torsion springs fabricated from steel-spring wire complying with ASTM A 229/A 229M, mounted on torsion shaft made of steel tube or solid steel. Provide springs designed for number of operation cycles indicated.
- B. Cable Drums and Shaft for Doors: Cast-aluminum or gray-iron casting cable drums mounted on torsion shaft and grooved to receive door-lifting cables as door is raised. Mount counterbalance mechanism with manufacturer's standard ball-bearing brackets at each end of torsion shaft. Provide one additional midpoint bracket for shafts up to 16 feet long and two additional brackets at one-third points to support shafts more than 16 feet long unless closer spacing is recommended by door manufacturer.

- C. Cables: Galvanized-steel, multistrand, lifting cables with cable safety factor of at least 7 to 1.
- D. Cable Safety Device: Include a spring-loaded steel or spring-loaded bronze cam mounted to bottom door roller assembly on each side and designed to automatically stop door if either lifting cable breaks.
- E. Bracket: Provide anchor support bracket as required to connect stationary end of spring to the wall and to level the shaft and prevent sag.
- F. Bumper: Provide spring bumper at each horizontal track to cushion door at end of opening operation.

2.8 ELECTRIC DOOR OPERATORS

- A. General: Electric door operator assembly of size and capacity recommended and provided by door manufacturer for door and "operation cycles" requirement specified, with electric motor and factory-prewired motor controls, starter, gear-reduction unit, solenoid-operated brake, clutch, control stations, control devices, integral gearing for locking door, and accessories required for proper operation.
 - 1. Comply with NFPA 70.
 - 2. Control equipment complying with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6; with NFPA 70, Class 2 control circuit, maximum 24-V ac or dc.
- B. Usage Classification: Electric operator and components capable of operating for not less than number of cycles per hour indicated for each door.
- C. Door-Operator Type: Unit consisting of electric motor, gears, pulleys, belts, sprockets, chains, and controls needed to operate door and meet required usage classification.
 - 1. Jackshaft, Side Mounted: Jackshaft operator mounted on the inside front wall on right or left side of door and connected to torsion shaft with an adjustable coupling or drive chain.
- D. Motors: Reversible-type motor with controller (disconnect switch) for motor exposure indicated.
 - 1. Electrical Characteristics:
 - a. Phase: Three phase.
 - b. Volts: 208 V.
 - c. Hertz: 60.
 - 2. Motor Size: Minimum size as indicated. If not indicated, large enough to start, accelerate, and operate door in either direction from any position, at a speed not less than 8 in./sec. and not more than 12 in./sec., without exceeding nameplate ratings or service factor.
 - 3. Operating Controls, Controllers (Disconnect Switches), Wiring Devices, and Wiring: Manufacturer's standard unless otherwise indicated.
 - 4. Coordinate wiring requirements and electrical characteristics of motors and other electrical devices with building electrical system and each location where installed.

5. Use adjustable motor-mounting bases for belt-driven operators.
- E. Limit Switches: Equip motorized door with adjustable switches interlocked with motor controls and set to automatically stop door at fully opened and fully closed positions.
- F. Obstruction Detection Device: External entrapment protection consisting of indicated automatic safety sensor capable of protecting full width of door opening. Activation of device immediately stops and reverses downward door travel.
 1. Photoelectric Sensor: Manufacturer's standard system designed to detect an obstruction in door opening without contact between door and obstruction.
 - a. Self-Monitoring Type: Designed to interface with door operator control circuit to detect damage to or disconnection of sensing device. When self-monitoring feature is activated, door closes only with sustained pressure on close button.
- G. Control Station: Three-button control station in fixed location with momentary-contact push-button controls labeled "Open" and "Stop" and sustained- or constant-pressure, push-button control labeled "Close."
 1. Interior-Mounted Units: Full-guarded, surface-mounted, heavy-duty type, with general-purpose NEMA ICS 6, Type 1 enclosure.
- H. Emergency Manual Operation: Equip electrically powered door with capability for emergency manual operation. Design manual mechanism so required force for door operation does not exceed 25 lbf.
- I. Emergency Operation Disconnect Device: Equip operator with hand-operated disconnect mechanism for automatically engaging manual operator and releasing brake for emergency manual operation while disconnecting motor without affecting timing of limit switch. Mount mechanism so it is accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.
- J. Motor Removal: Design operator so motor may be removed without disturbing limit-switch adjustment and without affecting emergency manual operation.
- K. Audible and Visual Signals: Audible alarm and visual indicator lights in compliance with regulatory requirements for accessibility.
- L. Portable, Radio-Control System: Consisting of two of the following:
 1. Three-channel universal coaxial receiver to open, close, and stop door.
 2. Portable control device to open and stop door may be momentary-contact type; control to close door shall be sustained- or constant-pressure type.
 3. Remote antenna and mounting kit.

2.9 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM/NOMMA's "Metal Finishes Manual for Architectural and Metal Products (AMP 500-06)" for recommendations for applying and designating finishes.
- B. 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.

2.10 STEEL AND GALVANIZED-STEEL FINISHES

- A. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrate construction and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install sectional doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.
- B. Tracks:
 - 1. Fasten vertical track assembly to opening jambs and framing, spaced not more than 24 inches apart.
 - 2. Hang horizontal track assembly from structural overhead framing with angles or channel hangers attached to framing by welding or bolting, or both. Provide sway bracing, diagonal bracing, and reinforcement as required for rigid installation of track and door-operating equipment.
- C. Accessibility: Install sectional doors, switches, and controls along accessible routes in compliance with regulatory requirements for accessibility.

3.3 ADJUSTING

- A. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion.

- B. Lubricate bearings and sliding parts as recommended by manufacturer.
- C. Adjust doors and seals to provide weather-resistant fit around entire perimeter.
- D. Touch-up Painting: Immediately after welding galvanized materials, clean welds and abraded galvanized surfaces and repair galvanizing to comply with ASTM A 780/A 780M.

END OF SECTION 083613

SECTION 084513 - STRUCTURED-POLYCARBONATE-PANEL ASSEMBLIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes aluminum-framed assemblies glazed with structured-polycarbonate panels as follows:
 - 1. Wall assemblies.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for aluminum components of panel assemblies.
- B. Shop Drawings: For panel assemblies.
 - 1. Include plans, elevations, sections, details, and attachments to other work.
 - 2. Include details of provisions for assembly expansion and contraction and for draining moisture within the assembly to the exterior.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.5 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of 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, but not limited to, excessive deflection.
 - b. Deterioration of metals and other materials beyond normal weathering.
 - c. Water leakage.

2. Warranty Period: Two years from date of Substantial Completion.
- B. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace structured-polycarbonate panels that exhibit defects in materials or workmanship within specified warranty period.
1. Defects include, but are not limited to, the following:
 - a. Delamination.
 - b. Color changes exceeding requirements.
 - c. Losses in light transmission beyond 6 percent from original when measured according to ASTM D 1003.
 2. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Loads: As indicated on Drawings.
- B. Deflection Limits:
 1. Vertical Panel Assemblies: Limited to 1/60 of clear span for each assembly component.
 2. Provide additional aluminum structure where required.
- C. Structural-Test Performance: Panel assemblies tested according to ASTM E 330, as follows:
 1. When tested at positive and negative wind-load design pressures, assemblies do not show evidence of deflection exceeding specified deflection limits.
- D. Water Penetration under Static Pressure: Provide panel assemblies 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..
- E. Thermal Movements: Allow for thermal movements from ambient- and surface-temperature changes. Base calculations 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.

2.2 STRUCTURED-POLYCARBONATE-PANEL ASSEMBLIES

- A. Structured-Polycarbonate-Panel Assemblies: Translucent assemblies that are supported by aluminum framing and glazed with structured-polycarbonate panels.

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. **CO-EX Corp.**
 - b. **CPI Daylighting, Inc.**
 - c. **Duo-Gard Industries Inc.**
 - d. **EXTECH/Exterior Technologies, Inc.**
 - e. **Gallina USA, LLC.**

2.3 STRUCTURED-POLYCARBONATE PANELS

- A. Structured-Polycarbonate Panels: Translucent, extruded-polycarbonate sheet with multiwall cellular cross section that provides isolated airspaces and that is coextruded with a UV-protective layer.
- B. Panel Thickness: Nominal 1 inch.
- C. UV Resistance: Coextruded into panel, not coated.
- D. Color: Green.
- E. Panel Performance:
 1. Plastic Self-Ignition Temperature: 650 deg F or more according to ASTM D 1929.
 2. Smoke-Developed Index: 450 or less according to ASTM E 84, or 75 or less according to ASTM D 2843.
 3. Color Change: Not more than 3.0 units Delta E, when measured according to ASTM D 2244, after outdoor weathering compliant with procedures in ASTM D 1435.
 - a. Outdoor Weathering Conditions: 60 months in Arizona or 120 months in a moderate North American climate.

2.4 ALUMINUM FRAMING SYSTEMS

- A. Components: Manufacturer's standard extruded-aluminum members of thickness required and reinforced as required to support imposed loads.
 1. Construction: Thermally broken, extruded aluminum.
- B. Aluminum: Alloy and temper recommended in writing by manufacturer for type of use and finish indicated.
 1. Sheet and Plate: ASTM B 209.
 2. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221.
 3. Extruded Structural Pipe and Tubes: ASTM B 429.
 4. Structural Profiles: ASTM B 308.
- C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning skylight components.

- D. Fasteners and Accessories: Manufacturer's standard, corrosion-resistant, nonstaining, and nonbleeding fasteners and accessories; compatible with adjacent materials.
 - 1. At closures, retaining caps, or battens, use ASTM A 193, 300 series stainless-steel screws.
 - 2. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
 - 3. At movement joints, use slip-joint linings, spacers, and sleeves of material and type recommended in writing by manufacturer.
- E. Concealed Flashing: Corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.
- F. Exposed Flashing and Closures: Aluminum sheet not less than 0.050 inch thick, finished to match framing.
- G. Framing Gaskets: Manufacturer's standard gasket system with low-friction surface treatment designed specifically for retaining structured-polycarbonate panels.
- H. Frame-System Sealants: As specified in Section 079200 "Joint Sealants."
- I. Corrosion-Resistant Coating: Cold-applied asphalt mastic, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.5 FABRICATION

- A. 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 through joints and moisture migrating within assembly to exterior.
- B. Fabricate aluminum sill closures with weep holes and for installation as continuous component.
- C. Reinforce aluminum components as required to receive fastener threads.

2.6 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

PART 3 - EXECUTION

3.1 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.

3.2 INSTALLATION

- A. General: Comply with manufacturer's written instructions. Install Structured Polycarbonate Panel Assemblies including aluminum flashing, fasteners, hardware, gaskets, joint sealants, and glazing materials required for a complete, weathertight installation.
 - 1. Do not install damaged components.
 - 2. Fit joints between aluminum components to produce hairline joints free of burrs and distortion.
 - 3. Rigidly secure nonmovement joints.
 - 4. Install anchors with separators and isolators to prevent metal corrosion, electrolytic deterioration, and immobilization of moving joints.
 - 5. Seal joints watertight unless otherwise indicated.
- B. Metal Protection: Where aluminum components will contact dissimilar materials, protect against galvanic action by painting contact surfaces with corrosion-resistant coating or by installing nonconductive spacers as recommended in writing by manufacturer for this purpose.
- C. Install components plumb and true in alignment with established lines and elevations.
- D. Erection Tolerances: Install panel assemblies 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.
- E. Install sheet metal flashing as specified elsewhere in specifications.
- F. Repair minor damages to metal finish or glazing in accordance with manufacturer's instructions and as approved by Architect. Remove and replace damaged components that cannot be successfully repaired as determined by Architect.

3.3 CLEANING

- A. Clean panel assembly in accordance with manufacturer's instructions.

3.4 PROTECTION

- A. Protect installed panels from damage during construction
- B. Remove and replace damaged components as determined by Architect.

END OF SECTION 084513

SECTION 087100 - DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes:
 - 1. Mechanical door hardware for the following:
 - a. Swinging doors.
- B. Related Sections:
 - 1. Section 081113 "Hollow Metal Doors and Frames".

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction and installation details, material descriptions, dimensions of individual components and profiles, and finishes.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Supplier of products and an employer of workers trained and approved by product manufacturers.
- B. Accessibility Requirements: Comply with applicable provisions in ICC A117.1 for door hardware on doors in an accessible route.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

- A. Provide door hardware for each door as scheduled in Part 3 "Door Hardware Schedule" Article to comply with requirements in this Section.
 - 1. Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and products equivalent in function and comparable in quality to named products.

2.2 HINGES

- A. Hinges: BHMA A156.1.

2.3 MECHANICAL LOCKS AND LATCHES

- A. Lock Functions: As indicated in door hardware schedule.
- B. Strikes: Provide manufacturer's standard strike for each lock bolt or latchbolt complying with requirements indicated for applicable lock or latch and with strike box and curved lip extended to protect frame; finished to match lock or latch.

2.4 LOCK CYLINDERS

- A. Lock Cylinders: Tumbler type, constructed from brass or bronze, stainless steel, or nickel silver.
- B. High-Security Lock Cylinders: BHMA A156.30; Grade 1; Type M, mechanical; permanent cores that are removable; face finished to match lockset.
- C. Construction Cores: Provide construction cores that are replaceable by permanent cores. Provide 10 construction master keys.

2.5 KEYING

- A. Keying System: Factory registered, complying with guidelines in BHMA A156.28, Appendix A. Incorporate decisions made in keying conference.
 - 1. Grand Master Key System: Change keys, a master key, and a grand master key operate cylinders.
- B. Keys: Nickel silver.
 - 1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:
 - a. Notation: "DO NOT DUPLICATE."
 - 2. Quantity: In addition to one extra key blank for each lock, provide the following:
 - a. Cylinder Change Keys: Three.
 - b. Master Keys: Five.
 - c. Grand Master Keys: Three.
 - 3. Master keys and all high-security or restricted keyway blanks shall be sealed in a tamper-proof packaged boxes when shipped from the factory. The boxes shall be shrink wrapped and imprinted to ensure the integrity of the packaging.

2.6 OPERATING TRIM

- A. Operating Trim: BHMA A156.6.

2.7 SURFACE CLOSERS

- A. Surface Closers: BHMA A156.4; rack-and-pinion hydraulic type with adjustable sweep and latch speeds controlled by key-operated valves and forged-steel main arm. Comply with manufacturer's written recommendations for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.

2.8 MECHANICAL STOPS AND HOLDERS

- A. Wall- and Floor-Mounted Stops: BHMA A156.16; polished cast brass, bronze, or aluminum base metal.

2.9 OVERHEAD STOPS AND HOLDERS

- A. Overhead Stops and Holders: BHMA A156.8.

2.10 DOOR GASKETING

- A. Door Gasketing: BHMA A156.22; air leakage not to exceed 0.50 cfm per foot of crack length for gasketing other than for smoke control, as tested according to ASTM E 283; with resilient or flexible seal strips that are easily replaceable and readily available from stocks maintained by manufacturer.

2.11 THRESHOLDS

- A. Thresholds: BHMA A156.21; fabricated to full width of opening indicated.

2.12 METAL PROTECTIVE TRIM UNITS

- A. Metal Protective Trim Units: BHMA A156.6; fabricated from 0.050-inch-thick stainless steel; with manufacturer's standard machine or self-tapping screw fasteners.

2.13 FABRICATION

- A. Manufacturer's Nameplate: Do not provide products that have manufacturer's name or trade name displayed in a visible location except in conjunction with required fire-rated labels and as otherwise approved by Architect.
 - 1. Manufacturer's identification is permitted on rim of lock cylinders only.

- B. Base Metals: Produce door hardware units of base metal indicated, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18.
- C. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine, and sheet metal screws. Provide screws that comply with commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated.
 - 1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.
 - 2. Spacers or Sex Bolts: For through bolting of hollow-metal doors.
 - 3. Gasketing Fasteners: Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

2.14 FINISHES

- A. Provide finishes complying with BHMA A156.18 as indicated in door hardware schedule.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance.
- B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Steel Doors and Frames: For surface applied door hardware, drill and tap doors and frames according to ANSI/SDI A250.6.

3.3 INSTALLATION

- A. Mounting Heights: Mount door hardware units at heights to comply with the following unless otherwise indicated or required to comply with governing regulations.
 - 1. Standard Steel Doors and Frames: ANSI/SDI A250.8.
- B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing. Do not install surface-mounted items until finishes have been completed on substrates involved.
 - 1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
 - 2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
- C. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than the number recommended by manufacturer for application indicated or one hinge for every 30 inches of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.
- D. Lock Cylinders: Install construction cores to secure building and areas during construction period.
 - 1. Replace construction cores with permanent cores as directed by Owner.
 - 2. Furnish permanent cores to Owner for installation.
- E. Thresholds: Set thresholds for exterior doors and other doors indicated in full bed of sealant complying with requirements specified in Section 079200 "Joint Sealants."
- F. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they will impede traffic.
- G. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
- H. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

3.4 FIELD QUALITY CONTROL

- A. Independent Architectural Hardware Consultant: Owner will engage a qualified independent Architectural Hardware Consultant to perform inspections and to prepare inspection reports.

3.5 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
 - 1. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.

3.6 CLEANING AND PROTECTION

- A. Clean adjacent surfaces soiled by door hardware installation.
- B. Clean operating items as necessary to restore proper function and finish.
- C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

3.7 DOOR HARDWARE SCHEDULE

Doors 101B & 101D

3 Hinges	T4A3386 4-1/2 x 4-1/2 x NRP	630	McKinney
1 Lockset	8205 B	626	Sargent
1 Cylinder	Schlage Primus to match existing	626	Schlage
1 Overhead Stop	1 Series	630	Rixson
1 Closer	PR7500	689	Norton
1 Kickplate	K1050 12" x 2"LDW	630	Rockwood
1 Threshold	252X3 AFG		Pemko
1 Weatherstrip	303AS, 2891AS		Pemko
1 Sweep	18061 CNB		Pemko
1 Rain Drip	346 C		Pemko

Door 101 E (Alternate Bid)

3 Hinges	T4A3386 4-1/2 x 4-1/2	630	McKinney
1 Lockset	8265 B	626	Sargent

END OF SECTION 087100

SECTION 088000 - GLAZING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes:
 - 1. Glass for doors.
 - 2. Glazing sealants and accessories.

1.3 DEFINITIONS

- A. Glass Manufacturers: 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. IBC: International Building Code.
- D. Interspace: Space between lites of an insulating-glass unit.

1.4 COORDINATION

- A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.
- B. Comply with insulating-glass manufacturer's written instructions for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

1.6 FIELD 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 glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or are below 40 deg F.

1.7 WARRANTY

- A. Manufacturer's Special Warranty for Insulating Glass: Manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to 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.
 - 1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.
- B. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined according to the IBC and ASTM E 1300.
 - 1. Design Wind Pressures: As indicated on Drawings.
 - 2. Differential Shading: Design glass to resist thermal stresses induced by differential shading within individual glass lites.
- C. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.
- D. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:
 - 1. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
 - 2. U-Factors: Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F.

3. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
4. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

2.2 GLASS PRODUCTS, GENERAL

- A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.
 1. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."
- B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
- C. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.
- D. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than the thickness indicated.

2.3 GLASS PRODUCTS

- A. Clear Annealed Float Glass: ASTM C 1036, Type I, Class 1 (clear), Quality-Q3.
- B. Tinted Annealed Float Glass: ASTM C 1036, Type I, Class 2 (tinted), Quality-Q3.
- C. Fully Tempered Float Glass: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
 1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.

2.4 INSULATING GLASS

- A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E 2190.
 1. Sealing System: Dual seal, with manufacturer's standard primary and secondary sealants.
 2. Spacer: Manufacturer's standard spacer material and construction.
 3. Desiccant: Molecular sieve or silica gel, or a blend of both.

2.5 GLAZING SEALANTS

- A. General:

1. Compatibility: Compatible with one another and with other materials they 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.

2.6 GLAZING TAPES

- A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; 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; and complying with ASTM C 1281 and AAMA 800 for products indicated below:
 1. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.

2.7 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standard, with 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 of 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).

2.8 FABRICATION OF GLAZING UNITS

- A. Fabricate glazing units in sizes required to fit 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.
 1. Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.
 - a. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:
 - 1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
 - 2. Presence and functioning of weep systems.
 - 3. Minimum required face and edge clearances.
 - 4. Effective sealing between joints of glass-framing members.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.
- B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that leave visible marks in the completed Work.

3.3 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. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.
- C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.
- D. 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.
- E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- F. 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.

3.4 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, then to jambs. Cover horizontal framing joints by applying tapes to jambs, 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 right 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.

3.5 GASKET GLAZING (DRY)

- A. Cut compression gaskets to 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. Installation with Drive-in Wedge Gaskets: 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. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- E. Install gaskets so they protrude past face of glazing stops.

3.6 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.

3.7 CLEANING AND PROTECTION

- A. Immediately after installation remove nonpermanent labels and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations. 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.
 - 1. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.
- C. Remove and replace glass that is damaged during construction period.
- D. Wash glass on both exposed surfaces 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.

3.8 MONOLITHIC GLASS SCHEDULE

- A. Glass Type : Clear fully tempered float glass.
 - 1. Minimum Thickness: 6 mm.
 - 2. Safety glazing required.
- B. Glass Type : Tinted fully tempered float glass.
 - 1. Tint Color: Blue-green.
 - 2. Minimum Thickness: 6 mm.
 - 3. Safety glazing required.

3.9 INSULATING GLASS SCHEDULE

- A. Glass Type : Low-E-coated, tinted insulating glass.
 - 1. Overall Unit Thickness: 1 inch.
 - 2. Minimum Thickness of Each Glass Lite: 6 mm.
 - 3. Outdoor Lite: Tinted fully tempered float glass.
 - 4. Tint Color: Blue-green.
 - 5. Interspace Content: Air.
 - 6. Indoor Lite: Clear fully tempered float glass.
 - 7. Low-E Coating: Pyrolytic on second surface.

END OF SECTION 088000

SECTION 092216 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Non-load-bearing steel framing systems for interior partitions.
 - 2. Suspension systems for interior ceilings and soffits.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Horizontal Deflection: For wall assemblies, limited to 1/240 of the wall height based on horizontal loading of 5 lbf/sq. ft..

2.2 FRAMING SYSTEMS

- 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.
- B. Studs and Runners: ASTM C 645.
- C. Cold-Rolled Channel Bridging: Steel, 0.0538-inch minimum base-metal thickness, with minimum 1/2-inch-wide flanges.

2.3 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/D 226M, 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

3.1 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 of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 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.

3.3 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C 754.
 1. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.
- B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.
- C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
- D. Install bracing at terminations in assemblies.
- E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.4 INSTALLING FRAMED ASSEMBLIES

- A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
- B. Install studs so flanges within framing system point in same direction.

- C. Install tracks (runners) at 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 that penetrate 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. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint in finished assembly.
 - c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
- D. 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 092216

SECTION 092900 - GYPSUM BOARD

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Interior gypsum board.

1.3 DELIVERY, STORAGE AND HANDLING

- A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.4 FIELD 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 paper-faced gypsum panels 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

2.1 GYPSUM BOARD, GENERAL

- A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.2 INTERIOR GYPSUM BOARD

A. Gypsum Wallboard: ASTM C 1396/C 1396M.

1. Thickness: 5/8 inch.
2. Long Edges: Tapered.

2.3 TRIM ACCESSORIES

A. Interior Trim: ASTM C 1047.

1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized steel sheet.
2. Shapes:
 - a. Cornerbead.
 - b. Bullnose bead.
 - c. LC-Bead: J-shaped; exposed long flange receives joint compound.
 - d. L-Bead: L-shaped; exposed long flange receives joint compound.
 - e. U-Bead: J-shaped; exposed short flange does not receive joint compound.
 - f. Expansion (control) joint.

B. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. **Fry Reglet Corporation.**
2. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B 221, Alloy 6063-T5.
3. Finish: Corrosion-resistant primer compatible with joint compound and finish materials specified.

2.4 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C 475/C 475M.

B. Joint Tape:

1. Interior Gypsum Board: Paper.

C. Joint Compound for Interior Gypsum Board: 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 drying-type, all-purpose 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.

2.5 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.
- B. 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.
- C. Acoustical Joint Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. 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.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates including welded hollow-metal frames and framing, with Installer present, 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.

3.2 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.

3.3 APPLYING INTERIOR GYPSUM BOARD

- A. Install interior gypsum board in the following locations:
 - 1. Wallboard Type: As indicated on Drawings.
- B. Single-Layer Application:
 - 1. 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.
 - 2. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

3.4 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: Install control joints according to ASTM C 840 and in specific locations approved by Architect for visual effect.
- C. Interior Trim: Install in the following locations:
 - 1. Cornerbead: Use at outside corners unless otherwise indicated.
 - 2. LC-Bead: Use at exposed panel edges.

- D. Aluminum Trim: Install in locations indicated on Drawings.

3.5 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 for trim products specifically indicated as not intended to receive 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 3: Where indicated on Drawings.
 - 4. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.
 - a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."
 - 5. Level 5: Where indicated on Drawings.
 - a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."

3.6 PROTECTION

- A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.
- B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- C. 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 092900

SECTION 095113 - ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes acoustical panels and exposed suspension systems for ceilings.

1.3 ACTION SUBMITTALS

- A. Samples: For each exposed product and for each color and texture specified, 6 inches in size.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Acoustical Ceiling Panels: Full-size panels equal to 2 percent of quantity installed.

1.5 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.

1.6 FIELD 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.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: Comply with ASTM E 1264 for Class A materials.
 - 2. Smoke-Developed Index: 50 or less.
- B. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

2.2 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.
- 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.

2.3 ACOUSTICAL PANELS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. [Armstrong World Industries, Inc.](#)
 - 2. [CertainTeed Corp.](#)
 - 3. [Chicago Metallic Corporation.](#)
 - 4. [USG Interiors, Inc.; Subsidiary of USG Corporation.](#)
- B. Acoustical Panels Type: Armstrong World Industries – Fine Fissured Ceramaguard, 605.
 - 1. Surface Texture: Medium.
 - 2. Composition: Mineral Fiber
 - 3. Color: White
 - 4. Size: As indicated x 5/8 in.
 - 5. Edge Profile: Square Lay-In.

6. Ceiling Attenuation Class: ASTM C 1414; Classified with UL label on product carton, 40.
 7. Flame Spread: ASTM E 1264; Fire Resistive
 8. Light Reflectance: ASTM E 1477; White Panel: Light Reflectance: 0.88.
- 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.

2.4 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/C 635M.
- B. Attachment Devices: Size for five times the design load indicated in ASTM C 635/C 635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
- C. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
 1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
 2. Size: Select wire diameter so its stress at three times hanger design load (ASTM C 635/C 635M, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 12 Gauge diameter wire.
- D. Hold-Down Clips: Provide manufacturer's standard hold-down clips spaced 24 inches o.c. on all cross tees.

2.5 METAL SUSPENSION SYSTEM

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. [Armstrong World Industries, Inc.](#)
 2. [CertainTeed Corp.](#)
 3. [Chicago Metallic Corporation.](#)
 4. [USG Interiors, Inc.; Subsidiary of USG Corporation.](#)
- 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.
 1. Structural Classification: Heavy-duty system.
 2. End Condition of Cross Runners: Override (stepped) type.

3. Face Design: Flat, flush.
4. Cap Material: Steel or aluminum cold-rolled sheet.
5. Cap Finish: Painted to match color of acoustical unit.

2.6 METAL EDGE MOLDINGS AND TRIM

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. **Armstrong World Industries, Inc.**
 2. **CertainTeed Corp.**
 3. **Chicago Metallic Corporation.**
 4. **USG Interiors, Inc.; Subsidiary of USG Corporation.**
- B. 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.
 3. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.

PART 3 - EXECUTION

3.1 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.
- B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 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.

3.3 INSTALLATION

- A. General: Install acoustical panel ceilings to comply with ASTM C 636/C 636M and seismic design requirements indicated, according to 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. 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.
 4. 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.
 5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or 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 roof deck. Attach hangers to structural members.
 9. 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.
 10. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
- C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.
- D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
1. Screw attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet. Miter corners accurately and connect securely.
 2. Do not use exposed fasteners, including pop rivets, on moldings and trim.

- E. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- F. Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.
 - 1. Arrange directionally patterned acoustical panels as follows:
 - a. Install panels in a basket-weave pattern.
 - 2. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension-system runners and moldings.
 - 3. For reveal-edged panels on suspension-system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
 - 4. For reveal-edged panels on suspension-system members with box-shaped flanges, install panels with reveal surfaces in firm contact with suspension-system surfaces and panel faces flush with bottom face of runners.
 - 5. 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.
 - 6. Install hold-down clips in areas indicated, in areas required by authorities having jurisdiction, and for fire-resistance ratings; space as recommended by panel manufacturer's written instructions unless otherwise indicated.
 - 7. Protect lighting fixtures and air ducts to comply with requirements indicated for fire-resistance-rated assembly.

3.4 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 095113

SECTION 099113 - EXTERIOR PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes surface preparation and the application of paint systems on exterior substrates.

1.3 DEFINITIONS

- A. MPI Gloss Level 1: Not more than five units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.
- B. MPI Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
- C. MPI Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.
- D. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.
- E. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.
- F. MPI Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

1.4 ACTION SUBMITTALS

- A. Samples for Initial Selection: For each type of topcoat product.

1.5 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.

1.6 FIELD 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.

PART 2 - PRODUCTS

2.1 PAINT, GENERAL

- A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."
- B. Material Compatibility:
 - 1. Materials for use within each paint system shall be 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, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.
- C. Colors: As selected by Architect from manufacturer's full range.

2.2 SOURCE QUALITY CONTROL

- A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure:
 - 1. Owner will engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
 - 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.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

- B. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.
- C. Proceed with coating application only after unsatisfactory conditions have been corrected.
 - 1. Application of coating indicates acceptance of surfaces and conditions.

3.2 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 hardware, covers, plates, and similar items already in place that are removable and 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.
- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
 - 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
- D. Steel Substrates: Remove rust, loose mill scale, and shop primer if any. Clean using methods recommended in writing by paint manufacturer, but not less than the following:
 - 1. SSPC-SP 3.
- E. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.
- F. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."
 - 1. Use applicators and techniques suited for paint and substrate indicated.
 - 2. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.
 - 3. Paint both sides and edges of exterior doors and entire exposed surface of exterior door frames.
 - 4. Paint entire exposed surface of window frames and sashes.

5. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
 6. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
- 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.

3.4 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.

3.5 EXTERIOR PAINTING SCHEDULE

- A. Steel and Iron Substrates:
1. Alkyd System MPI EXT 5.1D:
 - a. Prime Coat: Primer, alkyd, anticorrosive, for metal, MPI #79.
 - b. Prime Coat: Shop primer specified in Section where substrate is specified.
 - c. Intermediate Coat: Exterior, alkyd enamel, matching topcoat.
 - d. Topcoat: Alkyd, exterior, semi-gloss (MPI Gloss Level 5), MPI #94.
- B. Galvanized-Metal Substrates:
1. Alkyd System MPI EXT 5.3B:
 - a. Prime Coat: Primer, galvanized, cementitious, MPI #26.
 - b. Intermediate Coat: Exterior, alkyd enamel, matching topcoat.
 - c. Topcoat: Alkyd, exterior, semi-gloss (MPI Gloss Level 5), MPI #94.

END OF SECTION 099113

SECTION 099123 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes surface preparation and the application of paint systems on interior substrates.
- B. Related Requirements:
 - 1. Section 099600 "High-Performance Coatings" for tile-like coatings.

1.3 DEFINITIONS

- A. MPI Gloss Level 1: Not more than five units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.
- B. MPI Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
- C. MPI Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
- D. MPI Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.
- E. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.
- F. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.
- G. MPI Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

1.4 ACTION SUBMITTALS

- A. Samples for Initial Selection: For each type of topcoat product.

1.5 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.

1.6 FIELD 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 when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 PAINT, GENERAL

- A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."
- B. Material Compatibility:
 1. Materials for use within each paint system shall be 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, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.
- C. Colors: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 1. Gypsum Board: 12 percent.
- C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.
- D. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.
- E. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 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 hardware, covers, plates, and similar items already in place that are removable and 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.
- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
- D. Steel Substrates: Remove rust, loose mill scale, and shop primer, if any. Clean using methods recommended in writing by paint manufacturer but not less than the following:
 1. SSPC-SP 3.
- E. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.
- F. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual."
 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. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
 5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.

- 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.

3.4 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.

3.5 INTERIOR PAINTING SCHEDULE

- A. Steel Substrates:
 - 1. Alkyd System MPI INT 5.1E:
 - a. Prime Coat: Primer, alkyd, quick dry, for metal, MPI #76.
 - b. Prime Coat: Shop primer specified in Section where substrate is specified.
 - c. Intermediate Coat: Alkyd, interior, matching topcoat.
 - d. Topcoat: Alkyd, interior, semi-gloss (MPI Gloss Level 5), MPI #47.
- B. Galvanized-Metal Substrates:
 - 1. High-Performance Architectural Latex System MPI INT 5.3M:
 - a. Prime Coat: Primer, galvanized, water based, MPI #134.
 - b. Intermediate Coat: Latex, interior, high performance architectural, matching topcoat.
 - c. Topcoat: Latex, interior, high performance architectural, semi-gloss (MPI Gloss Level 5), MPI #141.
- C. Gypsum Board Substrates:
 - 1. Latex over Latex Sealer System MPI INT 9.2A:
 - a. Prime Coat: Primer sealer, latex, interior, MPI #50.

- b. Intermediate Coat: Latex, interior, matching topcoat.
- c. Topcoat: Latex, interior (MPI Gloss Level 3), MPI #52.

END OF SECTION 099123

SECTION 099600 - HIGH-PERFORMANCE COATINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes surface preparation and the application of high-performance coating systems.
- B. Related Requirements:
 - 1. Section 099113 "Exterior Painting" for general field painting.
 - 2. Section 099123 "Interior Painting" for general field painting.

1.3 DEFINITIONS

- A. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.
- B. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.
- C. MPI Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
- B. Samples for Initial Selection: For each type of topcoat product indicated.

1.5 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.

1.6 FIELD CONDITIONS

- A. Apply coatings only when temperature of surfaces to be coated and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply coatings when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. General Polymers Saniglaze High Build Wall System, Sherwin-Williams Company (The).

2.2 HIGH-PERFORMANCE COATINGS, GENERAL

- A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."
- B. Material Compatibility:
 - 1. Products shall be of same manufacturer for each coat in a coating system.
- C. Colors: As selected by Architect from manufacturer's full range.

2.3 SOURCE QUALITY CONTROL

- A. Testing of Coating Materials: Owner reserves the right to invoke the following procedure:
 - 1. Owner will engage the services of a qualified testing agency to sample coating materials. Contractor will be notified in advance and may be present when samples are taken. If coating materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
 - 2. Testing agency will perform tests for compliance with product requirements.
 - 3. Owner may direct Contractor to stop applying coatings if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying coating materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. Contractor will be required to remove rejected materials from previously coated surfaces if, on recoating with complying materials, the two coatings are incompatible.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 - 1. Gypsum Board: 12 percent.
- C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.
- D. Proceed with coating application only after unsatisfactory conditions have been corrected.
 - 1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and coating systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and 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.
- C. Clean substrates of substances that could impair bond of coatings, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
 - 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce coating systems indicated.

3.3 APPLICATION

- A. Apply high-performance coatings according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."
 - 1. Use applicators and techniques suited for coating and substrate indicated.
 - 2. Coat surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, coat surfaces behind permanently fixed equipment or furniture with prime coat only.
 - 3. Coat backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
 - 4. Do not apply coatings over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

- B. If undercoats or other conditions show through final coat, apply additional coats until cured film has a uniform coating finish, color, and appearance.
- C. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Produce sharp glass lines and color breaks.

3.4 FIELD QUALITY CONTROL

- A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test coatings for dry film thickness.
 - 1. Contractor shall touch up and restore coated surfaces damaged by testing.
 - 2. If test results show that dry film thickness of applied coating does not comply with coating manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with coating manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from coating operation. Correct damage to work of other trades by cleaning, repairing, replacing, and recoating, 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 coated surfaces.

3.6 INTERIOR HIGH-PERFORMANCE COATING SCHEDULE

- A. Gypsum Board Substrates:
 - 1. Epoxy, High-Build System:
 - a. Prime Coat: Primer sealer, latex, interior, MPI #50.
 - 1) 3479 Water-Based Epoxy Wall Coating.
 - b. Intermediate Coat: High-build epoxy, matching prime coat.
 - c. Topcoat: High-build epoxy, low gloss, MPI #108.
 - 1) 4408 WB Polyurethane.

END OF SECTION 099600

SECTION 102800 - TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Public-use washroom accessories.

1.3 ACTION 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.
 - 5. Manufacturer's warranty.

1.4 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.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Stainless Steel: ASTM A 666, Type 304, 0.031-inch minimum nominal thickness unless otherwise indicated.
- B. Steel Sheet: ASTM A 1008/A 1008M, Designation CS (cold rolled, commercial steel), 0.036-inch minimum nominal thickness.
- C. Galvanized-Steel Sheet: ASTM A 653/A 653M, with G60 hot-dip zinc coating.

- D. Galvanized-Steel Mounting Devices: ASTM A 153/A 153M, hot-dip galvanized after fabrication.
- E. 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.
- F. Chrome Plating: ASTM B 456, Service Condition Number SC 2 (moderate service).
- G. Mirrors: ASTM C 1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.
- H. ABS Plastic: Acrylonitrile-butadiene-styrene resin formulation.

2.2 PUBLIC-USE WASHROOM ACCESSORIES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. Bobrick Washroom Equipment, Inc.
 - 2. Bradley Corporation.
- B. Toilet Tissue (Roll) Dispenser:
 - 1. Description: Double-roll dispenser with shelf.
 - 2. Mounting: Surface mounted.
 - 3. Operation: Noncontrol delivery with theft-resistant spindle.
 - 4. Capacity: Designed for 5-inch- diameter tissue rolls.
 - 5. Material and Finish: Stainless steel, No. 4 finish (satin).
- C. Paper Towel (Folded) Dispenser:
 - 1. Mounting: Surface mounted.
 - 2. Minimum Capacity: 400 C-fold or 525 multifold towels.
 - 3. Material and Finish: Stainless steel, No. 4 finish (satin).
 - 4. Lockset: Tumbler type.
 - 5. Refill Indicators: Pierced slots at sides or front.
- D. Liquid-Soap Dispenser:
 - 1. Description: Designed for dispensing soap in liquid or lotion form.
 - 2. Mounting: Vertically oriented, surface mounted.
 - 3. Lockset: Tumbler type.
 - 4. Refill Indicator: Window type.
- E. Grab Bar:
 - 1. Mounting: Flanges with concealed fasteners.
 - 2. Material: Stainless steel, 0.05 inch thick.
 - a. Finish: Smooth, No. 4 finish (satin).
 - 3. Outside Diameter: 1-1/2 inches.
 - 4. Configuration and Length: As indicated on Drawings.

F. Mirror Unit:

1. Frame: Stainless-steel channel.
 - a. Corners: Mitered and mechanically interlocked.
2. Hangers: Produce rigid, tamper- and theft-resistant installation.
3. Size: As indicated on Drawings.

2.3 UNDERLAVATORY GUARDS

A. Underlavatory Guard:

1. Description: Insulating pipe covering for supply and drain piping assemblies that prevent direct contact with and burns from piping; allow service access without removing coverings.
2. Material and Finish: Antimicrobial, molded plastic, white.

PART 3 - EXECUTION

3.1 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 ASTM F 446.

3.2 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 102800

SECTION 104416 - FIRE EXTINGUISHERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes portable, fire extinguishers.

1.3 QUALITY ASSURANCE

- A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."
- B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

- A. Fire Extinguishers: Type, size, and capacity for each fire protection cabinet indicated.
- B. Multipurpose Dry-Chemical Type in Steel Container: UL-rated 2-A:10-B:C, 10-lb nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.

2.2 MOUNTING BRACKETS

- A. Mounting Brackets: Manufacturer's standard steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or red baked-enamel finish.
- B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.
 - 1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.
 - 2. If more than one orientation is required, indicate location of each on Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine fire extinguishers for proper charging and tagging.
 - 1. Remove and replace damaged, defective, or undercharged fire extinguishers.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install fire extinguishers in locations indicated and in compliance with requirements of authorities having jurisdiction.
- B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

END OF SECTION 104416

SECTION 133419 - METAL BUILDING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Structural-steel framing.
2. Metal roof panels.
3. Metal wall panels.
4. Thermal insulation.
5. Accessories.

- B. Related Requirements:

1. Section 077253 "Snow Guards" for prefabricated devices designed to hold snow on the roof surface.
2. Section 083430 "Hangar Doors" for bi-fold hangar doors in metal building systems.
3. Section 083613 "Sectional Doors" for sectional vehicular doors in metal building systems.
4. Section 084513 "Structured-Polycarbonate-Panel Assemblies for aluminum-framed assemblies glazed with structured-polycarbonate panels in metal building systems.

1.3 DEFINITIONS

- A. Terminology Standard: See MBMA's "Metal Building Systems Manual" for definitions of terms for metal building system construction not otherwise defined in this Section or in standards referenced by this Section.

1.4 COORDINATION

- A. Coordinate sizes and locations of concrete foundations and casting of anchor-rod inserts into foundation walls and footings. Anchor rod installation, concrete, reinforcement, and formwork requirements are specified in Section 033000 "Cast-in-Place Concrete."
- B. Coordinate metal panel assemblies with rain drainage work, flashing, trim, and construction of supports and other adjoining work to provide a leak-proof, secure, and noncorrosive installation.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of metal building system component.
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
 - a. Metal roof panels.
 - b. Metal wall panels.
 - c. Metal liner panels.
 - d. Thermal insulation and vapor-retarder facings.
 - e. Translucent panels.
 - f. Flashing and trim.
 - g. Accessories.
- B. Shop Drawings: Indicate components by others. Include full building plan, elevations, sections, details and the following:
1. Anchor-Bolt Plans: Submit anchor-bolt plans and templates before foundation work begins. Include location, diameter, and minimum required projection of anchor bolts required to attach metal building to foundation.
 2. Column reactions and base plates: Provide column reactions and base plate details to engineer within 2 weeks of project award in order to confirm foundation sizes.
 3. Structural-Framing Drawings: Show complete fabrication of primary and secondary framing; include provisions for openings. Indicate welds and bolted connections, distinguishing between shop and field applications. Include transverse cross-sections.
 4. Metal Roof, Metal Wall and Metal Liner Panel Layout Drawings: Show layouts of panels including methods of support. Include details of edge conditions, joints, panel profiles, corners, anchorages, clip spacing, trim, flashings, closures, and special details. Distinguish between factory- and field-assembled work; show locations of exposed fasteners.
 - a. Show wall-mounted items including doors, windows, louvers, and lighting fixtures.
 - b. Show translucent panels.
 5. Accessory Drawings: Include details of the following items, at a legible scale.
 - a. Flashing and trim.
 - b. Gutters.
 - c. Downspouts.
- C. Samples for Initial Selection: For units with factory-applied finishes.
- D. Samples for Verification: For the following products:
1. Panels: Nominal 12 inches long by actual panel width. Include fasteners, closures, and other exposed panel accessories.

2. Flashing and Trim: Nominal 12 inches long. Include fasteners and other exposed accessories.

E. Delegated-Design Submittal: For metal building systems.

1. Professional engineer's metal building permit drawings, prepared and signed by a Wisconsin registered Professional Engineer, verifying that the structural framing and covering panels meet indicated loading requirements and codes of authorities having jurisdiction. Submit five copies of stamped drawings and two sets of calculations for submittal to Wisconsin Department of Safety and Professional Services.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer and fabricator continuously engaged in the business of manufacturing high quality prefabricated metal building systems similar to the one described herein, for at least the past immediate five (5) years.
- B. Erector Qualifications: An experienced erector who specializes in erecting and installing work similar in material, design, and extent to that indicated for this Project and who is certified in writing by the metal building system manufacturer as qualified for erection of the manufacturer's products.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver components, sheets, panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.
- B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.
- C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.
- D. Protect foam-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 foam-plastic insulation materials to Project site before installation time.
 3. Complete installation and concealment of foam-plastic materials as rapidly as possible in each area of construction.

1.8 FIELD CONDITIONS

- A. Weather Limitations: Proceed with panel installation only when weather conditions permit metal panels to be installed according to manufacturers' written instructions and warranty requirements.

1.9 WARRANTY

- A. Special Warranty on Metal Panel Finishes: Manufacturer agrees to repair finish or replace metal 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.
- B. Special Weathertightness Warranty for Standing-Seam Metal Roof Panels: Manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that leak or otherwise fail to remain weathertight within specified warranty period.
 - 1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. American Buildings Company; a Nucor Company.
 - 2. Butler Manufacturing Company; a division of BlueScope Buildings North America, Inc.
 - 3. Kirby Buildings; a Nucor Company.
 - 4. Star Building Systems; a division of NCI Building Systems, Inc.
 - 5. Varco-Pruden Buildings; a division of BlueScope Buildings North America, Inc.
- B. Source Limitations: Obtain metal building system components, including primary and secondary framing and metal panel assemblies, from single source from single manufacturer.

2.2 SYSTEM DESCRIPTION

- A. Provide a complete, integrated set of mutually dependent components and assemblies that form a metal building system capable of withstanding structural and other loads, thermally induced movement, and exposure to weather without failure or infiltration of water into building interior.
- B. Primary-Frame Type:
 - 1. Rigid Clear Span: Solid-member, structural-framing system without interior columns.
- C. End-Wall Framing: Manufacturer's standard, for buildings not required to be expandable, consisting of load-bearing end-wall and corner columns and rafters.

- D. Secondary-Frame Type: Manufacturer's standard purlins and joists and exterior-framed (bypass) girts.
- E. Eave Height: as indicated by nominal height on Drawings.
- F. Bay Spacing: As indicated on Drawings.
- G. Roof Slope: 2 inches per 12 inches.
- H. Roof System: Manufacturer's standard standing-seam, trapezoidal-rib, metal roof panels.
- I. Exterior Wall System: Manufacturer's standard exposed-fastener, corrugated, metal wall panels.
 - 1. Liner Panels: Match exterior wall panels.

2.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer to design metal building system, using performance requirements and design criteria indicated.
- B. Engineer, design, fabricate and erect the pre-engineered metal building system to withstand loads from winds, gravity, structural movement including movement thermally induced, and to resist in-service use conditions that the building will experience, including exposure to the weather without failure.
- C. Structural Performance: Metal building systems shall withstand the stresses within limits and under conditions indicated according to procedures in MBMA's "Metal Building Systems Manual."
- D. Design Loads: Basic design loads are as follows; auxiliary and collateral loads are indicated on the drawings.
 - 1. Structural Shapes: Flanges 50 KSI minimum yield.
 - 2. Structural shapes: Webs 50 KSI minimum yield.
 - 3. Structural shapes: Pipe Columns 42 KSI minimum yield.
 - 4. Light gauge members: Flanges 50KSI minimum yield.
- E. Structural Framing and Roof and Siding Panels: Design primary and secondary structural members and exterior covering materials for applicable secondary structural members and exterior covering materials for applicable loads and combinations of loads in accordance with the MBMA's "Metal Building Systems Manual."
 - 1. Collateral loads: As indicated on Drawings.
- F. 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: 120 deg F, ambient; 180 deg F, material surfaces.
- G. Structural Performance for Metal Roof and Wall Panels: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E 1592:
1. Wind Loads: As indicated on Drawings and determined by ASCE 7-05.
- H. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.
1. Uplift Rating: UL 90.

2.4 STRUCTURAL-STEEL FRAMING

- A. Structural Steel: Comply with AISC 360, "Specification for Structural Steel Buildings."
- B. Bolted Connections: Comply with RCSC's "Specification for Structural Joints Using High-Strength Bolts."
- C. Cold-Formed Steel: Comply with AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members" for design requirements and allowable stresses.
- D. Primary Framing: Manufacturer's standard primary-framing system, designed to withstand required loads and specified requirements. Primary framing includes transverse and lean-to frames; rafters, rake, and hangar door frames; sidewall, intermediate, end-wall, and corner columns; and wind bracing.
1. General: Provide frames with attachment plates, bearing plates, and splice members. Factory drill for field-bolted assembly. Provide frame span and spacing indicated. Slight variations in length of span and frame spacing may be acceptable if necessary to meet manufacturer's standard.
 2. Rigid Clear-Span Frames: I-shaped frame sections fabricated from shop-welded, built-up steel plates or structural-steel shapes. Interior columns are not permitted.
- E. End-Wall Framing: Manufacturer's standard primary end-wall framing fabricated for field-bolted assembly to comply with the following:
1. End-Wall and Corner Columns: I-shaped sections fabricated from structural-steel shapes; shop-welded, built-up steel plates; or C-shaped, cold-formed, structural-steel sheet.
 2. End-Wall Beams: C-shaped, cold-formed, structural-steel sheet; or I-shaped sections fabricated from shop-welded, built-up steel plates or structural-steel shapes.
- F. Secondary Framing: Manufacturer's standard secondary framing, including purlins, girts, eave struts, flange bracing, base members, gable angles, clips, headers, jambs, and other miscellaneous structural members. Unless otherwise indicated, fabricate framing from either cold-formed, structural-steel sheet or roll-formed, metallic-coated steel sheet, prepainted with coil coating, to comply with the following:
1. Purlins: C- or Z-shaped sections; fabricated from built-up steel plates, steel sheet, or structural-steel shapes; minimum 2-1/2-inch-wide flanges.

2. Girts: C- or Z-shaped sections; fabricated from built-up steel plates, steel sheet, or structural-steel shapes. Form ends of Z-sections with stiffening lips angled 40 to 50 degrees from flange, with minimum 2-1/2-inch-wide flanges.
3. Eave Struts: Unequal-flange, C-shaped sections; fabricated from built-up steel plates, steel sheet, or structural-steel shapes; to provide adequate backup for metal panels.
4. Flange Bracing: Minimum 2-by-2-by-1/8-inch structural-steel angles or 1-inch-diameter, cold-formed structural tubing to stiffen primary-frame flanges.
5. Sag Bracing: Minimum 1-by-1-by-1/8-inch structural-steel angles.
6. Base or Sill Angles: Manufacturer's standard base angle, minimum 3-by-2-inch, fabricated from zinc-coated (galvanized) steel sheet.
7. Purlin and Girt Clips: Manufacturer's standard clips fabricated from steel sheet. Provide galvanized clips where clips are connected to galvanized framing members.
8. Framing for Openings: Channel shapes; fabricated from cold-formed, structural-steel sheet or structural-steel shapes. Frame head and jamb of door openings and head, jamb, and sill of other openings.
9. Miscellaneous Structural Members: Manufacturer's standard sections fabricated from cold-formed, structural-steel sheet; built-up steel plates; or zinc-coated (galvanized) steel sheet; designed to withstand required loads.

G. Bracing: Provide adjustable wind bracing as follows:

1. Rods: ASTM A 36/A 36M; ASTM A 572/A 572M, Grade 50; or ASTM A 529/A 529M, Grade 50; minimum 1/2-inch-diameter steel; threaded full length or threaded a minimum of 6 inches at each end.

H. Anchor Rods: Headed anchor rods as indicated in Anchor Rod Plan for attachment of metal building to foundation.

I. Materials:

1. W-Shapes: ASTM A 992/A 992M; ASTM A 572/A 572M, Grade 50 or 55; or ASTM A 529/A 529M, Grade 50 or 55.
2. Channels, Angles, M-Shapes, and S-Shapes: ASTM A 36/A 36M; ASTM A 572/A 572M, Grade 50 or 55; or ASTM A 529/A 529M, Grade 50 or 55.
3. Plate and Bar: ASTM A 36/A 36M; ASTM A 572/A 572M, Grade 50 or 55; or ASTM A 529/A 529M, Grade 50 or 55.
4. Structural-Steel Sheet: Hot-rolled, ASTM A 1011/A 1011M, Structural Steel (SS), Grades 30 through 55, or High-Strength Low-Alloy Steel (HSLAS) or High-Strength Low-Alloy Steel with Improved Formability (HSLAS-F), Grades 45 through 70; or cold-rolled, ASTM A 1008/A 1008M, Structural Steel (SS), Grades 25 through 80, or HSLAS, Grades 45 through 70.
5. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, SS, Grades 33 through 80, or HSLAS or HSLAS-F, Grades 50 through 80; with G60 coating designation; mill phosphatized.
6. Structural 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.
7. High-Strength Bolts, Nuts, and Washers: ASTM A 490, Type 1, heavy-hex steel structural bolts; ASTM A 563 heavy-hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers, plain.

- J. Finish: Factory primed. Apply specified primer immediately after cleaning and pretreating.
 - 1. Clean and prepare in accordance with SSPC-SP2.
 - 2. Coat with manufacturer's standard primer. Apply primer to primary and secondary framing to a minimum dry film thickness of 1 mil.
 - a. Prime secondary framing formed from uncoated steel sheet to a minimum dry film thickness of 0.5 mil on each side.

2.5 METAL ROOF PANELS

- A. Basis of Design: Manufacturers' names and products are given to clarify the designer's intent and are not intended to limit selection of similar products from acceptable manufacturers. Provide basis of design product, or comparable product by one of the following:
 - 1. Centria; SRS 2 Structural Standing Seam Roof
 - 2. Berridge; Zee-Lock
 - 3. Una-Clad, Firestone; UC-6
 - 4. MCElroy Metal; Maxima
- B. Structural Standing-Seam Metal Roof Panels: Formed with vertical ribs at panel edges and intermediate stiffening ribs symmetrically spaced 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.
 - 1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.024-inch nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
 - a. Exterior Finish: Two-coat fluoropolymer.
 - b. Color: As selected by Architect from manufacturer's full range.
 - 2. Joint Type: Mechanically seamed.
 - 3. Panel Coverage: 16 inches.
 - 4. Panel Height: 2 inches.
- C. Finishes:
 - 1. Exposed Coil-Coated Finish:
 - a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - 1) Basis of Design: Centria Duraguard.
 - 2. 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.

2.6 METAL WALL PANELS

- A. Exposed-Fastener, Corrugated, Metal Wall Panels: Formed with raised, corrugated ribs; designed to be installed by lapping side edges of adjacent panels and mechanically attaching panels to supports using exposed fasteners in side laps.
1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.030-inch nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
 - a. Exterior Finish: Two-coat fluoropolymer.
 - b. Color: As selected by Architect from manufacturer's full range.
 2. Major-Rib Spacing: 6 inches o.c.
 3. Panel Coverage: 36 inches.
 4. Panel Height: 1.5 inches.
- B. Finishes:
1. Exposed Coil-Coated Finish:
 - a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 2. 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.

2.7 THERMAL INSULATION

- A. Unfaced Metal Building Insulation: ASTM C 991, Type I, or NAIMA 202, glass-fiber-blanket insulation; 0.5-lb/cu. ft. density; 2-inch-wide, continuous, vapor-tight edge tabs; with a flame-spread index of 25 or less.
- B. Retainer Strips: For securing insulation between supports, 0.025-inch nominal-thickness, formed, metallic-coated steel or PVC retainer clips colored to match insulation facing.
- C. Vapor-Retarder Facing: ASTM C 1136, with permeance not greater than 0.02 perm when tested according to ASTM E 96/E 96M, Desiccant Method.
1. Composition: White polypropylene film facing, fiberglass scrim reinforcement, and metallized-polyester film backing.
- D. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.

2.8 STRUCTURED-POLYCARBONATE-PANEL ASSEMBLIES

- A. Structured Polycarbonate Panels: As specific in Section 084513 “Structured-Polycarbonate-Panel Assemblies.

2.9 ACCESSORIES

- A. General: Provide accessories as standard with metal building system manufacturer and as specified. Fabricate and finish accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes. Comply with indicated profiles and with dimensional and structural requirements.
 - 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.
- B. Roof Panel Accessories: Provide components required for a complete metal roof panel assembly including copings, fasciae, corner units, ridge closures, clips, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal roof panels unless otherwise indicated.
 - 1. Closures: Provide closures at eaves and ridges, fabricated of same material as metal roof panels.
 - 2. Clips: Manufacturer's standard, formed from stainless-steel sheet, designed to withstand negative-load requirements.
 - 3. Cleats: Manufacturer's standard, mechanically seamed cleats formed from stainless-steel sheet or nylon-coated aluminum sheet.
 - 4. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
 - 5. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch-thick, flexible closure strips; cut or premolded to match metal roof panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
 - 6. Thermal Spacer Blocks: Where metal panels attach directly to purlins, provide thermal spacer blocks of thickness required to provide 1-inch standoff; fabricated from extruded polystyrene.
- C. Wall Panel Accessories: Provide components required for a complete metal wall panel assembly including copings, fasciae, mullions, sills, corner units, clips, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal wall panels unless otherwise indicated.
 - 1. Closures: Provide closures at eaves and rakes, fabricated of same material as metal wall panels.
 - 2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
 - 3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch-thick, flexible closure strips; cut or premolded to match metal wall panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

- D. Flashing and Trim: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.018-inch nominal uncoated steel thickness, prepainted with coil coating; finished to match adjacent metal panels.
1. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers.
 2. Opening Trim: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.030-inch nominal uncoated steel thickness, prepainted with coil coating. Trim head and jamb of door openings, and head, jamb, and sill of other openings.
- E. Gutters: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.018-inch nominal uncoated steel thickness, prepainted with coil coating; finished to match roof fascia and rake trim. Match profile of gable trim, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum 96-inch-long sections, sized according to SMACNA's "Architectural Sheet Metal Manual."
1. Gutter Supports: Fabricated from same material and finish as gutters.
 2. Strainers: Bronze, copper, or aluminum wire ball type at outlets.
- F. Downspouts: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.018-inch nominal uncoated steel thickness, prepainted with coil coating; finished to match metal wall panels. Fabricate in minimum 10-foot-long sections, complete with formed elbows and offsets.
1. Mounting Straps: Fabricated from same material and finish as gutters.
- G. Louvers: Size and design indicated; self-framing and self-flashing. Fabricate welded frames from zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.048-inch nominal uncoated steel thickness; finished to match metal wall panels. Form blades from zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.036-inch nominal uncoated steel thickness; folded or beaded at edges, set at an angle that excludes driving rains, and secured to frames by riveting or welding. Fabricate louvers with equal blade spacing to produce uniform appearance.
- H. Pipe Flashing: Premolded, EPDM pipe collar with flexible aluminum ring bonded to base.
- I. Materials:
1. Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Provide fasteners with heads matching color of materials being fastened by means of plastic caps or factory-applied coating.
 - a. Fasteners for Metal Roof Panels: Self-drilling, Type 410 stainless steel or self-tapping, Type 304 stainless-steel or zinc-alloy-steel hex washer head, with EPDM washer under heads of fasteners bearing on weather side of metal panels.
 - b. Fasteners for Metal Wall Panels: Self-drilling, Type 410 stainless steel or self-tapping, Type 304 stainless-steel or zinc-alloy-steel hex washer head, with EPDM sealing washers bearing on weather side of metal panels. Provide fasteners with heads matching color of panels.
 - c. Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws with hex washer head.

- d. Blind Fasteners: High-strength aluminum or stainless-steel rivets.
- 2. Corrosion-Resistant Coating: Cold-applied asphalt mastic, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.
- 3. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107/C 1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.
- 4. Metal Panel Sealants:
 - a. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene-compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape of manufacturer's standard size.
 - b. Joint Sealant: ASTM C 920; one part elastomeric polyurethane or polysulfide; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended by metal building system manufacturer.

2.10 FABRICATION

- A. General: Design components and field connections required for erection to permit easy assembly.
 - 1. Mark each piece and part of the assembly to correspond with previously prepared erection drawings, diagrams, and instruction manuals.
 - 2. Fabricate structural framing to produce clean, smooth cuts and bends. Punch holes of proper size, shape, and location. Members shall be free of cracks, tears, and ruptures.
- B. Tolerances: Comply with MBMA's "Metal Building Systems Manual" for fabrication and erection tolerances.
- C. Primary Framing: Shop fabricate framing components to indicated size and section, with baseplates, bearing plates, stiffeners, and other items required for erection welded into place. Cut, form, punch, drill, and weld framing for bolted field assembly.
 - 1. Make shop connections by welding or by using high-strength bolts.
 - 2. Join flanges to webs of built-up members by a continuous, submerged arc-welding process.
 - 3. Brace compression flange of primary framing with steel angles or cold-formed structural tubing between frame web and purlin web or girt web, so flange compressive strength is within allowable limits for any combination of loadings.
 - 4. Weld clips to frames for attaching secondary framing if applicable, or punch for bolts.
 - 5. Shop Priming: Prepare surfaces for shop priming according to SSPC-SP 2. Shop prime primary framing with specified primer after fabrication.
- D. Secondary Framing: Shop fabricate framing components to indicated size and section by roll forming or break forming, with baseplates, bearing plates, stiffeners, and other plates required for erection welded into place. Cut, form, punch, drill, and weld secondary framing for bolted field connections to primary framing.
 - 1. Make shop connections by welding or by using non-high-strength bolts.

2. Shop Priming: Prepare uncoated surfaces for shop priming according to SSPC-SP 2. Shop prime uncoated secondary framing with specified primer after fabrication.
- E. Metal Panels: Fabricate and finish metal panels at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements. Comply with indicated profiles and with dimensional and structural requirements.
1. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of metal panel.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with erector present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Before erection proceeds, survey elevations and locations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments to receive structural framing, with erector present, for compliance with requirements and metal building system manufacturer's tolerances.
 1. Engage land surveyor to perform surveying.
- C. Proceed with erection only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition.
- B. Provide temporary shores, guys, braces, and other supports during erection to keep structural framing secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural framing, connections, and bracing are in place unless otherwise indicated.

3.3 ERECTION OF STRUCTURAL FRAMING

- A. Erect metal building system according to manufacturer's written instructions and drawings.
- B. Do not field cut, drill, or alter structural members without written approval from metal building system manufacturer's professional engineer.
- C. Set structural framing accurately in locations and to elevations indicated, according to AISC specifications referenced in this Section. Maintain structural stability of frame during erection.
- D. Base and Bearing Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.

1. Set plates for structural members on wedges, shims, or setting nuts as required.
 2. 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 plate before packing with grout.
 3. Promptly pack grout solidly between bearing surfaces and 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.
- E. Align and adjust structural framing before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with framing. 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 will be completed and in service.
- F. Primary Framing and End Walls: Erect framing level, plumb, rigid, secure, and true to line. Level baseplates to a true even plane with full bearing to supporting structures, set with double-nutted anchor bolts. Use grout to obtain uniform bearing and to maintain a level base-line elevation. Moist-cure grout for not less than seven days after placement.
1. Make field connections using high-strength bolts installed according to RCSC's "Specification for Structural Joints Using High-Strength Bolts" for bolt type and joint type specified.
 - a. Joint Type: Snug tightened or pretensioned as required by manufacturer.
- G. Secondary Framing: Erect framing level, plumb, rigid, secure, and true to line. Field bolt secondary framing to clips attached to primary framing.
1. Provide rake or gable purlins with tight-fitting closure channels and fasciae.
 2. Locate and space wall girts to suit openings such as doors and windows.
 3. Provide supplemental framing at entire perimeter of openings, including doors, windows, louvers, ventilators, and other penetrations of roof and walls.
- H. Bracing: Install bracing in roof and sidewalls where indicated on erection drawings.
1. Tighten rod and cable bracing to avoid sag.
 2. Locate interior end-bay bracing only where indicated.
- I. Framing for Openings: Provide shapes of proper design and size to reinforce openings and to carry loads and vibrations imposed, including equipment furnished under mechanical and electrical work. Securely attach to structural framing.
- J. Erection Tolerances: Maintain erection tolerances of structural framing within AISC 303.

3.4 METAL PANEL INSTALLATION, GENERAL

- A. Fabricate and finish metal panels and accessories at the factory, 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. On-Site Fabrication: Subject to compliance with requirements of this Section, metal panels may be fabricated on-site using UL-certified, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate according to equipment manufacturer's written instructions and to comply with details shown.
- C. Examination: Examine primary and secondary framing to verify that structural-panel support members and anchorages have been installed within alignment tolerances required by manufacturer.
 - 1. Examine roughing-in for components and systems penetrating metal panels, to verify actual locations of penetrations relative to seams before metal panel installation.
- D. General: Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.
 - 1. Field cut metal panels as required for doors, windows, and other openings. Cut openings as small as possible, neatly to size required, and without damage to adjacent metal panel finishes.
 - a. Field cutting of metal panels by torch is not permitted unless approved in writing by manufacturer.
 - 2. Install metal panels perpendicular to structural supports unless otherwise indicated.
 - 3. Flash and seal metal panels with weather closures at perimeter of openings and similar elements. Fasten with self-tapping screws.
 - 4. Locate and space fastenings in uniform vertical and horizontal alignment.
 - 5. Locate metal panel splices over structural supports with end laps in alignment.
 - 6. Lap metal flashing over metal panels to allow moisture to run over and off the material.
- E. Lap-Seam Metal Panels: Install screw fasteners using power tools with controlled torque adjusted to compress EPDM washers tightly without damage to washers, screw threads, or metal panels. Install screws in predrilled holes.
 - 1. Arrange and nest side-lap joints so prevailing winds blow over, not into, lapped joints. Lap ribbed or fluted sheets one full rib corrugation. Apply metal panels and associated items for neat and weathertight enclosure. Avoid "panel creep" or application not true to line.
- F. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with corrosion-resistant coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by metal roof panel manufacturer.
- G. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of metal panel assemblies. Provide types of gaskets, fillers, and sealants indicated; or, if not indicated, provide types recommended by metal panel manufacturer.

1. Seal metal panel end laps with double beads of tape or sealant the full width of panel. Seal side joints where recommended by metal panel manufacturer.
2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."

3.5 METAL ROOF PANEL INSTALLATION

- A. General: Provide metal roof panels of full length from eave to ridge unless otherwise indicated or restricted by shipping limitations.
 1. Install ridge caps as metal roof panel work proceeds.
 2. Flash and seal metal roof panels with weather closures at eaves and rakes. Fasten with self-tapping screws.
- B. Standing-Seam Metal Roof Panels: Fasten metal roof panels to supports with concealed clips at each standing-seam joint, at location and spacing and with fasteners recommended by manufacturer.
 1. Install clips to supports with self-drilling or 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 that clip, metal roof panel, and factory-applied sealant are completely engaged.
 4. Rigidly fasten eave end of metal roof panels and allow ridge end free movement for thermal expansion and contraction. Predrill panels for fasteners.
 5. Provide metal closures at peaks, rake edges and each side of ridge caps.
- C. Metal Fascia Panels: Align bottom of metal panels and fasten with blind rivets, bolts, or self-drilling or self-tapping screws. Flash and seal metal panels with weather closures where fasciae meet soffits, along lower panel edges, and at perimeter of all openings.
- D. Metal Roof Panel Installation Tolerances: Shim and align metal roof panels within installed tolerance of 1/4 inch in 20 feet on slope and location lines and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.6 METAL WALL PANEL INSTALLATION

- A. General: Install metal wall panels in orientation, sizes, and locations indicated on Drawings. Install panels perpendicular to girts, extending full height of building, unless otherwise indicated. Anchor metal wall panels and other components of the Work securely in place, with provisions for thermal and structural movement.
 1. Unless otherwise indicated, begin metal panel installation at corners with center of rib lined up with line of framing.
 2. Shim or otherwise plumb substrates receiving metal wall panels.
 3. When two rows of metal panels are required, lap panels 4 inches minimum.
 4. When building height requires two rows of metal panels at gable ends, align lap of gable panels over metal wall panels at eave height.

5. Rigidly fasten base end of metal wall panels and allow eave end free movement for thermal expansion and contraction. Predrill panels.
 6. Flash and seal metal wall panels with weather closures at eaves and rakes, and at perimeter of all openings. Fasten with self-tapping screws.
 7. Install screw fasteners in predrilled holes.
 8. Install flashing and trim as metal wall panel work proceeds.
 9. Apply elastomeric sealant continuously between metal base channel (sill angle) and concrete, and elsewhere as indicated on Drawings; if not indicated, as necessary for waterproofing.
 10. Align bottom of metal wall panels and fasten with blind rivets, bolts, or self-drilling or self-tapping screws.
 11. Provide weatherproof escutcheons for pipe and conduit penetrating exterior walls.
- B. Metal Wall Panels: Install metal wall panels on exterior side of girts. Attach metal wall panels to supports with fasteners as recommended by manufacturer.
- C. Installation Tolerances: Shim and align metal wall panels within installed tolerance of 1/4 inch in 20 feet, noncumulative; level, plumb, and on location lines; and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.7 THERMAL INSULATION INSTALLATION

- A. General: Install insulation concurrently with metal panel installation, in thickness indicated to cover entire surface, according to manufacturer's written instructions.
1. Set vapor-retarder-faced units with vapor retarder toward warm side of construction unless otherwise indicated. Do not obstruct ventilation spaces except for firestopping.
 2. Tape joints and ruptures in vapor retarder, and seal each continuous area of insulation to the surrounding construction to ensure airtight installation.
 3. Install factory-laminated, vapor-retarder-faced blankets straight and true in one-piece lengths, with both sets of facing tabs sealed, to provide a complete vapor retarder.
 4. Install blankets straight and true in one-piece lengths. Install vapor retarder over insulation, with both sets of facing tabs sealed, to provide a complete vapor retarder.
- B. Blanket Roof Insulation: Comply with the following installation method:
1. Over-Purlin-with-Spacer-Block Installation: Extend insulation and vapor retarder over and perpendicular to top flange of secondary framing. Install layer of filler insulation over first layer to fill space formed by metal roof panel standoffs. Hold in place by panels fastened to standoffs.
 - a. Thermal Spacer Blocks: Where metal roof panels attach directly to purlins, install thermal spacer blocks.
 2. Two-Layers-between-Purlin-with-Spacer-Block Installation: Extend insulation and vapor retarder between purlins. Carry vapor-retarder-facing tabs up and over purlin, overlapping adjoining facing of next insulation course and maintaining continuity of retarder. Install layer of filler insulation over first layer to fill space between purlins formed by thermal spacer blocks. Hold in place with bands and crossbands below insulation.

- a. Thermal Spacer Blocks: Where metal roof panels attach directly to purlins, install thermal spacer blocks.
3. Retainer Strips: Install retainer strips at each longitudinal insulation joint, straight and taut, nesting with secondary framing to hold insulation in place.
- C. Blanket Wall Insulation: Extend insulation and vapor retarder over and perpendicular to top flange of secondary framing. Hold in place by metal wall panels fastened to secondary framing.
 1. Retainer Strips: Install retainer strips at each longitudinal insulation joint, straight and taut, nesting with secondary framing to hold insulation in place.

3.8 DOOR AND FRAME INSTALLATION

- A. General: Install doors and frames plumb, rigid, properly aligned, and securely fastened in place according to manufacturers' written instructions. Coordinate installation with wall flashings and other components. Seal perimeter of each door frame with elastomeric sealant used for metal wall panels.

3.9 WINDOW INSTALLATION

- A. General: Install windows plumb, rigid, properly aligned, without warp or rack of frames or sash, and securely fasten in place according to manufacturer's written instructions. Coordinate installation with wall flashings and other components. Seal perimeter of each window frame with elastomeric sealant used for metal wall panels.
 1. Separate dissimilar materials from sources of corrosion or electrolytic action at points of contact with other materials by complying with requirements specified in AAMA/WDMA/CSA 101/I.S.2/A440.

3.10 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 roof panel assembly, including trim, copings, ridge closures, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
 2. Install components for a complete metal wall panel assembly, including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
 3. Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with corrosion-resistant coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by manufacturer.
- 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. 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).
- C. Gutters: Join sections with riveted-and-soldered or lapped-and-sealed joints. Attach gutters to eave with gutter hangers spaced as required for gutter size, but not more than 36 inches o.c. using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.
- D. Downspouts: Join sections with 1-1/2-inch telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch away from walls; locate fasteners at top and bottom and at approximately 60 inches o.c. in between.
1. Tie downspouts to underground drainage system indicated.
- E. Louvers: Locate and place louver units level, plumb, and at indicated alignment with adjacent work.
1. 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.
 2. Provide perimeter reveals and openings of uniform width for sealants and joint fillers.
 3. Protect galvanized- and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of corrosion-resistant paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.
 4. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Section 079200 "Joint Sealants" for sealants applied during louver installation.
- F. Roof Curbs: Install curbs at locations indicated on Drawings. Install flashing around bases where they meet metal roof panels.
- G. Pipe Flashing: Form flashing around pipe penetration and metal roof panels. Fasten and seal to panel as recommended by manufacturer.

3.11 CLEANING AND PROTECTION

- A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A 780/A 780M and manufacturer's written instructions.

- B. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.
- C. Touchup Painting: After erection, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted structural framing and accessories.
- D. Metal Panels: Remove temporary protective coverings and strippable films, if any, as metal panels are installed. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.
 - 1. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 133419

**SECTION 22 00 00
PLUMBING INDEX**

SECTION 22 05 00 - GENERAL PLUMBING REQUIREMENTS
SECTION 22 05 03 - PIPE AND PIPE FITTINGS
SECTION 22 05 13 - MOTORS AND ELECTRICAL WORK
SECTION 22 05 23 - VALVES
SECTION 22 05 29 - SUPPORTS AND ANCHORS
SECTION 22 07 00 - PLUMBING INSULATION
SECTION 22 10 00 - PIPING SPECIALTIES
SECTION 22 10 01 - PLUMBING SPECIALTIES
SECTION 22 30 00 - PLUMBING EQUIPMENT
SECTION 22 40 00 - PLUMBING FIXTURES

SECTION 22 05 00
BASIC PLUMBING REQUIREMENTS

PART 1 - GENERAL

1.01 GENERAL

- A. Applicable provisions of Division 00 govern work under this section.

1.02 SCOPE

- A. This section includes information common to two or more technical plumbing specification sections or items that are of a general nature, not conveniently fitting into other technical sections.

1.03 STANDARDS

- A. Abbreviations of standards organizations referenced in this and other sections are as follows:

ABMA	American Boiler Manufacturers Association
ACPA	American Concrete Pipe Association
AGA	American Gas Association
AMCA	Air Movement and Control Association
ANSI	American National Standards Institute
ARI	Air Conditioning and Refrigeration Institute
ASME	American Society of Mechanical Engineers
ASPE	American Society of Plumbing Engineers
ASSE	American Society of Sanitary Engineering
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
AWS	American Welding Society
CISPI	Cast Iron Soil Pipe Institute
CGA	Compressed Gas Association
CS	Commercial Standards, Products Standards Sections, Office of Eng. Standards Service, NBS
EPA	Environmental Protection Agency
FS	Federal Specifications, Superintendent of Documents, U.S. Government Printing Office
GAMA	Gas Appliance Manufacturers Association
IAPMO	International Association of Plumbing & Mechanical Officials
IEEE	Institute of Electrical and Electronics Engineers
ISA	Instrument Society of America
MCA	Mechanical Contractors Association
MICA	Midwest Insulation Contractors Association
MSS	Manufacturer's Standardization Society of the Valve & Fitting Industry, Inc.
NBS	National Bureau of Standards
NEC	National Electric Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NSF	National Sanitation Foundation
PDI	Plumbing and Drainage Institute
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association. Inc.

STI Steel Tank Institute
UL Underwriters Laboratories Inc.

1.04 QUALITY ASSURANCE

- A. Refer to Division 00, General Conditions, Equals and Substitutions.
- B. All products and materials used are to be new, undamaged, clean and in good condition. Existing products and materials are not to be reused unless specifically indicated.
- C. Where equipment or accessories are used which differ in arrangement, configuration, dimensions, ratings, or engineering parameters from those indicated on the contract documents, the contractor is responsible for all costs involved in integrating the equipment or accessories into the system and for obtaining the intended performance from the system into which these items are placed.

1.05 CONTINUITY OF EXISTING SERVICES

- A. Do not interrupt or change existing services without prior written approval from the Owner's Project Representative. When interruption is required, coordinate scheduling of down-time with the Owner to minimize disruption to his activities. Unless specifically stated, all work involved in interrupting or changing existing services is to be done during normal working hours.

1.06 PROTECTION OF FINISHED SURFACES

- A. Refer to Division 01, General Requirements, Protection of Finished Surfaces.

1.07 SLEEVES AND OPENINGS

- A. Refer to Division 01, General Requirements, Sleeves and Openings.

1.08 SEALING AND FIRESTOPPING

- A. Sealing and firestopping of sleeves/openings between piping, etc. and the sleeve or structural opening shall be the responsibility of the contractor whose work penetrates the opening. The contractor responsible shall hire individuals skilled in such work to do the sealing and fireproofing. These individuals hired shall normally and routinely be employed in the sealing and fireproofing occupation.

1.09 EQUIPMENT FURNISHED BY OTHERS

1.10 PROVISIONS OF FUTURE

1.11 OFF SITE STORAGE

- A. Prior approval by the A/E will be needed. The contractor shall submit Storage Agreement Form for consideration of off site materials storage. Generally, sleeves, pipe/pipe fittings and similar rough-in material will not be accepted for off site storage. No material will be accepted for off site storage unless shop drawings for the material have been approved.

1.12 CODES

- A. Comply with requirements of State Codes, including local and health department codes.

1.13 CERTIFICATES AND INSPECTIONS

- A. Refer also to Division 00, General Conditions, Permits, Regulations, Utilities and Taxes.
- B. Obtain and pay for all required State installation inspections except those provided by the Architect/Engineer in accordance with State and Local authorities. Deliver originals of these certificates to the Owner's Project Representative. Include copies of the certificates in the Operating and Maintenance Instructions.

1.14 SUBMITTALS

- A. Refer to Division 01, General Conditions, Submittals.
- B. Not more than two weeks after award of contract but before any shop drawings are submitted, contractor to submit the following plumbing system data sheet. List piping material type for each piping service on the project, ASTM number, schedule or pressure class, joint type, manufacturer and model number where appropriate. List valves and specialties for each piping service, fixture and equipment with manufacturer and model number. The approved plumbing system data sheet(s) will be made available at the job site for their use on this project.

Plumbing System Data Sheet

<u>Item</u>	<u>Pipe Service/Sizes</u>	<u>Manufacturer/Model No.</u>	<u>Remarks</u>
Pipe			
Fittings			
Unions			
Valves:			
Ball			
Butterfly			
Balancing			
Check			
Gate			
Curb Stop			
Other			
Pipe Specialties:			
Thermometers			
Pres Gauges			
Strainers			
Building Penetrations			
Hangers & Supports			
Insulation			
Plbg. Specialties:			
Floor/Roof Drains			
Cleanouts			
Water Hammer Arrestors			
Backflow Preventers			
Wall/Yard Hydrants			
Hose Bibbs			
Trap Primers			
Hydrants			
Valve Boxes			
Manhole Castings			

Wash Machine Boxes
Plbg. Fixtures
Plbg. Equipment

- C. Shop drawing submittals are to be bound, labeled, contain the project manual cover page and a material index list page showing item designation, manufacturer and additional items supplied with the installation. Submit for all equipment and systems as indicated in the respective specification sections, marking each submittal with that specification section number. Mark general catalog sheets and drawings to indicate specific items being submitted and proper identification of equipment by name and/or number, as indicated in the contract documents. Include wiring diagrams of electrically powered equipment.
- D. Submit sufficient quantities of data sheets and shop drawings to allow the following distribution:
 - 1. Operating and Maintenance Manuals 2 copies
 - 2. Architect 1 copy
 - 3. Engineer 1 copy

1.15 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. Refer to Division 01, General Requirements, Operating and Maintenance Instructions.
- B. Assemble material in three-ring or post binders, using an index at the front of each volume and tabs for each system or type of equipment. In addition to the data indicated in the General Requirements, include the following information:
 - 1. Copies of all approved shop drawings.
 - 2. Manufacturer's wiring diagrams for electrically powered equipment
 - 3. Records of tests performed to certify compliance with system requirements
 - 4. Certificates of inspection by regulatory agencies
 - 5. Parts lists for fixtures, equipment, valves and specialties.
 - 6. Manufacturer's installation, operation and maintenance recommendations for fixtures, equipment, valves and specialties.
 - 7. Valve schedules
 - 8. Lubrication instructions, including list/frequency of lubrication
 - 9. Warranties
 - 10. Additional information as indicated in the technical specification sections

1.16 TRAINING OF OWNER PERSONNEL

- A. Instruct user agency personnel in the proper operation and maintenance of systems and equipment provided as part of this project. Include not less than ____ hours of instruction, using the Operating and Maintenance manuals during this instruction. Demonstrate startup, operation and shutdown procedures for all equipment. All training to be during normal working hours. Videotape all instructions and provide Owner with copy.

1.17 RECORD DRAWINGS

- A. Refer to Division 01, General Requirements, Record Drawings.

PART 2 - PRODUCTS

2.01 ACCESS PANELS AND DOORS

- A. Lay-In Ceilings: Removable lay-in ceiling tiles in 2 x 2 foot or 2 x 4 foot configuration provided under Section 09500 are sufficient; no additional access provisions are required unless specifically indicated.
- B. Concealed Spline Ceilings: Removable sections of ceiling tile held in position with metal slats or tabs compatible with the ceiling system used will be provided under Section 09500.
- C. Metal Pan Ceilings: Removable sections of ceiling tile held in position by a pressure fit will be provided under Section 09500.
- D. Plaster Walls and Ceilings: 16 gauge frame with not less than a 20 gauge hinged door panel, prime coated steel for general applications, stainless steel for use in toilets, showers, and similar wet areas, concealed hinges, screwdriver operated cam latch for general applications, key lock for use in public or secured areas, UL listed for use in fire rated partitions if required by the application. Use the largest size access opening possible, consistent with the space and the item needing service; minimum size is 12" by 12".

2.02 IDENTIFICATION

- A. Stencils: Not less than 1-inch high letters/numbers for marking pipe and equipment.
- B. Engraved Name Plates: White letters on a black background, 1/16-inch thick plastic laminate, beveled edges, screw mounting, Setonply Style 2060 by Seton Name Plate Company or Emedolite Style EIP by EMED Co., or equal by W. H. Brady.
- C. Snap-Around Pipe Markers: One-piece, preformed, vinyl construction, snap-around or strap-around pipe markers with applicable labeling and flow direction arrows, 3/4" min. size for lettering. Provide nylon ties on each end of pipe markers equal to Seton Setmark.
- D. Valve Tags: Round brass tags with 1/2-inch numbers, 1/4-inch system identification abbreviation, 1 1/4-inch minimum diameter, with brass jack chains, brass "S" hooks or one piece nylon ties around the valve stem, available from EMED Co., Seton Name Plate Company, or W. H. Brady.
- E. Underground Warning Tape: Detectable underground warning tape, 5.0 mil overall thickness, 6" width, .0035" thick aluminum foil core with polyethylene jacket bonded to both sides. Color code tape and print caution along with name of buried service in bold letters on face of tape. Thor Enterprises Magnatec or equal by Carlton, MSI Marking Services, Seton.

2.03 BEDDING AND BACKFILL

- A. Bedding up to a point 12"-inches above the top of the pipe shall be thoroughly compacted sand or crushed stone chips meeting the following gradations:

<u>Gradation for Bedding Sand</u>		<u>Gradation for Crushed Stone Chip Bedding</u>	
<u>Sieve Size</u>	<u>% Passing (by Wt)</u>	<u>Sieve Size</u>	<u>% Passing (by Wt)</u>
1-inch	100	1/2-inch	100
No. 16	45 - 80	No. 4	75 - 100

- B. Backfill above the bedding in lawn areas shall be thoroughly compacted excavated material free of large stones, organic, perishable, and frozen materials.
- C. Backfill above the bedding under existing and future utilities, paving, sidewalks, curbs, roads and buildings shall be granular materials, pit run sand, gravel, or crushed stone, free from large stones, organic, perishable, and frozen materials.

2.04 SEALING AND FIRESTOPPING

A. Fire and/or Smoke Rated Penetrations:

- 1. Manufacturers:
 - a. 3M
 - b. Hilti
 - c. Rectorseal
 - d. STI/SpecSeal
 - e. Tremco, or approved equal.
- 2. All firestopping systems shall be provided by the same manufacturer.
- 3. Fire stop systems shall be UL listed or tested by an independent testing laboratory approved by the Department of Commerce.
- 4. Submittals: Contractor shall submit product data for each firestop system. Submittals shall include product characteristics, performance and limitation criteria, test data, MSDS sheets, installation details and procedures for each method of installation applicable to this project. For non-standard conditions where no UL tested system exists, submit manufacturer's drawings for UL system with known performance for which an engineering judgment can be based upon.
- 5. Use a product that has a rating not less than the rating of the wall or floor being penetrated. Reference architectural drawings for identification of fire and/or smoke rated walls and floors.
- 6. Use firestop putty, caulk sealant, intumescent wrapstrips, intumescent firestop collars, firestop blocks, firestop mortar or a combination of these products to provide a UL listed system for each application required for this project. Provide mineral wool backing where specified in manufacturer's application detail.

B. Non-Rated Penetrations:

- 1. In exterior wall openings below grade, use a modular mechanical type seal consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the uninsulated pipe and the cored opening or a water-stop type wall sleeve. The operating bolts of the mechanical type seal shall be accessible from the interior of the building.
- 2. At pipe penetrations of interior partitions, floors and exterior walls, use urethane caulk in annular space between pipe insulation and sleeve.

PART 3 - EXECUTION

3.01 DEMOLITION

- A. Perform all demolition as indicated on the drawings to accomplish new work. Where demolition work is to be performed adjacent to existing work that remains in an occupied area, construct temporary dust partition to minimize the amount of contamination of the occupied space. Where pipe is removed and not reconnected with new work, cap ends of

existing services as if they were new work. Coordinate work with the Owner to minimize disruption to the existing building occupants.

- B. All pipe, fixtures, equipment, wiring and associated conduit, insulation and similar items demolished, abandoned, or deactivated are to be removed from the site by the Contractor except as specifically noted otherwise. All designated equipment is to be turned over to the user agency for their use at a place and time so designated. Maintain the condition of material and/or equipment that is indicated to be reused equal to that existing before work began.

3.02 EXCAVATION AND BACKFILL

- A. Perform all excavation and backfill work necessary to accomplish indicated plumbing systems installation. Excavate to bottom of pipe and structure bedding, 4" in stable soils, 6" in rock or wet trenches and 8" in unstable soil. Finish bottoms of excavations to true, level surface.
- B. Tunnel or remove sidewalk and curb in areas of excavation to the nearest joint. Remove pavements, curbs and gutters to neat and straight lines to the limits of removal. Make sawcut lines parallel to existing joints, or parallel or perpendicular to pavement edges to form a neat patch. Carefully remove remaining pavement within the sawcut area. Leave existing base materials between the area disturbed by the work and the sawcut line undisturbed by the sawcutting, pavement removal, or pavement replacement processes.
- C. Strip topsoil from area to be excavated, free from subsoil and debris, and store for later respreading.
- D. At no time place excavated materials where they will impede surface drainage unless such drainage is being safely rerouted away from the excavation.
- E. Excavate whatever materials are encountered as required to place at the elevations shown, all pipe, manholes, and other work. Remove debris and rubbish from excavations before placing bedding and backfill material.
- F. Remove surplus excavated materials from site.
- G. Verify the locations of any water, drainage, gas, sewer, electric, telephone or steam lines which may be encountered in the excavation. Underpin and support all lines. Cut off service connections encountered which are to be removed at the limits of the excavation and cap.
- H. Provide and maintain all fencing, barricades, signs, warning lights, and/or other equipment necessary to keep all excavation pits and trenches and the entire subgrade area safe under all circumstances and at all times. No excavation shall be left unattended without adequate protection.
- I. Elevations shown on the plans are subject to such revisions as may be necessary to fit field conditions. No adjustment in compensation will be made for adjustments up to two (2) feet above or below the grades indicated on the plans.
- J. Install lines passing under foundations with minimum of 1½-inch clearance to concrete and insure there is no disturbance of bearing soil.

- K. Bed pipe up to a point 12" above the top of the pipe. Take care during bedding, compaction and backfill not to disturb or damage piping.
- L. Mechanically compact bedding and backfill to prevent settlement. The initial compacted lift to not exceed 24" compacted to 95% density per Modified Proctor Test (ASTM D-1557). Subsequent lifts under pavements, curbs, walks and structures are not to exceed 12" and be compacted to 95% density per Modified Proctor Test. In all other areas where construction above the excavation is not anticipated within 2 years, mechanically compact backfill in lifts not exceeding 24" to 90% density per Modified Proctor Test. Route the equipment over each lift of the material so that the compaction equipment contacts all areas of the surface of the lift.

3.03 SHEETING, SHORING AND BRACING

- A. Provide shoring, sheet piling and bracing in conformance with the State Code to prevent earth from caving or washing into the excavation. Shore and underpin to properly support adjacent or adjoining structures. Abandon in place shoring, sheet piling and underpinning below the top of the pipe, or, if approved in advance by the engineer, maintained in place until other permanent support approved by the engineer is provided.

3.04 DEWATERING

- A. Provide, operate and maintain all pumps and other equipment necessary to drain and keep all excavation pits, trenches and the entire subgrade area free from water under all circumstances. Obtain general permit from the State Department of Natural Resources district office for discharge of construction dewatering effluent.

3.05 ROCK EXCAVATION

- A. Remove rock encountered in the excavation to a minimum dimension of six (6)-inches outside the pipe. Rock excavation includes all hard, solid rock in ledges, bedded deposits and unstratified masses, all natural conglomerate deposits so firmly cemented as to present all the characteristics of solid rock; which material is so hard or so firmly cemented that in the opinion of the Engineer it is not practical to excavate and remove same with a power shovel except after thorough and continuous drilling and blasting. Rock excavation includes rock boulders of 1/2 cubic yard or more in volume.
- B. Rock excavation will be computed on the basis of the depth of rock removed and a trench width two (2) feet larger than the outside diameter of the pipe where one (1) pipe is laid in the trench and three (3) feet larger than the combined outside diameter where two (2) pipes are laid in the trench. Include 6" pipe and structure bedding in rock excavation. Include rock excavation shown on the plans in the Base Bid.

3.06 SURFACE RESTORATION

- A. Completely restore the surface of all disturbed areas to a like condition of the surface prior to the work. Level off all waste disposal areas and clean up all areas used for the storage of materials or the temporary deposit of excavated earth. Remove all surplus material, tools and equipment.
- B. Lawns: Topsoil with 4" of clean, friable, fertile topsoil conforming to D.O.T. Section 625, free from debris, lumps, rocks, roots, plants and seeds. Grade surfaces to match adjacent elevations. Rake smooth, free of lumps and debris. Sod with good quality nursery sod conforming to D.O.T. Section 631, be uniform, dense, free from weeds and

consist of approximately 60% Kentucky blue grass and the balance perennial rye, fescue and white clover. Place sod with joints staggered and abutting. Maintain lawn areas for one month after installation. [Contractor] [user agency] will be responsible for necessary watering and mowing. Do necessary weeding, repair, reseeding or resodding until uniform catch is obtained.

- C. Curb and Gutter: Concrete curb and gutter conforming to city requirements and D.O.T. Section 601, Type D or L.
- D. Sidewalk and Walkways: Nonreinforced concrete conforming to D.O.T. Section 602, thickness to match existing, cross slope of one-fourth-inch per foot, scored into squares approximately equal to width.
- E. Bituminous Concrete Pavements: 4" thick crushed stone base course conforming to D.O.T. Section 304 (excluding 304.2.4) and two pass bituminous concrete pavement conforming to D.O.T. Section 407, first course 1½" binder, second course 1½" surface.

3.07 CONCRETE WORK

- A. Cast-in-place concrete within the building will be performed by the Division 03 Contractor unless otherwise noted. Provide all layout drawings, anchor bolts, metal shapes, and/or templates required to be cast into concrete or used to form concrete for support or installation of plumbing piping, fixtures, specialties and equipment. Coordinate locations of equipment, pipe penetrations in wet areas, etc. with the Division 03 Contractor.

3.08 CUTTING AND PATCHING

- A. Refer to Division 01, General Requirements, Cutting and Patching.
- B. Plumbing related cast-in-place concrete on the exterior of the building to be provided by this Contractor in conformance with requirements of 03. This includes piping thrust restraints, pipe supports, hydrant supports, manholes, catch basins, grease traps, septic tanks, distribution boxes, valve pits, meter pits, cleanout cover pads, yard hydrant pads, etc.

3.09 BUILDING ACCESS

- A. Arrange for the necessary openings in the building to allow for admittance or removal of all apparatus. When the building access was not previously arranged and must be provided by this contractor, restore any opening to its original condition after the apparatus has been brought into the building.

3.10 EQUIPMENT ACCESS

- A. Install all piping, conduit, and accessories to permit access to equipment for maintenance. Coordinate the exact location of wall and ceiling access panels and doors with the General Contractor, making sure that access is available for all equipment and specialties. Where access is required in plaster walls or ceilings, furnish the access doors to the General Contractor.

3.11 COORDINATION

- A. Coordinate all work with other contractors prior to installation. Any work that is not coordinated and that interferes with other contractor's work shall be removed or relocated at the installing contractor's expense.
- B. Verify that all devices are compatible for the type of construction and surfaces on which they will be used.

3.12 IDENTIFICATION

- A. Identify equipment in mechanical equipment rooms by stenciling equipment number and service with one coat of black enamel against a light background or white enamel against a dark background. Use a primer where necessary for proper paint adhesion.
- B. Where stenciling is not appropriate for equipment identification, engraved name plates may be used.
- C. Identify interior piping not less than once every 30 feet, not less than once in each room, adjacent to each access door or panel, and on both side of the partition where accessible piping passes through walls or floors. Place flow directional arrows at each pipe identification location. Use one coat of black enamel against a light background or white enamel against a dark background.
- D. Identify all exterior buried piping for entire length with underground warning tape except for sewer piping which is routed in straight lines between manholes or cleanouts. Place tape 6"-12" below finished grade along entire length of pipe. Extend tape to surface at building entrances, meters, hydrants and valves. Where existing underground warning tape is broken during excavation, replace with new tape identifying appropriate service and securely spliced to ends of existing tape.
- E. Identify valves with brass tags bearing a system identification and a valve sequence number. Identify medical gas and vacuum valves with brass tags and wall or cabinet mounted color coded engraved nameplate with the following "(Type of Gas) Shutoff Valve for (Location or Zone)". Valve tags are not required at a terminal device unless the valves are greater than ten feet from the device, located in another room or not visible from device. Provide a typewritten valve schedule and pipe identification schedule indicating the valve number and the equipment or areas supplied by each valve and the symbols used for pipe identification; locate schedules in mechanical room and in each Operating and Maintenance manual. Schedule in mechanical room to be framed under clear plastic.

3.13 LUBRICATION

- A. Lubricate all bearings with lubricant as recommended by the manufacturer before the equipment is operated for any reason. Once the equipment has been run, maintain lubrication in accordance with the manufacturer's instructions until the work is accepted by the Owner. Maintain a log of all lubricants used and frequency of lubrication; include this information in the Operating and Maintenance Manuals at the completion of the project.

3.14 SLEEVES

- A. Provide galvanized sheet metal sleeves for pipe penetrations through interior and exterior walls to provide a backing for sealant or firestopping. Patch wall around sleeve to match adjacent wall construction and finish. Grout area around sleeve in masonry construction. In finished spaces where pipe penetration through wall is exposed to view, sheet metal

sleeve shall be installed flush with face of wall. In existing poured concrete walls where penetration is core drilled, pipe sleeve is not required.

- B. Pipe sleeves in new poured concrete construction shall be schedule 40 steel pipe, cast in place.
- C. In all piping floor penetrations, fire rated and non-fire rated, top of sleeve shall extend $\frac{3}{4}$ -inch above the adjacent finished floor. In existing floor penetrations, core drill sleeve opening large enough to insert schedule 40 sleeve and grout area around sleeve with hydraulic setting, non-shrink grout. If the pipe penetrating the sleeve is supported by a pipe clamp resting on the sleeve, weld a collar or struts to the sleeve that will transfer weight to existing floor structure.

3.15 SEALING AND FIRESTOPPING

- A. Fire and/or Smoke Rated Penetrations:
 - 1. Install approved product in accordance with the manufacturer's instructions where a pipe penetrates a fire/smoke rated surface. When pipe is insulated, use a product which maintains the integrity of the insulation and vapor barrier.
 - 2. Where firestop mortar is used to infill large fire-rated floor openings that could be required to support weight, provide permanent structural forming. Firestop mortar alone is not adequate to support substantial weight.
- B. Non-Rated Partitions:
 - 1. In exterior wall openings below grade, assemble rubber links of mechanical seal to the proper size for the pipe and tighten in place, in accordance with manufacturer's instructions.
 - 2. At all interior partitions and exterior walls, pipe penetrations are required to be sealed. Apply sealant to both sides of the penetration in such a manner that the annular space between the pipe sleeve or cored opening and the pipe or insulation is completely blocked.

END OF SECTION

**SECTION 22 05 03
PIPE AND PIPE FITTINGS**

PART 1 - GENERAL

1.01 GENERAL

- A. Applicable provisions of Division 00 govern work under this section.

1.02 SCOPE

- A. This section contains specifications for plumbing pipe and pipe fittings for this project.

1.03 REFERENCE STANDARDS

- A. Abbreviations of standards organizations referenced in this and other sections are as follows:

ANSI B16.3	Malleable Iron Threaded Fittings
ANSI B16.4	Cast Iron Threaded Fittings
ANSI B16.5	Pipe Flanges and Flanged Fittings
ANSI B16.22	Wrought Copper and Wrought Copper Alloy Solder Joint Pressure Fittings
ANSI B16.29	Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV
ASTM A53	Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless
ASTM A74	Cast Iron Soil Pipe and Fittings
ASTM A105	Forgings, Carbon Steel, for Piping Components
ASTM A126	Gray Cast Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A234	Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
ASTM A861	High Silicon Iron Pipe and Fittings
ASTM A888	Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
ASTM B32	Solder Metal
ASTM B88	Seamless Copper Water Tube
ASTM B280	Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
ASTM B306	Copper Drainage Tube (DWV)
ASTM B813	Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube
ASTM B819	Seamless Copper Tube for Medical Gas Systems
ASTM C76	Reinforced Concrete Culvert, Storm Drain and Sanitary Pipe
ASTM C443	Joints for Circular Concrete Pipe Sewer and Culvert Pipe Using Rubber Gaskets
ASTM C564	Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM D1785	Poly Vinyl Chloride (PVC) Plastic Pipe
ASTM D2321	Underground Installation of Flexible Thermoplastic Sewer Pipe
ASTM D2241	Poly Vinyl Chloride (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D2464	Threaded Poly Vinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2466	Poly Vinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D2513	Thermoplastic Gas Pressure Pipe, Tubing, and Fittings
ASTM D2564	Solvent Cements for Poly Vinyl Chloride (PVC) Plastic Pipe and Fittings

ASTM D2657	Heat Fusion Joining of Polyolefin Pipe and Fittings
ASTM D2665	Poly Vinyl Chloride (PVC) Plastic Drain, Waste and Vent Pipe and Fittings
ASTM D2729	Poly Vinyl Chloride (PVC) Sewer Pipe and Fittings
ASTM D2774	Recommended Practice for Underground Installation of Thermoplastic Pressure Piping
ASTM D2855	Making Solvent Cemented Joints with Poly Vinyl Chloride (PVC) Pipe and Fittings
ASTM D3034	Type PSM Poly Vinyl Chloride (PVC) Sewer Pipe and Fittings
ASTM D3139	Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D3212	Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D3222	Unmodified Poly Vinylidene Fluoride (PVDF) Molding Extrusion and Coating Materials
ASTM D3311	Drain, Waste and Vent (DWV) Plastic Fitting Patterns
ASTM D4101	Propylene Plastic Injection and Extrusion Materials
ASTM F405	Corrugated Polyethylene (PE) Tubing and Fittings
ASTM F437	Threaded Chlorinated Poly Vinyl Chloride (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F438	Socket Type Chlorinated Poly Vinyl Chloride (CPVC) Plastic Pipe Fittings, Schedule 40
ASTM F441	Chlorinated Poly Vinyl Chloride (CPVC) Plastic Pipe, Schedules 40 and 80
ASTM F493	Solvent Cements for Chlorinated Poly Vinyl Chloride (CPVC) Plastic Pipe and Fittings
ASTM F656	Primers for Use in Solvent Cement Joints of Poly Vinyl Chloride (PVC) Plastic Pipe and Fittings
AWS A5.8	Brazing Filler Metal
AWWA C104	Cement Mortar Lining for Ductile Iron Pipe and Fittings for Water
AWWA C105	Polyethylene Encasement for Ductile Iron Piping for Water
AWWA C110	Ductile Iron and Gray Iron Fittings, 3 In. Through 48 In., for Water and Other Liquids
AWWA C111	Rubber Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings
AWWA C151	Ductile Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds for Water or Other Liquids
AWWA C153	Ductile Iron Compact Fittings, 3 In. Through 48 In., for Water and Other Liquids
AWWA C600	Installation of Ductile Iron Water Mains and Their Appurtenances
AWWA C651	Disinfecting Water Mains
AWWA C900	Polyvinyl Chloride (PVC) Pressure Pipe, 4 In. Through 12 In., for Water Distribution
CISPI 310	Couplings For Use In Connection With Hubless Cast Iron Soil Pipe And Fittings For Sanitary And Storm Drain, Waste And Vent Piping Applications
NFPA 54	National Fuel Gas Code
NFPA 50	Bulk Oxygen Systems at Consumers Sites
NFPA 99	Health Care Facilities
CGA G-4.1	Equipment Cleaned for Oxygen Service
CGA G-4.4	Industrial Practices for Gaseous Oxygen Transmission and Distribution Piping Systems
CGA G-6.1	Standard for Low Pressure Carbon Dioxide Systems at Consumer Sites
CGA G-8.1	Standard for Nitrous Oxide Systems at Consumer Sites
CGA P-2.1	Standards for Medical-Surgical Vacuum Systems in Health Care Facilities

1.04 SHOP DRAWINGS

- A. Schedule from the contractor indicating the ASTM, AWWA or CISPI specification number of the pipe being proposed along with its type and grade if known at the time of submittal, and sufficient information to indicate the type and rating of fittings for each service.
- B. Statement from manufacturer on his letterhead that pipe furnished meets the ASTM, AWWA or CISPI specification contained in this section.

1.05 QUALITY ASSURANCE

- A. Order all copper, cast iron, steel, PVC and polyethylene pipe with each length marked with the name or trademark of the manufacturer and type of pipe; with each shipping unit marked with the purchase order number, metal or alloy designation, temper, size, and name of supplier.
- B. Any installed material not meeting the specification requirements must be replaced with material that meets these specifications without additional cost to the State.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Promptly inspect shipments to insure that the material is undamaged and complies with specifications.
- B. Cover pipe to prevent corrosion or deterioration while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade. Protect pipe, tube, and fitting ends so they are not damaged. Where end caps are provided or specified, take precautions so the caps remain in place. Protect fittings, flanges, and unions by storage inside or by durable, waterproof, above ground packaging.
- C. Offsite storage agreements will not relieve the contractor from using proper storage techniques.
- D. Storage and protection methods must allow inspection to verify products.

1.07 DESIGN CRITERIA

- A. Use only new material, free of defects, rust and scale, and meeting the latest revision of ASTM, AWWA or CISPI specifications as listed in this specification.
- B. Construct all piping for the highest pressures and temperatures in the respective system.
- C. Non-metallic piping will be acceptable only for the services indicated. It will not be acceptable in ventilation plenum spaces, including plenum ceilings.
- D. Where weld fittings or mechanical grooved fittings are used, use only long radius elbows having a centerline radius of 1.5 pipe diameters.
- E. Where ASTM A53 type F pipe is specified, Grade A type E or S, or grade B type E or S may be substituted at Contractor's option. Where the grade or type is not specified, Contractor may choose from those commercially available.

- F. Where ASTM B88, type L H (drawn) temper copper tubing is specified, ASTM B88, type K H (drawn) temper copper tubing may be substituted at Contractor's option.
- G. NOTE: In ceiling plenums, all combustible piping shall be insulated with ½" FireMaster PlemumWrap as manufactured by Thermal Ceramics, consisting of a one-piece foil-jacketed ceramic fiber blanket secured with 16 ga. stainless steel tie wire. Install per manufacturers recommendations and all applicable Federal, State, and Local codes.

1.08 WELDER QUALIFICATIONS

- A. Welding procedures, welders, and welding operators for all building service piping to be in accordance with certified welding procedures of the National Certified Pipe Welding Bureau and Section 927.5 of ASME B31.9 Building Services Piping or AWS 10.9 Qualification of Welding Procedures and Welders for Piping and Tubing. Before any metallic welding is performed, Contractor to submit his Standard Welding Procedure Specification together with the Procedure Qualification Record as required by Section 927.6 of ASME B31.9 Building Services Piping.
- B. Before any polyethylene fusion welding is performed, Contractor to submit certification that the welders to be used on this project have successfully demonstrated proper welding procedures in accordance with the Code of Federal Regulations, Title 49, Part 192, Section 192.285.
- C. The Architect or Engineer reserves the right to test the work of any welder employed on the project, at the State's expense. If the work of the welder is found to be unsatisfactory, the welder shall be prevented from doing further welding on the project and all defective welds replaced.

PART 2 - PRODUCTS

2.01 DOMESTIC WATER

- A. Above Ground:
 - 1. Type L copper water tube, H (drawn) temper, ASTM B88; wrought copper pressure fittings, ANSI B16.22; lead free (<.2%) solder, ASTM B32; flux, ASTM B813; copper phosphorous brazing alloy, AWS A5.8 BCuP. Copper mechanical grooved fittings, ProPress fittings, and couplings on roll grooved pipe may be used in lieu of soldered fittings. Mechanically formed brazed tee connections may be used in lieu of specified tee fittings for branch takeoffs up to one-half (1/2) the diameter of the main. **Pro-Press system may be used on type K, L and M hard copper tubing, sizes 1/2" to 4" and soft copper tubing in sizes ½" to 1 ¼" . System shall be approved for up to 200 psi operating pressure and 250 °F for joining copper tubing. Pro-Press shall only be used on piping system containing fluids and gases as indicated in the manufacturers approved listing. All applications shall include the proper factory standard or field installed specialty seals. 2-1/2" to 4" press fittings shall feature a stainless steel grip ring.**
 - 2. CPVC plastic pipe, Schedule 40, SDR 11, ASTM D2846; CPVC threaded fittings, ASTM F437; socket fitting patterns, ASTM F438; primer, ASTM F656; solvent cement, ASTM F493.
 - 3. Ductile iron pipe, thickness Class 53, AWWA C151/C115; with standard thickness cement mortar lining, AWWA C104; ductile iron mechanical grooved cement mortar lined fittings and couplings on cut grooved pipe, Class 350 12" and below, Class 250 above 12", AWWA C606; ductile iron or gray iron flanged

- cement mortar lined fittings, Class 250, AWWA C110; rubber gasket joints with non-toxic gasket lubricant, AWWA C111.
4. Copper and PEX Hybrid system:

Copper Tubing: ASTM B88, Type "L". Fittings: ANSI/ASTM B16.18 or ANSI/ASTM B16.22, wrought copper. Joints: ANSI/ASTM B32 No-lead Solder. **Pro-Press system may be used on type K, L and M hard copper tubing, sizes 1/2" to 4" and soft copper tubing in sizes 1/2" to 1 1/4" . System shall be approved for up to 200 psi operating pressure and 250 °F for joining copper tubing. Pro-Press shall only be used on piping system containing fluids and gases as indicated in the manufacturers approved listing. All applications shall include the proper factory standard or field installed specialty seals.**

 - a. PEX Components: Tubing: Cross-linked polyethylene (PEX) manufactured by PEX-a or Engel method. Material Standard: Manufactured in accordance with ASTM F876 and ASTM F877 and tested for compliance by an independent third party agency. Manufacturer: Uponor Wirsbo.
 - b. Fittings:Material: Fitting assembly shall be manufactured from material listed in paragraph 5.1 of ASTM F1960. Material Standard: Comply with ASTM F1960. Type: PEX-A cold expansion fitting.
 - c. Manifolds: Type "L" copper body with UNS 3600 series brass ProPEX outlet connections
 - d. Accessories: ProPEX expander tool to install the ASTM F 1960 compatible fittings shall be supplied by the PEX tubing manufacturer. Clips and/or PEX rails for supporting tubing runs shall be provided by the tubing manufacturer.
 5. Galvanized steel, Schedule 40, Grade A, ASTM A53; with cast iron threaded fittings, Class 125, ANSI B16.4; forged steel threaded fittings, ANSI 16.11; mechanical cut groove couplings and fittings; galvanize coat all fittings, ASTM A123.
- B. Below Ground 2½" and Smaller: Type K copper water tube, O (annealed) temper, ASTM B88; with cast copper pressure fittings, ANSI B16.18; wrought copper pressure fittings, ANSI B16.22; lead free (<.2%) solder, ASTM B32; flux, ASTM B813; or cast copper flared pressure fittings, ANSI B16.26.
- C. Below Ground 3" and Larger:
1. Ductile iron pipe, mechanical or push on joint, thickness Class 52, AWWA C151; with standard thickness cement mortar lining, AWWA C104; ductile iron or gray iron mechanical joint cement mortar lined fittings, Class 250, AWWA C110; ductile iron mechanical joint compact fittings, Class 350, AWWA C153; rubber gasket joints with non-toxic gasket lubricant, AWWA C111. Provide 8 mil tube or sheet polyethylene encasement of iron pipe and pipe fittings, AWWA C105.
 2. PVC pressure pipe, DR 18, Class 150, AWWA C900 and C905; with integral bell and elastomeric gaskets, ASTM D3139. Fittings and fitting polyethylene encasement to be same as noted above for ductile iron.
- D. Hydrant Leads: Ductile iron pipe, restrained mechanical joint, thickness Class 52, AWWA C151; with standard thickness cement mortar lining, AWWA C104; ductile iron or gray iron restrained mechanical joint cement mortar lined fittings, Class 250, AWWA C110;

ductile iron restrained mechanical joint compact fittings, Class 350, AWWA C153; rubber gasket joints with non-toxic gasket lubricant, AWWA C111. Provide 8 mil tube or sheet polyethylene encasement of iron pipe and pipe fittings, AWWA C105.

- E. Thrust Restraints: 2500 psi concrete; retainer glands; restrained joint fittings; steel rods, ASTM A575; steel clamps and straps, ASTM A506; steel bolts, ASTM A307; malleable iron rod couplings, ASTM A197; cast iron washers, ASTM A307; bitumastic anti-corrosion coating.

2.02 SANITARY WASTE AND VENT

A. Interior Above Ground:

1. Hubless cast iron soil pipe and fittings, ASTM A888; with no-hub couplings, CISPI 310.
2. Type M copper water tube, H (drawn) temper, ASTM B88; with cast copper drainage fittings (DWV), ANSI B16.23; wrought copper drainage fittings (DWV), ANSI B16.29; lead free (<.2%) solder, ASTM B32; flux, ASTM B813; copper phosphorous brazing alloy, AWS A5.8 BcuP.
3. PVC plastic pipe, Schedule 40, Class 12454-B (PVC 1120), ASTM D1785; PVC plastic drain, waste and vent pipe and fittings, ASTM D2665; socket fitting patterns, ASTM D3311; primer, ASTM F656; solvent cement, ASTM D2564.
4. Galvanized steel pipe, Schedule 40, Type F, Grade A, ASTM A53; with cast iron threaded drainage fittings, ASTM B16.12.

B. Pressurized Interior Above Ground:

1. Type L copper water tube, H (drawn) temper, ASTM B88; with cast copper drainage fittings (DWV), ANSI B16.23; wrought copper drainage fittings (DWV), ANSI B16.29; lead free (<.2%) solder, ASTM B32; flux, ASTM B813.
2. Galvanized steel pipe, Schedule 40, Type F, Grade A, ASTM A53; with cast iron threaded drainage fittings, ASTM B16.12.

C. Interior Below Ground:

1. Cast iron soil pipe and fittings, hub and spigot, service weight, ASTM A74; with neoprene rubber compression gaskets, ASTM C564 and CISPI HSN 85.
2. PVC plastic pipe, Schedule 40, Class 12454-B (PVC 1120), ASTM D1785; PVC plastic drain, waste and vent pipe and fittings, ASTM D2665; socket fitting patterns, ASTM D3311; primer, ASTM F656; solvent cement, ASTM D2564.

- D. Exterior Below Ground 10" and Smaller: Non-reinforced concrete sewer, storm drain and culvert pipe, Class III, ASTM C14; rubber gasket joints, ASTM C443; bell and spigot ends with opposing shoulder or confined O-ring seal configuration, ASTM C302.

E. Exterior Below Ground 15" and Smaller:

1. Cast iron soil pipe and fittings, ASTM A74; with neoprene rubber compression gaskets, ASTM C564 and CISPI HSN 85.
2. PVC plastic pipe, Schedule 40, Class 12454-B (PVC 1120), ASTM D1785; PVC plastic drain, waste and vent pipe and fittings, ASTM D2665; socket fitting patterns, ASTM D3311; primer, ASTM F656; solvent cement, ASTM D2564.

3. Type PSM PVC sewer pipe and socket fittings, SDR 35, Class 12454-B (PVC 1120), ASTM D3034; primer, ASTM F656; solvent cement, ASTM 2564; or integral bell and flexible elastomeric seal, ASTM D3212.
 4. Corrugated PVC pipe and fittings with smooth interior, ASTM F949; gasketed joint, ASTM D3212; elastomeric gasket, ASTM F477.
 5. Corrugated polyethylene pipe with smooth interior and minimum pipe stiffness of 50 psi, ASTM F-405/ASTM F-667, AASHTO M-252/AASHTO M-294 Type S; PVC gasketed fittings, ASTM F1336; elastomeric gasket, ASTM F477.
- F. Exterior Below Ground 12" and Larger: Reinforced concrete culvert, storm drain and sewer pipe, Class III, ASTM C76; rubber gasket joints, ASTM C443; bell and spigot ends with opposing shoulder or confined O-ring seal configuration, ASTM C302.
- G. Pressurized Below Ground 3" and Smaller:
1. PVC plastic pipe, Schedule 40, Class 12454-B (PVC 1120), ASTM D1785; PVC plastic drain, waste and vent pipe and fittings, ASTM D2665; socket fitting patterns, ASTM D3311; primer, ASTM F656; solvent cement, ASTM D2564.
 2. Type K copper water tube, H (drawn) temper, ASTM B88; with cast copper drainage fittings (DWV), ANSI B16.23; wrought copper drainage fittings (DWV), ANSI B16.29; lead free (<.2%) solder, ASTM B32; flux, ASTM B813.
- H. Pressurized Below Ground 3" and Larger:
1. Ductile iron pipe, mechanical or push on joint, thickness Class 52, AWWA C151; with standard thickness cement mortar lining, AWWA C104; ductile iron or gray iron mechanical joint cement mortar lined fittings, Class 250, AWWA C110; ductile iron mechanical joint compact fittings, Class 350, AWWA C153; rubber gasket joints with gasket lubricant, AWWA C111. Provide 8 mil tube or sheet polyethylene encasement of iron pipe and pipe fittings, AWWA C105.
 2. PVC pressure pipe, DR 18, Class 150, AWWA C900; with integral bell and elastomeric gaskets, ASTM D3139. Fittings and fitting polyethylene encasement to be same as noted above for ductile iron.

2.03 STORM AND CLEARWATER WASTE

- A. Interior Above Ground:
1. Hubless cast iron soil pipe and fittings, ASTM A888; with no-hub couplings, CISPI 310.
 2. Type M copper water tube, H (drawn) temper, ASTM B88; with cast copper drainage fittings (DWV), ANSI B16.23; wrought copper drainage fittings (DWV), ANSI B16.29; lead free (<.2%) solder, ASTM B32; flux, ASTM B813; copper phosphorous brazing alloy, AWS A5.8 BCuP. Mechanically formed brazed tee connections may be used in lieu of specified tee fittings for clearwater waste vent branch takeoffs up to one-half (1/2) the diameter of the main.
 3. Copper drainage tube (DWV), ASTM B306; with cast copper drainage fittings (DWV), ANSI B16.23; wrought copper drainage fittings (DWV), ANSI B16.29; lead free (<.2%) solder, ASTM B32; flux, ASTM B813; copper phosphorous brazing alloy, AWS A5.8 BCuP. Mechanically formed brazed tee connections may be used in lieu of specified tee fittings for clearwater waste vent branch takeoffs up to one-half (1/2) the diameter of the main.

4. PVC plastic pipe, Schedule 40, Class 12454-B (PVC 1120), ASTM D1785; PVC plastic drain, waste and vent pipe and fittings, ASTM D2665; fitting patterns, ASTM D3311; primer, ASTM F656; solvent cement, ASTM D2564.
- B. Pressurized Interior Above Ground:
1. Type L copper water tube, H (drawn) temper, ASTM B88; with cast copper drainage fittings (DWV), ANSI B16.23; wrought copper drainage fittings (DWV), ANSI B16.29; lead free (<.2%) solder, ASTM B32; flux, ASTM B813.
 2. Galvanized steel pipe, Schedule 40, Type F, Grade A, ASTM A53; with cast iron threaded drainage fittings, ASTM B16.12.
- C. Interior Below Ground 15" and Smaller:
1. Cast iron soil pipe and fittings, hub and spigot, service weight, ASTM A74; with neoprene rubber compression gaskets, ASTM C564 and CISPI HSN 85.
 2. PVC plastic pipe, Schedule 40, Class 12454-B (PVC 1120), ASTM D1785; PVC plastic drain, waste and vent pipe and fittings, ASTM D2665; fitting patterns, ASTM D3311; primer, ASTM F656; solvent cement, ASTM D2564.
- D. Exterior Below Ground 10" and Smaller: Non-reinforced concrete sewer, storm drain and culvert pipe, Class III, ASTM C14; rubber gasket joints, ASTM C443; bell and spigot or tongue and groove ends.
- E. Exterior Below Ground 15" and Smaller:
1. Cast iron soil pipe and fittings, hub and spigot, service weight, ASTM A74; with neoprene compression rubber gaskets, ASTM C564 and CISPI HSN 85.
 2. PVC plastic pipe, Schedule 40, Class 12454-B (PVC 1120), ASTM D1785; PVC plastic drain, waste and vent pipe and fittings, ASTM D2665; fitting patterns, ASTM D3311; primer, ASTM F656; solvent cement, ASTM 2564.
 3. Type PSM PVC sewer pipe and fittings, SDR 35, Class 12454-B (PVC 1120), ASTM D3034; primer, ASTM F656; solvent cement, ASTM 2564; or integral bell and flexible elastomeric seal, ASTM D3212.
 4. Corrugated PVC pipe and fittings with smooth interior, ASTM F949; gasketed joint, ASTM D3212; elastomeric gasket, ASTM F477.
 5. Corrugated polyethylene pipe with smooth interior and minimum pipe stiffness of 50 psi, ASTM F-405/ASTM F-667, AASHTO M-252/AASHTO M-294 Type S; PVC gasketed fittings, ASTM F1336; elastomeric gasket, ASTM F477.
- F. Exterior Below Ground 12" and Larger: Reinforced concrete culvert, storm drain and sewer pipe, Class III, ASTM C76; rubber gasket joints, ASTM C443; bell and spigot or tongue and groove ends.
- G. Pressurized Below Ground 3" and Smaller:
1. PVC plastic pipe, Schedule 40, Class 12454-B (PVC 1120), ASTM D1785; PVC plastic drain, waste and vent pipe and fittings, ASTM D2665; socket fitting patterns, ASTM D3311; primer, ASTM F656; solvent cement, ASTM D2564.
 2. Type K copper water tube, H (drawn) temper, ASTM B88; with cast copper drainage fittings (DWV), ANSI B16.23; wrought copper drainage fittings (DWV), ANSI B16.29; lead free (<.2%) solder, ASTM B32; flux, ASTM B813.
- H. Pressurized Below Ground 3" and Larger:

1. Ductile iron pipe, mechanical or push on joint, thickness Class 52, AWWA C151; with standard thickness cement mortar lining, AWWA C104; ductile iron or gray iron mechanical joint cement mortar lined fittings, Class 250, AWWA C110; ductile iron mechanical joint compact fittings, Class 350, AWWA C153; rubber gasket joints with gasket lubricant, AWWA C111. Provide 8 mil tube or sheet polyethylene encasement of iron pipe and pipe fittings, AWWA C105.
2. PVC pressure pipe, DR 18, Class 150, AWWA C900; with integral bell and elastomeric gaskets, ASTM D3139. Fittings and fitting polyethylene encasement to be same as noted above for ductile iron.

2.04 ACID WASTE AND VENT

- A. Polypropylene pipe and fittings, Schedule 40, ASTM F1412; Type 110 or 210, ASTM D4101; flame retardant (<5 sec & 5 mm) ASTM D635; electrofusion socket fittings; fitting patterns, ASTM D3311. Spears Mfrg. or equal.
- B. Borosilicate glass pipe and fittings for drain, waste and vent; ASTM C1053; with beaded ends; 304 stainless steel mechanical couplings; Buna-N rubber compression liners; TFE seal ring gaskets; padded pipe hangers and padded pipe riser clamps. Factory fabricate underground piping with expanded polystyrene covering. Field wrap and secure underground fittings with 5 mil polyvinyl film. Include minimum of 3 site installation training and inspection sessions from factory representative.

2.05 SUBSOIL DRAIN

- A. Corrugated polyethylene tubing and fittings, standard tubing, perforated, ASTM F405; with polypropylene fabric filter cover.
- B. PVC sewer pipe and fittings, perforated, Class 12454-B (PVC 1120), ASTM D2729; primer, ASTM F656; solvent cement, ASTM 2564; with polypropylene fabric filter cover.

2.06 NATURAL AND LP GAS

- A. Above Ground 2" and Smaller: Black steel pipe, Schedule 40, Type F, Grade A, ASTM A53; with black malleable iron threaded fittings, Class 150, ASTM A197/ANSI B16.3; seamless carbon steel weld fittings, standard weight, ASTM A234 grade WPB/ANSI B16.9.
- B. Above Ground 2½" and Larger: Black steel pipe, Schedule 40, type F, Grade A, ASTM A53; with seamless carbon steel weld fittings, ASTM A234 grade WPB/ANSI B16.9.
- C. Below Ground:
 1. Thermoplastic polyethylene gas pressure pipe, tubing and fittings, PE 2406/3406/3408, SDR 11.5 maximum, ASTM D2513; with butt-weld ASTM D3261 or socket-type polyethylene heat fusion fittings.
 2. Exterior LP Only - Type K copper water tube, O (annealed) temper, ASTM B88; with cast copper pressure fittings, ANSI B16.18; wrought copper pressure fittings, ANSI B16.22; copper phosphorous or copper-phosphorous-silver brazing alloy, AWS A5.8 BCuP; or cast copper flared pressure fittings, ANSI B16.26.
- D. Below Ground at Service Entrance: Same as above ground covered with a flexible polymer film with a coal tar and synthetic elastomeric coating of 36 mil thickness or

extruded high density polyethylene factory applied coating of 30 mil thickness. Wrap fittings with 10 mil polyethylene tape, ANSI A21.5, double layer, half-lapped. Minimum dielectric strength exceeding 12 KV. Use a compatible primer below polymer film or polyethylene tape.

2.07 COMPRESSED AIR (NON-MEDICAL, NON-LAB)

- A. Instrument Air: Type L copper water tube, H (drawn) temper, ASTM B88; with cast copper pressure fittings, ANSI B16.18; wrought copper pressure fittings, ANSI B16.22; lead free (<.2%) solder, ASTM B32; flux, ASTM B813; copper phosphorous brazing alloy, AWS A5.8 BCuP.
- B. 2" and Smaller TOOL AIR: Black steel pipe, Schedule 40, Type F, Grade A, ASTM A53; with black malleable iron threaded fittings, Class 150, ASTM A197/ANSI B16.3; seamless carbon steel weld fittings, standard weight, ASTM A234 grade WPB/ANSI B16.9.
- C. 2½" and Larger TOOL AIR: Black steel pipe, Schedule 40, type F, Grade A, ASTM A53; with seamless carbon steel weld fittings, ASTM A234 grade WPB/ANSI B16.9.
- D. 4" and Smaller: Modified rigid acrylonitrile-butadiene-styrene (ABS) pipe and solvent weld socket fittings manufactured specifically for compressed air service, cell classification 54322, ASTM D-3965; IPS outside diameter; SDR 9 for 2" and smaller, SDR 10 for 3" and 4"; rated for 185 psi at 100 F continuous service and 120 F maximum; solvent cement resin of same cell classification as pipe.

2.08 SWIMMING POOL AND FISH HATCHERY/AQUARIUM WATER

- A. PVC plastic pipe and fittings, Class 12454-B (PVC 1120), ASTM D1785; Schedule 80 with ASTM D2467 fittings; [Schedule 40 with ASTM D2466 fittings;] rated for 140° F; primer, ASTM F656; solvent cement, ASTM D2564; Schedule 80 threaded fittings, ASTM D2464.
- B. Hot Water: CPVC plastic pipe and fittings, Class 23447-B, ASTM F441; Schedule 80 with ASTM F439 fittings; [Schedule 40 with ASTM F438 fittings;] rated for 200° F; primer, ASTM F656; solvent cement, ASTM F493; Schedule 80 threaded fittings, ASTM F437.
- C. Valves, unions, flanges and piping specialties to be constructed of same material as pipe and fittings and rated for 150 psi at 68°F.

2.09 PURE WATER

- A. Polypropylene pipe and fittings, copolymer ASTM D-4101, Schedule 80 or SDR 11, 150 psi rating at 68°F, maximum 200°F, heat fusion fittings using [electrofusion] [socket fusion] [conventional butt fusion].

Generally for 5 megohm-cm resistivity and lower quality water suitable for general lab use such as CAP type II and III or ASTM D1193 Type II, III or IV or USP pharmaceutical use.

- B. Polypropylene pipe and fittings, Type 110 or 120 homopolymer, ASTM D4101, Schedule 80 or SDR 11, 150 psi rating at 68°F, maximum 200°F, heat fusion fittings using [socket fusion] [conventional butt fusion] [infrared butt fusion].

Generally for 16 megohm-cm resistivity and lower quality water suitable for general lab use such as CAP type I, II and III or ASTM D1193 Type II, III or IV, USP pharmaceutical use or biomedical use ASTM D1193.

- C. Polyvinylidene Fluoride (PVDF) virgin unpigmented pipe and fittings, ASTM D3222, Schedule 80 pipe and Schedule 80 fittings or SDR series rated for 230 psi at 68°F, maximum 280°F, heat fusion fittings using [conventional butt fusion][infrared butt fusion] [bead and crevice free (BCF) fusion].

Generally for above 16 megohm-cm resistivity water suitable for ultra-high purity use, semiconductor processing (SEMI), lab use such as CAP type I or ASTM D1193 Type I, USP pharmaceutical use, biomedical use ASTM D1193 or water for injection.

Select one of the above materials and joining systems based on water purity requirements. Polypropylene and PVDF have similar resistance to bacteria growth. PVDF has a smoother surface finish, higher temperature rating, is not susceptible to UV or ozone degradation (as is polypropylene) but costs 4 to 6 times as much as polypropylene.

- D. Valves, unions, flanges and piping specialties to be constructed of same material as pipe and fittings and rated for 150 psi at 68°F.

2.10 MEDICAL GAS

- A. Type L seamless copper medical gas tube, H (drawn) temper, ASTM B819; with wrought copper pressure fittings, ANSI B16.22; copper phosphorous or copper-phosphorous-silver brazing alloy for copper-to-copper joints, AWS A5.8 BCuP; flux and silver brazing alloy AWS A5.8 BAg for copper-to-brass/bronze joints. Medically clean piping and fittings at factory in accordance with ASTM B819 and CGA G-4.1. Cap, plug or seal piping to prevent contamination prior to assembly.

Specify Type K for systems operating at 200-300 psig.

2.11 LAB GAS

- A. Type L seamless copper tube for air conditioning, H (drawn) temper, ASTM B280 or Type L seamless copper medical gas tube, H (drawn) temper, ASTM B819; with wrought copper pressure fittings, ANSI B16.22; copper phosphorous or copper-phosphorous-silver brazing alloy for copper-to-copper joints, AWS A5.8 BCuP; flux and silver brazing alloy AWS A5.8 BAg for copper-to-brass/bronze joints. Clean piping and fittings at factory in accordance with CGA G-4.1. Cap, plug or seal piping to prevent contamination prior to assembly.

Specify Type K for systems operating at 200-300 psig.

2.12 VACUUM

- A. Type L seamless copper water tube, H (drawn) temper, ASTM B88, Type L seamless copper tube for air conditioning, H (drawn) temper, ASTM B280 or Type L seamless copper medical gas tube, H (drawn) temper, ASTM B819; with wrought copper pressure fittings, ANSI B16.22; lead free (<.2%) solder, ASTM B32; flux, ASTM B813 or copper phosphorous or copper-phosphorous-silver brazing alloy for copper-to-copper joints, AWS A5.8 BCuP; flux and silver brazing alloy AWS A5.8 BAg for copper-to-brass/bronze joints. Mechanically formed brazed tee connections may be used in lieu of specified tee fittings for branch takeoffs up to one-half (1/2) the diameter of the main. Where vacuum piping and medical or laboratory gases are installed on the same project, the vacuum piping must either meet the medical or laboratory gas piping specification or it must be field labeled every 5' prior to installation to prevent use for those gases.

2.13 DIELECTRIC UNIONS AND FLANGES

- A. Watts Regulator Company, Lochinvar, Wilkins or EPCO Sales, Inc., dielectric unions 2" and smaller; dielectric flanges 2" and larger; with iron female pipe thread to copper solder joint or brass female pipe thread end connections, non-asbestos gaskets, having a pressure rating of not less than 175 psig at 180 degrees.

2.14 UNIONS AND FLANGES

- A. Unions, flanges and gasket materials to have a pressure rating of not less than 150 psig at 180 degrees.
- B. 2" and Smaller Steel: ASTM A197/ANSI B16.3 malleable iron unions with brass seats. Use black malleable iron on black steel piping and galvanized malleable iron on galvanized steel piping. Use unions of a pressure class equal or higher than that specified for the fittings of the respective piping service but not less than 250 psi.
- C. 2" and Smaller Copper: ANSI B16.18 cast bronze union coupling or ANSI B15.24 Class 150 cast bronze flanges.
- D. 2½" and Larger Steel: ASTM 181 or A105, grade 1 hot forged steel flanges of threaded, welding neck, or slip-on pattern and of a pressure class compatible with that specified for valves, piping specialties and fittings of the respective piping service. Flanges smaller than 2 ½" may be used as needed for connecting to equipment and piping specialties. Use raised face flanges ANSI B16.5 for mating with other raised face flanges on equipment with flat ring or full face gaskets. Use ANSI B16.1 flat face flanges with full face gaskets for mating with other flat face flanges on equipment. Gasket material to be non-asbestos and suitable for pressures and temperatures of the piping system.
- E. 2½" and Larger Copper: ANSI B15.24 Class 150 cast bronze flanges with full face gaskets.

2.15 MECHANICAL GROOVED PIPE CONNECTIONS

- A. Mechanical grooved pipe couplings and fittings, ASTM F1476, as manufactured by Victaulic, ITT Grinnell or Gustin-Bacon may be used with cut groove galvanized steel pipe, cut groove ductile iron pipe or roll groove copper pipe where noted. Mechanical grooved components and assemblies to be rated for minimum 250 psi working pressure.
- B. All mechanical grooved pipe material including gaskets, couplings, fittings and flange adapters to be from the same manufacturer.
- C. Couplings to be malleable iron, ASTM A47, or ductile iron ASTM A536 with painted finish. Reducing couplings are not acceptable.
- D. Fittings used on galvanized steel pipe to be malleable iron, ASTM A47, or ductile iron A536, with galvanized finish, ASTM A153. Fittings used on ductile iron pipe to be cement mortar lined ductile iron with coal tar coating, ASTM A536; conforming to requirements of AWWA C110/C153 and AWWA C606. Fittings used on copper pipe to be copper.
- E. Gaskets to be EPDM, ASTM D2000. Gaskets for hot water systems and dry pipe systems to be flush seal design. Heat treated carbon steel oval neck track bolts and nuts, ASTM A183, with zinc electroplated finish ASTM B633.

- F. Flange adapters to be ductile iron, ASTM A536; except at lug type butterfly valves where standard threaded flanges shall be used.
- G. Credit for the inherent flexibility of mechanical grooved pipe connections when used for expansion joints or flexible connectors may be allowed upon specific application by the Contractor. Three flexible couplings at first three connection points both upstream and downstream of pumps may be used in lieu of flexible connectors. Request for expansion joints shall be made in writing and shall include service, location, line size, proposed application and supporting calculations for the intended service.

PART 3 - EXECUTION

3.01 GENERAL

- A. Install pipe and fittings in accordance with reference standards, manufacturers recommendations and recognized industry practices.

3.02 PREPARATION

- A. Cut pipe ends square. Ream ends of piping to remove burrs. Clean scale and dirt from interior and exterior of each section of pipe and fitting prior to assembly.

3.03 ERECTION

- A. Install all piping parallel to building walls and ceilings and at heights which do not obstruct any portion of a window, doorway, stairway, or passageway. Where interferences develop in the field, offset or reroute piping as required to clear such interferences. Coordinate locations of plumbing piping with piping, ductwork, conduit and equipment of other trades to allow sufficient clearances. In all cases, consult drawings for exact location of pipe spaces, ceiling heights, door and window openings, or other architectural details before installing piping.
- B. Where copper or steel piping is embedded in masonry or concrete, provide protective sleeve covering of elastomeric pipe insulation.
- C. Install underground warning tape 6"-12" below finished grade above all exterior below ground piping. Where existing underground warning tape is encountered, repair and replace.
- D. Maintain piping in clean condition internally during construction.
- E. Provide clearance for installation of insulation, access to valves and piping specialties.
- F. Provide anchors, expansion joints, swing joints and/or expansion loops so that piping may expand and contract without damage to itself, equipment, or building.
- G. Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including the required service space for this equipment, unless the piping is serving this equipment
- H. Install all valves and piping specialties, including items furnished by others, as specified and/or detailed. Provide access to valves and specialties for maintenance. Make

connections to all equipment, fixtures and systems installed by others where same requires the piping services indicated in this section.

3.04 INSTALLATION IN PLENUM SPACES

- A. Pipe and fittings installed in mechanical air plenum spaces shall be of noncombustible material. PVC pipe tested according to ASTM D-635, shall be wrapped with at least one-inch of noncombustible insulation.

3.05 COPPER PIPE JOINTS

- A. Remove all slivers and burrs remaining from the cutting operation by reaming and filing both pipe surfaces. Clean fitting and tube with metal brush, emery cloth or sandpaper. Remove residue from the cleaning operation, apply flux and assemble joint to socket stop. Apply flame to fitting until solder melts when placed at joint. Remove flame and feed solder into joint until full penetration of cup and ring of solder appears. Wipe excess solder and flux from joint.

3.06 WELDED PIPE JOINTS

- A. Make all welded joints by fusion welding in accordance with ASME Codes, ANSI B31, and State Codes where applicable. "Weldolets" and "Threadolets" may be used for branch takeoffs up to one-half ($\frac{1}{2}$) the diameter of the main.

3.07 THREADED PIPE JOINTS

- A. Use a thread lubricant or teflon tape when making joints; no hard setting pipe thread cement or caulking will be allowed.

3.08 PROPRESS PIPE FITTINGS

- A. Copper and copper alloy fitting shall conform with NSF 61 and ASME B16.18 or ASME B16.22. Sealing elements for press fitting shall be EPDM. Install per manufacturers recommendations.

3.09 SOLVENT WELDED PIPE JOINTS

- A. Install in accordance with ASTM D2855 "Making Solvent Cemented Joints With PVC Pipe and Fittings". Saw cut piping square and smooth. Tube cutters may be used if they are fitted with wheels designed for use with PVC/CPVC pipe that do not leave a raised bead on pipe exterior. Support and restrain pipe during cutting to prevent nicks and scratches. Bevel ends 10-15 degrees and deburr interior. Remove dust, drips, moisture, grease and other superfluous materials from pipe interior and exterior. Check dry fit of pipe and fittings. Reject materials which are out of round or do not fit within close tolerance. Use heavy body solvent cement for large diameter fittings.
- B. Maintain pipe, fittings, primer and cement between 40 and 100 degrees during application and curing. Apply primer and solvent using separate daubers (3" and smaller piping only) or clean natural bristle brushes about $\frac{1}{2}$ the size of the pipe diameter. Apply primer to the fitting socket and pipe surface with a scrubbing motion. Check for penetration and reapply as needed to dissolve surface to a depth of 4-5 thousandths. Apply solvent cement to the fitting socket and pipe in an amount greater than needed to fill any gap. While both surfaces are wet, insert pipe into socket fitting with a quarter turn to the bottom of the socket. Solvent cement application and insertion must be completed in less than 1

minute. Minimum of 2 installers is required on piping 4" and larger. Hold joint for 30 seconds or until set. Reference manufacturers recommendations for initial set time before handling and for full curing time before pressure testing. Cold weather solvent/cement may be utilized only under unusual circumstances and when specifically approved by the DFD Project Representative.

3.10 MECHANICAL HUBLESS PIPE CONNECTIONS

- A. Place the gasket on the end of one pipe or fitting and the clamp assembly on the end of the other pipe or fitting. Firmly seat the pipe or fitting ends against the integrally molded shoulder inside the neoprene gasket. Slide the clamp assembly into position over the gasket. Tighten fasteners to manufacturers recommended torque.

3.11 MECHANICAL JOINT PIPE CONNECTIONS

- A. Comply with AWWA C600/C605 installation requirements. Clean pipe end and socket. Clean and lubricate pipe end, socket and gasket with soapy water or gasket lubricant. Place gland and gasket, properly oriented, on pipe end. Insert pipe end fully into socket and press gasket evenly into recess keeping joint straight. Press gland evenly against gasket, insert bolts and hand tighten nuts. Make joint deflection prior to tightening bolts. Evenly tighten bolts in sequence to recommended torque.

3.12 PUSH-ON GASKETED PIPE CONNECTIONS

- A. Clean pipe end, bell, gasket seat and gasket of dirt or debris. Coat end of pipe and gasket with gasket lubricant. Insure pipe is supported off the ground so lubricant does not pick up dirt. Push spigot end into gasket bell with levered pipe joining tool recommended by pipe manufacturer. Large diameter exterior mains may be joined by pushing end of pipe section with backhoe against wood blocking over pipe end. Insert to fully seated position or to reference mark on pipe.

3.13 MECHANICAL GROOVED PIPE CONNECTIONS

- A. Use pipe factory grooved in accordance with the coupling manufacturer's specifications or field grooved pipe in accordance with the same specifications using specially designed tools specially designed for the application. Lubricate pipe and coupling gasket, align pipe, and secure joint in accordance with the coupling manufacturer's specifications.

3.14 MECHANICALLY FORMED TEE FITTINGS

- A. Form mechanically extracted collars in a continuous operation, consisting of drilling a pilot hole and drawing out the tube surface to form a collar having a height of not less than three times the thickness of the tube wall. Use an adjustable collaring device. Notch and dimple the branch tube. Braze the joint with neutral flame oxy-acetylene torch, applying heat properly so that pipe and tee do not distort; remove distorted connections.

3.15 DOMESTIC WATER

- A. Maintain piping system in clean condition during installation. Remove dirt and debris from assembly of piping as work progresses. Cap open pipe ends where left unattended or subject to contamination.
- B. Install exterior water piping below predicted frost level in accordance with State recognized historic data, but in no case less than 6' bury depth to top of pipe. Maintain

minimum of 8' horizontal distance between 2½" and larger water piping and sanitary sewer piping. Maintain minimum of 30" horizontal and 12" vertical distance, water on top, between 2" and smaller water piping and sanitary sewer piping. Where water piping crosses a sanitary sewer, provide minimum 18" vertical clearance and waterproof PVC water pipe sleeve (reference sanitary sewer materials) sealed at both ends for distance of 10' from sewer in both directions.

- C. Provide thrust restraints for 3" and larger exterior water piping joints, hydrants, caps, plugs, fittings and bends of 22½ degrees or more. Pour concrete thrust blocks against compacted or undisturbed soil. Where soil bearing capacity is less than 2000 psf or adjacent construction may affect soil bearing capacity, use both concrete thrust blocks and strapped/rodded restraints or restrained joints. Field apply continuous anti-corrosion coating to strapped and rodded restraint components. Protect mechanical joints, nuts and bolts from concrete cover.
- D. Install interior water piping with drain valves where indicated and at low points of system to allow complete drainage. Install shutoff valves where indicated and at the base of risers to allow isolation of portions of system for repair. Do not install water piping within exterior walls.
- E. Prior to use, isolate and fill system with potable water. Allow to stand 24 hours. Flush each outlet proceeding from the service entrance to the furthest outlet for minimum of 1 minute and until water appears clear. Fill system with a solution of water and chlorine containing at least 50 parts per million of chlorine and allow to stand for 24 hours. Alternately a solution containing at least 200 parts per million of chlorine may be used and allowed to stand for 3 hours. Flush system with potable water until chlorine concentration is no higher than source water level.
- F. Wait 24 hours after final flushing. Take samples of water for lab testing. The number and location of samples shall be representative of the system size and configuration and are subject to approval by Engineer. Test shall show the absence of coliform bacteria. If test fails, repeat disinfection and testing procedures until no coliform bacteria are detected. Submit test report indicating date and time of test along with test results.

3.16 SANITARY WASTE AND VENT

- A. Verify invert elevations and building elevations prior to installation. Install exterior piping pitched to drain at indicated elevations and slope. Install interior piping pitched to drain at minimum slope of ¼" per foot where possible and in no case less than ⅛" per foot for piping 3" and larger.
- B. Install exterior piping below predicted frost level and not less than 5' bury depth to top of pipe wherever possible. Where piping is located above predicted frost level, provide frost protection in accordance with State Code.
- C. Flush piping inlets (floor drains, mop basins, fixtures, etc.) with high flow of water at completion of project to demonstrate full flow capacity. Remove blockages and make necessary repairs where flow is found to be impeded.

3.17 STORM AND CLEARWATER WASTE

- A. Verify invert elevations and building elevations prior to installation. Install exterior piping pitched to drain at indicated elevations and slope. Install interior piping pitched to drain at

minimum slope of 1/8" per foot where possible and in no case less than 1/16" per foot for piping 3" and larger.

- B. Install exterior piping below predicted frost level and not less than 5' bury depth to top of pipe wherever possible. Where piping is located above predicted frost level, provide frost protection in accordance with COMM 82.30(11)(c).

3.18 SUBSOIL DRAIN

- A. Verify invert elevations and building elevations prior to installation. Install piping sloped to drain to locations indicated. Where subsoil drains are required to penetrate foundation work, sleeve subsoil drains or use nonperforated sections of piping and place prior to foundation work.
- B. Secure joints and piping where corrugated polyethylene is used to prevent movement during laying and backfill. Route piping in straight lines. Plug dead ends of pipe with pipe caps or concrete plugs. Extend filter fabric cover over all piping and fittings with fabric cover joints overlapping and banded.
- C. Bed piping on and backfill around subsoil drains with pea gravel or No. 2 coarse aggregate (DOT 501.3.6.4.5) to a level 12" above or as indicated.

3.19 NATURAL AND LP GAS

- A. Entire gas piping installation shall be in accordance with the latest requirements of the AGA, NFPA 54 – National Fuel Gas Code, State, and Local Codes.
- B. Permissible Assemblies for Welding Piping Systems:
 - 1. The following specification covers permissible assemblies for welded pipe lines for all services operating at 160 psig or less.
 - 2. Mitered tees will not be permitted in welded lines. Connections shall be made with welding tees. The use of lines provided they are installed in prefabricated assemblies and the pipe interior is cleaned of slag. Field installation of weldolets will be permitted in lines 5" and larger if the installation is cleaned inside after welding.
 - 3. The use of mitered elbows in welded lines will not be permitted. Welding elbows shall be used for bends.
 - 4. Mitered reducers will not be permitted in welded lines.
 - 5. The pipe ends in tees, laterals, and reducers shall be carefully prepared to provide for proper weld penetration.
 - 6. Steel and iron piping, 2-1/2" in size and larger, shall have joints welded, except joints obviously intended to be connected by means of bolted flanges. End to end joints of the same size pipe sizes 3/4" through 1" may be butt welded provided that an internal welding ring is used.
 - 7. Do not install gas piping below a building or its foundation.
 - 8. Gas piping shall be installed with plugged drip pockets at low points.

9. Valves, gas cocks, and unions shall be installed on inlet pipe to equipment including safety valves where required or noted to be installed.
10. Connect gas piping to gas meter provided by local gas company.
11. All gas piping in inaccessible areas and piping 2 1/2" and larger shall have welded joints. Provide pre-weld type fittings. Paint welded areas with primer.
12. Pitch horizontal piping down 1 inch in 60 feet in the direction of flow. Install full size dirt leg at the bottom of each vertical run and at each appliance. When installing mains and branches, cap gas tight each tee or pipe end which will not be immediately extended. All branch connections to the main shall be from the top of the main.
13. Prime coat and apply rust resistant finish enamel coat to all gas piping exposed to weather. Paint gas piping to blend in with adjacent wall or roof color. Color is subject to approval by architect.
14. Install all underground pipe in accordance with Manufacturer's recommendations and local gas utility company regulations and specifications.
15. Polyethylene pipe installers shall be properly trained and certified in procedure for joining polyethylene pipe.
16. Provide 24 inch minimum steel pipe between vertical rise of riser and end of polyethylene line if anode-less riser is not used. Use plastic-to-steel transition or compression fitting between end of polyethylene line and steel meter riser. Provide cathodic protection for steel riser or use anode-less riser.
17. Place tracer wire along side of polyethylene pipe from meter to point where pipe rises inside building.
18. Place 4 inches of sand around gas line buried underground.
19. Gas piping shall be installed with swing joints to relieve thrust on the pipe at point where it pierces building wall. The annular space between the pipe and sleeve, where pipe pierces building walls, shall be grouted airtight with an elastomeric compound.
20. Gas Pressure Regulator: Provide and install as required, regulators sized per loads of equipment being served. Regulators shall be of diaphragm, spring operation type with cast iron body, aluminum diaphragm case and vent valve with which are equipped with leak limiter venting may be used in lieu of the atmosphere venting type. Regulators by Maxitrol, Equimeter, Rockford or Fisher are acceptable. See schedule on drawings.
21. Make all final connections to all gas-fired equipment with shut-off valve, full size dirt leg and union. Coordinate incoming gas service and meter with local utility prior to the start of any work. Provide regulators as required and vent per manufacturers recommendations.
22. Provide shut-off valves in system to allow system zoning. Coordinate number of valves and locations with owner prior to installation.

3.20 COMPRESSED AIR

- A. Install a 4" minimum depth dirt leg at the bottom of each vertical run and at each outlet connection with shutoff valve at bottom of dirt leg.

3.21 PURE WATER

- A. Installers to be certified in writing by pipe manufacturer as having been trained, tested and evaluated with manufacturer's written procedures for installing and heat fusing pipe and fitting types required by project. Heat fusion equipment to be furnished by pipe and fitting manufacturer. All procedures for handling pipe, facing pipe, heat fusion, support and expansion compensation to comply with manufacturer's recommendations.
- B. Store indoors and handle pipe and fittings to maintain cleanliness, prevent exposure to sunlight or heat and prevent surface scarring or scratching. Maintain piping caps and sealed fitting/valve bags in place until installation. Follow ASTM D2657 Heat Fusion Joining of Polyolefin Pipe and Fittings requirements. Throughout project, remove and evaluate sample joints by cutting longitudinally or into straps per ASTM D2657. Inspect for melt pattern, bond continuity, voids, strength and excessive crevice or bead development. Modify installation procedures as required to obtain even melt, continuous bond and minimal crevice and bead development.
- C. Maintain record of installer's name and date of installation for piping within each room. Include record along with installer's certifications in operation and maintenance manuals.
- D. Upon system completion, fill system with distilled or RO water. Pressure test and flush system of all impurities. Disinfect with continuously circulated solution of distilled or RO water and hydrogen peroxide in concentration and for duration recommended by pure water equipment manufacturer. Flush with distilled or RO water until no trace of hydrogen peroxide remains. Test for hydrogen peroxide by adding drops of potassium permanganate solution to sample of system water. If drops turn brown, hydrogen peroxide is present. If drops remain purple, no hydrogen peroxide is present. Flush systems designed for 16 megohm-cm or higher water quality with a minimum of 10 times the volume of the piping.

3.22 MEDICAL GAS, LAB GAS AND VACUUM

- A. Comply with requirements of NFPA 99.
- B. Examine piping and fittings internally for contamination prior to assembly. Do not install contaminated material. On-site cleaning may be performed only at joints contaminated prior to brazing by scrubbing in hot alkaline cleaner and water solution (sodium carbonate or trisodium phosphate, one pound to 3 gallons of water) and rinsing with clean hot water.
- C. Purge piping system with dry nitrogen during brazing operations. Use flux only where copper to brass/bronze joints are required and on soldered vacuum systems. Apply flux sparingly avoiding contamination of piping system. Wash exterior of finished joints with water and stainless steel brush. Use hot water on fluxed joints. Inspect joints for flux residue, oxidation, unmelted filler metal, failure to fully penetrate or surround joint with filler metal, cracks in fittings or filler metal or potential leaks. Replace defective fittings or pipe and repair defective joints. Replace defective joints requiring more than two repairs. Assemble threaded joints with teflon tape. Unions are not allowed in distribution pipeline system for gas systems and only on vacuum distribution piping where exposed and readily accessible.

- D. Do not run piping where subject to physical damage, excessive heat, corrosion or contact with oil. Do not interconnect piping serving patients with piping serving laboratories.
- E. Installer Performance Testing: Blowout piping systems prior to connection of outlets, inlets or gauges with dry nitrogen to remove particulate contamination. Fill piping systems with dry nitrogen and perform initial pressure test. Complete installation of pressure sensitive components and perform final pressure test. Perform heavy, intermittent purging of pipeline with dry nitrogen until no discoloration is evident in white cloth held over outlets and inlets. Cross connect test one system at a time testing all inlets and outlets to verify that test gas is being dispensed only from the outlets or inlets of the system being tested.
- F. Medical Gas And Medical Vacuum System Verification: Provide systems verification by factory trained technician employed by the medical gas equipment manufacturer. Submit certification report describing testing procedures, results and indicating the system and all components and equipment were tested in accordance with and meet the requirements of NFPA 99.

3.23 UNDERGROUND PIPE WRAP

- A. Use for steel piping encased in concrete or underground which is not in a conduit. Remove all dirt and other foreign material from exterior of pipe. Apply primer as recommended by the manufacturer. Use a spiral wrap process for applying tape to the pipe. Repair any breaks in the tape coating caused by the installation process.

3.24 DIELECTRIC UNIONS AND FLANGES

- A. Install dielectric unions or flanges at each point where a copper-to-steel pipe connection is required in domestic water systems.

3.25 UNIONS AND FLANGES

- A. Install a union or flange at each connection to each piece of equipment and at other items which may require removal for maintenance, repair, or replacement. Where a valve is located at a piece of equipment, locate the flange or union connection on the equipment side of the valve. Concealed unions or flanges are not acceptable.

3.26 PIPING SYSTEM LEAK TESTS

- A. Isolate or remove components from system which are not rated for test pressure. Perform final testing for medical and lab gas with all system components in place. Test piping in sections or entire system as required by sequence of construction. Do not insulate or conceal pipe until it has been successfully tested.
- B. If required for the additional pressure load under test, provide temporary restraints at fittings or expansion joints. Backfill underground water mains prior to testing with the exception of thrust restrained valves which may be exposed to isolate potential leaks.
- C. For hydrostatic tests, use clean water and remove all air from the piping being tested by means of air vents or loosening of flanges/unions. Measure and record test pressure at the high point in the system.
- D. For air or nitrogen tests, gradually increase the pressure to not more than one half of the test pressure; then increase the pressure in steps of approximately one-tenth of the test pressure until the required test pressure is reached. Examine all joints and connections

with a soap bubble solution or equivalent method. System will not be approved until it can be demonstrated that there is no measurable loss of test pressure during the test period.

- E. Inspect system for leaks. Where leaks occur, repair the area with new materials and repeat the test; caulking will not be acceptable.
- F. Entire test must be witnessed by the Owner's representative. All pressure tests are to be documented on forms provided to the contractor. Form to include the following information:

System	Test Medium	Initial Test		Final Test	
		Pressure	Duration	Pressure	Duration
*Below Ground Domestic Water	Water	N/A		200 psig	2 hr
Above Ground Domestic Water	Water	N/A		100 psig	8 hr
Above Ground Non-potable Water	Water	N/A		100 psig	8 hr
Below Ground Non potable Water	Water	N/A		100 psig	8 hr
Sanitary Waste and Vent	Water	N/A		10' water	2 hr
Pressurized Sanitary Waste & Vent	Water	N/A		100 psig	2 hr
Storm and Clearwater Waste	Water	N/A		10' water	2 hr
Pressurized Storm/Clearwater Waste	Water	N/A		100 psig	2 hr
Acid Waste and Vent	Water	N/A		10' water	2 hr
Natural and LP Gas	Air	N/A		100 psig	24 hr
Compressed Air	Air	N/A		150 psig	24 hr
Swimming Pool/Fish/Aquarium	Water	N/A		100 psig	24 hr
Pure Water	Distilled Water	N/A		150 psig	8 hr
Oxygen	Nitrogen	150 psig	2 hr	65 psig	24 hr
Vacuum	Nitrogen	150 psig	2 hr	65 psig	24 hr
Nitrous Oxide	Nitrogen	150 psig	2 hr	65 psig	24 hr
Medical/Lab Compressed Air	Nitrogen	150 psig	2 hr	65 psig	24 hr
Nitrogen	Nitrogen	200 psig	2 hr	200 psig	24 hr
Helium	Nitrogen	150 psig	2 hr	65 psig	24 hr
Carbon Dioxide	Nitrogen	150 psig	2 hr	65 psig	24 hr

* Leakage on exterior mains 3" and larger may not exceed leakage calculated as follows:
 GPH Allowable Leakage = $\frac{(\text{Feet of Pipe}) (\text{Inches Dia. of Pipe}) (\text{Test Pressure})^{.5}}{133,200}$

END OF SECTION

**SECTION 22 05 13
MOTORS AND ELECTRICAL WORK**

PART 1 - GENERAL

1.02 GENERAL

- A. Applicable provisions of Division 00 govern work under this section.

1.01 SCOPE

- A. This section includes requirements for single and three phase motors that are used with equipment specified in other sections.

1.03 REFERENCE STANDARDS

- A. Abbreviations of standards organizations referenced in this and other sections are as follows:

ANSI/IEEE 112	Test Procedure for Polyphase Induction Motors and Generators
ANSI/NEMA MG-1	Motors and Generators
ANSI/NFPA 70	National Electrical Code

1.04 SHOP DRAWINGS

- A. Include with the equipment which the motor drives the following motor information: motor manufacturer, voltage, phase, hertz, rpm, full load efficiency, full load power factor, service factor, NEMA design designation, insulation class, and frame type.

1.05 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. Include manufacturer's instructions in the manuals with the specific equipment to which they apply.

1.06 ELECTRICAL COORDINATION

- A. All starters, disconnects, relays, wire, conduit, pushbuttons, pilot lights, and other devices required for the control of motors or electrical equipment are provided by the Electrical Contractor, except as specifically noted elsewhere in this division of specifications.
- B. Electrical drawings and/or specifications show number and horsepower rating of all motors furnished by this Contractor, together with their actuating devices if these devices are furnished by the Electrical Contractor. Should any discrepancy in size, horsepower rating, electrical characteristics or means of control be made to any motor or other electrical equipment after contracts are awarded, Contractor is to immediately notify the architect/engineer of such discrepancy. Costs involved in any changes required due to equipment substitutions initiated by this contractor will be the responsibility of this contractor.
- C. Furnish project specific wiring diagrams to Electrical Contractor for all equipment and devices furnished by this Contractor and indicated to be wired by the Electrical Contractor.

1.07 PRODUCT CRITERIA

- A. Motors to conform to all applicable requirements of NEMA, IEEE, ANSI, and NEC standards and shall be listed by U.L. for the service specified.
- B. Select motors for conditions in which they will be required to perform; i.e., general purpose, splashproof, explosion proof, standard duty, high torque or any other special type as required by the equipment or motor manufacturer's recommendations.
- C. Furnish motors for starting in accordance with utility requirements and compatible with starters as specified.

PART 2 - PRODUCTS

2.01 THREE PHASE, SINGLE SPEED MOTORS

- A. Use NEMA rated three phase, 60 hertz motors for all motors 1/2 HP and larger unless specifically indicated.
- B. Use NEMA general purpose, continuous duty, Design B , normal starting torque, T-frame or U-frame motors with Class B or better insulation unless the manufacturer of the equipment on which the motor is being used has different requirements. Use open drip-proof motors unless totally enclosed fan-cooled, totally enclosed non-ventilated, explosion-proof, or encapsulated motors are specified in the equipment sections.
- C. Use grease lubricated anti-friction ball bearings with housings equipped with plugged/capped provision for relubrication, rated for minimum AFBMA 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at the end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
- D. All open drip-proof motors to have a 1.15 service factor. Other motor types may have minimum 1.0 service factors.
- E. All motors 1 HP and larger, except specially wound motors and inline pump motors 56 frame and smaller, to be high efficiency design with full load efficiencies which meet or exceed the values listed below when tested in accordance with NEMA MG 1.

FULL LOAD NOMINAL MOTOR EFFICIENCY BY MOTOR SIZE AND SPEED

MOTOR HP	-----Open Drip-Proof Motors----- -----Nominal Motor Speed-----		
	1200 rpm	1800 rpm	3600 rpm
1	82.5	85.5	77.0
1½	86.5	86.5	84.0
2	87.5	86.5	85.5
3	88.5	89.5	85.5
5	89.5	89.5	86.5
7½	90.2	91.0	88.5
10	91.7	91.7	89.5
15	91.7	93.0	90.2
20	92.4	93.0	91.0
25	93.0	93.6	91.7
30	93.6	94.1	91.7
40	94.1	94.1	92.4

50	94.1	94.5	93.0
60	94.5	95.0	93.6
75	94.5	95.0	93.6
100	95.0	95.4	93.6
125	95.0	95.4	94.1
150	95.4	95.8	94.1
200	95.4	95.8	95.0

MOTOR HP	----Totally Enclosed Fan-Cooled----		
	-----Nominal Motor Speed-----		
	1200 rpm	1800 rpm	3600 rpm
1	82.5	85.5	77.0
1½	87.5	86.5	84.0
2	88.5	86.5	85.5
3	89.5	89.5	86.5
5	89.5	89.5	88.5
7½	91.0	91.7	89.5
10	91.0	91.7	90.2
15	91.7	92.4	91.0
20	91.7	93.0	91.0
25	93.0	93.6	91.7
30	93.0	93.6	91.7
40	94.1	94.1	92.4
50	94.1	94.5	93.0
60	94.5	95.0	93.6
75	94.5	95.4	93.6
100	95.0	95.4	94.1
125	95.0	95.4	95.0
150	95.8	95.8	95.0
200	95.8	96.2	95.4

2.02 SINGLE PHASE, SINGLE SPEED MOTORS

- A. Use NEMA rated 115 volt, single phase, 60 hertz motors for all motors ½ HP and smaller.
- B. Use permanent split capacitor or capacitor start, induction run motors equipped with permanently lubricated and sealed ball or sleeve bearings and Class A insulation. Service factor to be not less than 1.35.

2.03 TWO-SPEED MOTORS

- A. Unless otherwise indicated, three phase two speed motors to be [one winding, consequent pole, variable torque type] [two winding, variable torque] and single phase motors to be capacitor start capacitor run type having two capacitors in parallel with run capacitor remaining in circuit at operating speeds.

2.04 MOTORS USED FOR REDUCED VOLTAGE STARTING

- A. Furnish motors compatible with reduced voltage starting for the following motors:

<u>Equipment</u>	<u>Starter Type</u>
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2.05 MOTORS USED ON VARIABLE FREQUENCY DRIVES

- A. In addition to the requirements specified above, the motor must be suitable for use with the drive specified, including but not limited to motor cooling.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Mount motors on a rigid base designed to accept a motor, using shims if required under each mounting foot to get a secure installation.
- B. When motor will be flexible coupled to the driven device, mount coupling to the shafts in accordance with the coupling manufacturer's recommendations. Using a dial indicator, check angular misalignment of the two shafts; adjust motor position as necessary so that the angular misalignment of the shafts does not exceed 0.002-inches per-inch diameter of the coupling hub. Again using the dial indicator, check the shaft for run-out to assure concentricity of the shafts; adjust as necessary so that run-out does not exceed 0.002-inch.
- C. When motor will be connected to the driven device by means of a belt drive, mount sheaves on the appropriate shafts in accordance with the manufacturer's instructions. Use a straight edge to check alignment of the sheaves; reposition sheaves as necessary so that the straight edge contacts both sheave faces squarely. After sheaves are aligned, loosen the adjustable motor base so that the belt(s) can be added and tighten the base so that the belt tension is in accordance with the drive manufacturer's recommendations. Frequently recheck belt tension and adjust if necessary during the first day of operation and again after several days.
- D. Verify the proper rotation of each three-phase motor as it is being wired or before the motor is energized for any reason.
- E. Lubricate all motors requiring lubrication. Record lubrication material used and the frequency of use. Include this in the maintenance manuals.

END OF SECTION

**SECTION 22 05 23
VALVES**

PART 1 - GENERAL

1.01 GENERAL

- A. Applicable provisions of Division 00 govern work under this section.

1.02 SCOPE

- A. This section includes valve specifications for all Plumbing systems except where indicated under Related Work.

1.03 QUALITY ASSURANCE

- A. Refer to Division 00, General Conditions, Equals and Substitutions.

1.04 SUBMITTALS

- A. Schedule of all valves indicating type of service, dimensions, materials of construction, and pressure/temperature ratings for all valves to be used on the project. Temperature ratings specified are for continuous operation.

1.05 DESIGN CRITERIA

- A. ANSI Z21.22 - Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems.
- B. ASSE 1003 - Water Pressure Reducing Valves for Domestic Water Supply Systems.
- C. Where valve types (ball, butterfly, etc.) are specified for individual plumbing services (i.e. domestic water, gas, etc.), each valve type shall be of the same manufacturer unless prior written approval is obtained from the Owner.
- D. Valves to be line size unless specifically noted otherwise.

PART 2 - PRODUCTS

2.01 WATER SYSTEM VALVES

- A. All water system valves to be rated at not less than 125 water working pressure at 240 degrees F unless noted otherwise.
- B. Ball Valves: 3" and smaller: Two or three piece bronze body; sweat ends, chrome plated bronze ball; glass filled teflon seat; teflon packing and threaded packing nut; blowout-proof stem; 600 psig WOG. Provide valve stem extensions for valves installed in piping with vapor barrier type insulation. Apollo 70-200, Grinnell 3700, Hammond 8511, Milwaukee BA250, Nibco S580-70, Watts B-6001.
- C. Thermoplastic Ball Valves: 3" and smaller: Thermoplastic body; replaceable HDPE floating seat; ASTM F 1970; high impact polypropolyene handle; 325 psig (up to 2") 150

psig 2-1/2"-4". Provide valve stem extensions for valves installed in piping with vapor barrier type insulation. Spear Mfrg. or approved equal.

D. Butterfly valves:

1. 2½" and larger: Cast or ductile iron body; stainless steel shaft; bronze, copper or teflon bushings; EPDM resilient seat; EPDM seals; bronze, aluminum-bronze, EPDM encapsulated ductile iron or stainless steel disc. 200 psig WOG through 12", 150 psig WOG through 24". Valve assembly to be bubble tight to 175 psig with no downstream flange/pipe attached. Use tapped lug type valves with stud bolts or cap screws, or grooved end connection valves, permitting removal of downstream piping while using the valve for system shutoff. Centerline LT series, DeZurik 632, Grinnell Series 8000, Hammond 6200 Series, Milwaukee M or C Series, Nibco LD2000/LC2860, Victaulic 300/608/700/709, Watts BF-03.
2. Thermoplastic 2½" and larger: Thermoplastic body; EPDM seat and seals; ASME B16.5 Class 150 Bolt Pattern; fully isolated solid type 316L stainless steel stem; 150 psig. Spear Mfrg. or approved equal.
3. Provide 10 position locking lever handle actuators for valves 6" and smaller. Provide worm gear operators with external position indication for valves 8" and larger.

E. Swing check valves:

1. 3" and smaller: Bronze body, sweat ends, Y-pattern, regrindable bronze seat, renewable bronze disc, Class 125, suitable for installation in a horizontal or vertical line with flow upward. Crane 1342, Grinnell 3300SJ, Hammond IB941, Nibco S413B, Watts CVYS.
2. 4" and larger: Cast iron body, flanged ends, bronze trim, bolted cap, renewable bronze seat and disc, Class 125, non-asbestos gasket, suitable for installation in a horizontal or vertical line with flow upward. Crane 373, Grinnell 6300A, Hammond IR1124, Milwaukee F2974, Nibco F918B, Watts Series 411.

F. Spring loaded check valves:

1. 2" and smaller: Bronze body, sweat or threaded ends, bronze trim, stainless steel spring, stainless steel center guide pin, Class 125, teflon seat unless only bronze available. ConBraCo 61 series, Grinnell 3600SJ, Mueller 203BP, Nibco S480Y, Val-Matic S1400 series.
2. 2½" and larger: Cast or ductile iron body, wafer or globe type, bronze trim, bronze or EPDM seat, stainless steel spring, stainless steel stem if stem is required, Class 125. APCO 300 or 600 series, Centerline CLC with full body option, Hammond IR9354, Milwaukee 1800 series, Mueller Steam 101AP or 105AP, Nibco W910 or F910, Val-Matic 1400 or 1800 or 8000 series.

G. Stop & Waste Valves: 1" and smaller, Bronze body, sweat or threaded ends, 400 psi WOG, stainless steel ball and stem, full port ball valve, with threaded drain cap, Watts B-6300/6301 SS series. Apollo, Grinnell, Hammond, Milwaukee or Nibco manufacturer.

H. Balance valves: 2" and smaller: Lead-Free Brass body, sweat ends, stainless steel ball construction, glass filled teflon seat, ¼" NPT drain port, with adjustable memory stop position indicator, suitable for 200 psig water working pressure at 250 degrees F. Bell & Gossett CB-*/S LF or approved equal.

- I. Drain Valves: ¾-inch ball valve with integral threaded hose adapter, sweat or threaded inlet connections, with threaded cap and chain on hose threads, Watts B-6000-CC/B-6001-CC series.
- J. Buried Water Service Gate valves: Cast iron body, resilient elastomer coated cast iron disc, permanently lubricated stuffing box, bronze non-rising stem and stem nut, double O-ring stem seal, Delrin thrust bearings, electroplated nuts and bolts, cast iron operating nut, AWWA C509, rated for 200 psi. Coat valve inside and out with fusion bonded epoxy, AWWA C550. Clow F-6100, Kennedy 1571, M&H 3067, Mueller A-2360, Waterous 500, Watts 406RW.
- K. Corporation Stop valves: 2" and smaller: Bronze body ground key valve, bronze plug, AWWA taper thread inlet and copper flare outlet nut connections, AWWA C800.
- L. Curb Stop valves: 2" and smaller: Bronze body plug valve, bronze plug, quarter turn check, O-ring seals, copper flare nut connections, AWWA C800.

2.02 PURE WATER VALVES

A. DIAPHRAGM VALVES:

- 1. 2" smaller, polypropylene type 1 homopolymer construction ASTM D-4101 and D-2146, butt fusion or spigot ends, rated 150 psi at 68 deg. F, PTFE/Teflon diaphragm seals with EDPM backing, wheel handle operated. George Fischer type 315 or equal.
- 2. 2½" thru 4", polypropylene type 1 homopolymer construction ASTM D-4101 and D-2146, flanged connections, rated at 150 psi at 68 deg. F, PTFE/Teflon diaphragm seals with EDPM backing, wheel handle operated. George Fischer type 317 or equal.

B. Check Valves:

- 1. 2" and smaller, three piece body, ball check type, polypropylene type 1 homopolymer construction ASTM D-4101 and D-2146, fusion socket, rated 150 psi at 68 deg. F. George Fischer type 360 or equal.
- 2. Polypropylene valves, unions, flanges, fittings to be constructed of same materials as pipe and fittings and compatible with the piping installed in the system.

2.03 WASTE SYSTEM VALVES

A. Gate Valves:

- 1. 2" and smaller: Bronze body, bronze trim, threaded ends, solid wedge, rising stem, union bonnet, malleable iron hand wheel, suitable for 300 psi WOG. Crane 431UB, Grinnell 3080, Hammond IB629, Lunkenheimer 3151, Milwaukee 1151(M), Nibco T134, Powell 2714, Stockham B120.
- 2. 2½" and larger: Iron body, bronze trim, bolted bonnet, O.S. & Y., solid wedge, flanged, suitable for 200 psi WOG. Crane 465-1/2, Grinnell 6020A, Hammond IR1140, Lunkenheimer 1430, Milwaukee F2885, Nibco F617-O, Powell 1793, Stockham G623.

- B. Ball Valves: 3" and smaller: Two or three piece bronze body; sweat or threaded ends, chrome plated bronze ball; glass filled teflon seat; teflon packing and threaded packing

nut; blowout-proof stem; 400 psig WOG. Apollo 70-200, Grinnell 3700, Hammond 8511, Milwaukee BA150, Nibco S585-70, Watts B-6001.

C. Swing check valves:

1. 1½" and smaller: Bronze body, threaded ends, Y-pattern, regrindable bronze seat, renewable bronze disc, Class 125, suitable for installation in a horizontal or vertical line with flow upward. Crane 1342, Grinnell 3300SJ, Hammond IB941, Nibco S413B, Watts CVYS.
2. 2" and larger: Cast iron body, flanged ends, bronze trim, bolted cap, renewable bronze seat and disc, Class 125, non-asbestos gasket, outside lever and weight or spring, suitable for installation in a horizontal or vertical line with flow upward. Crane 383, Grinnell 6300A, Milwaukee F2974, Nibco F918B.

D. Spring Loaded Check Valves:

1. 2" and smaller: Bronze body, sweat or threaded ends, bronze trim, stainless steel spring, stainless steel center guide pin, Class 125, teflon seat unless only bronze available. ConBraCo 61 series, Grinnell 3600SJ, Mueller 203BP, Nibco S480Y, Val-Matic S1400 series.
2. 2½" and larger: Cast or ductile iron body, wafer or globe type, bronze trim, bronze or EPDM seat, stainless steel spring, stainless steel stem if stem is required, Class 125. APCO 300 or 600 series, Centerline CLC with full body option, Hammond IR9354, Milwaukee 1800 series, Mueller Steam 101AP or 105AP, Nibco W910 or F910, Val-Matic 1400 or 1800 or 8000 series.

2.05 NATURAL GAS SYSTEMS

A. Shut-Off Valves:

1. 4" and smaller: Ball or eccentric plug valve, bronze or cast iron body, 2" and under threaded ends, 2½" and over flanged ends, chrome plated bronze ball, bronze or nickel plated cast iron plug, TFE or Hycar seats and seals, lever handle, 175 psi W.O.G., U.L listed for use as natural gas shut-off. Apollo 80-100, DeZurik 425.
2. 5" and larger: Cast iron body, flanged ends, stainless steel bearings, resilient faced plugs, totally enclosed hand wheel actuators, 175 psi W.O.G., U.L. listed for use as natural gas shut-off.

B. Exterior Below Grade Shut-Off Valves: Plug or ball valve, body of same polyethylene type as piping system, pipe stub ends, high strength plastic stem and operating nut, position indicator, polyethylene plug or polypropylene ball, Buna-N seats and double stem seals, rated for 96 psi natural gas service (150 psi non-lethal service).

C. Gas Pressure Regulators: 2" and smaller: Cast iron body, aluminum spring and diaphragm, Nitrile diaphragm, threaded ends, 150 psi W.O.G., -20 degrees F to 150 degrees F.

2.06 COMPRESSED AIR SYSTEMS

A. Shut-Off Valves: 3" and smaller: Two or three piece bronze body; threaded ends, chrome plated bronze ball; glass filled teflon seat; teflon packing and threaded packing nut; blowout-proof stem; 600 psig WOG. Apollo 70-100, Milwaukee BA100, Nibco T585-70 or T-590-Y, Watts B-6000.

- B. Safety Exhaust Shut-Off Valves: 3" and smaller: Two or three piece bronze body; threaded ends, chrome plated bronze ball; downstream vent port; glass filled teflon seat; teflon packing and threaded packing nut; blowout-proof stem; 175 psig WOG. Apollo 70-100-41, Watts B-6000.
- C. Pressure Reducing Valves: Bronze or aluminum body and trim, diaphragm or balanced piston, 250 psig maximum, 0-125 psig adjustable output, internal relief, ¼" outlet gauge tapping.

2.07 SPECIALTY VALVES AND VALVE ACCESSORIES

- A. Gauge Valves: Use ¼" ball valves. Needle valves and gauge cocks will not be accepted.
- B. Water Pressure Reducing Valves: Bronze body, diaphragm operated, with an integral thermal expansion bypass valve, inlet union, stainless steel strainer, renewable monel or stainless steel seat and adjustable reduced pressure range, 300 psig at 160 degrees F. Pre-set for the scheduled pressure. A. W. Cash, Conbraco, Watts, Wilkins.
- C. Safety Relief Valves: Bronze body, temperature and pressure actuated, stainless steel stem and spring, thermostat with non-metallic coating, test lever, suitable for 125 psig water working pressure at 240 degrees F, sized for full BTUH input and operating pressure of equipment, with valve capacity on metal label. For equipment less than or equal to 200,000 BTUH input, provide AGA, UL or ASME listed and labeled valve. Provide ASME listed and labeled valve for larger equipment. Bell & Gossett, A. W. Cash, Conbraco, Watts, Wilkins. Temperature and pressure relief valve shall be sized per AGA rating for BTUH input, Re: COMM 82.40(5)(d).

PART 3 - EXECUTION

3.01 GENERAL

- A. Properly align piping before installation of valves. Install and test valves in strict accordance with valve manufacturer's installation recommendations. Do not support weight of piping system on valve ends.
- B. Mount valves in locations which allow access for operation, servicing and replacement.
- C. Install all valves with the stem in the upright or horizontal position. If possible, install butterfly valves with the stem in the horizontal position. Valves installed with the stems down will not be accepted.
- D. Prior to flushing of piping systems, place all valves in the full-open position.

3.02 SHUT-OFF VALVES

- A. Install shut-off valves at each piece of equipment, at each branch take-off from mains for isolation or repair and elsewhere as indicated.

3.03 BALANCING VALVES

- A. Install where indicated on the drawings and details for balancing of pumped systems.

- B. Upon project completion, adjust each valve and set position stop. Balance system to minimum flow in return piping branches needed to maintain even supply water temperature throughout building.

3.04 DRAIN VALVES

- A. Provide drain valves for complete drainage of all systems. Locations of drain valves include low points of piping systems, downstream of riser isolation valves, equipment locations specified or detailed, other locations required for drainage of systems and elsewhere as indicated.

3.05 SPRING LOADED CHECK VALVES

- A. Install a spring loaded check valve in each circulating pump discharge line, each clearwater sump pump discharge line and elsewhere as indicated.

3.06 SWING CHECK VALVES

- A. Install swing check valves in recirculation branch lines and elsewhere as indicated. Provide weighted swing check valves at sanitary sump pump discharges.

3.07 PRESSURE REDUCING VALVES

- A. Provide ball valve and strainer at inlet and ball valve at outlet. Install pressure gauges to indicate inlet and outlet pressure at each pressure reducing valve.

3.08 SAFETY RELIEF VALVES

- A. Install relief valves on all pressure vessels and elsewhere as indicated. Inlet and outlet piping connecting to valves must be the same size as valve connections or larger. Pipe discharge to drain where indicated or to floor.

3.09 GAS PRESSURE REGULATORS

- A. When the gas pressure regulator is equipped with a vent connection, run a connection size vent to outside air in accordance with codes. Use a larger size vent when required by the manufacturer's installation instructions.

3.10 COMPRESSED AIR VALVES

- A. Install shut-off valves at each piece of equipment, base of drip legs and elsewhere as indicated. Install safety exhaust shut-off valves at terminal equipment designed for frequent removal. Install pressure reducing valves at filter stations and elsewhere as indicated. Mount in readily accessible location for gauge and maintenance access.

3.11 SEWER AIR AND VACUUM VALVES

- A. Install sewer air and vacuum valves at high points of forcemains, at grade changes, every ½ mile on lines with little gradient and elsewhere as indicated. Locate in valve manhole with watertight cover, sealed to top of main and of sufficient depth to prevent freezing. Mount valves allowing access in manhole for backflushing and servicing.

END OF SECTION

**SECTION 22 05 29
SUPPORTS AND ANCHORS**

PART 1 - GENERAL

1.01 GENERAL

- A. Applicable provisions of Division 00 shall govern work under this section.

1.02 SCOPE

- A. This section includes specifications for supports of all plumbing equipment and materials as well as piping system anchors.

1.03 REFERENCE STANDARDS

- A. Abbreviations of standards organizations referenced in this and other sections are as follows:

MSS SP-58	Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP-69	Pipe Hangers and Supports - Selection and Application

1.04 QUALITY ASSURANCE

- A. Refer to Division 00, General Conditions, Equals and Substitutions.

1.05 DESCRIPTION

- A. Provide all supporting devices as required for the installation of mechanical equipment and materials. All supports and installation procedures are to conform to the latest requirements of the ANSI Code for building piping.
- B. Do not hang any mechanical item directly from a metal deck or run piping so its rests on the bottom chord of any truss or joist.
- C. Fasteners depending on soft lead for holding power or requiring powder actuation will not be accepted.
- D. Support apparatus and material under all conditions of operation, variations in installed and operating weight of equipment and piping, to prevent excess stress, and allow for proper expansion and contraction.
- E. Protect insulation at all hanger points; see Related Work above.

1.06 SHOP DRAWINGS

- A. Schedule of all hanger and support devices indicating attachment methods and type of device for each pipe size and type of service.

1.07 DESIGN CRITERIA

- A. Materials and application of pipe hangers and supports shall be in accordance with MSS Standard Practice SP-58 and SP-69 unless noted otherwise.

- B. Piping connected to pumps, compressors, or other rotating or reciprocating equipment is to have vibration isolation supports for a distance of one hundred pipe diameters or three supports away from the equipment, whichever is greater. Standard pipe hangers/supports as specified in this section are required beyond the 100 pipe diameter/3 support distance.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers:
 - 1. B-Line
 - 2. Grinnell
 - 3. Pate
 - 4. Piping Technology
 - 5. Roof Products & Systems or approved equal

2.02 STRUCTURAL SUPPORTS

- A. Provide all supporting steel required for the installation of mechanical equipment and materials, including angles, channels, beams, etc. to suspended or floor supported tanks and equipment. All of this steel may not be specifically indicated on the drawings.

2.03 PIPE HANGERS AND SUPPORTS

- A. Hangers for Pipe Sizes ½" Through 2":
 - 1. Carbon steel, adjustable swivel ring. B-Line B3170NF, Grinnell 69 or 70.
 - 2. Carbon steel, adjustable clevis, standard. B-Line B3100, Grinnell 260.
- B. Hangers for Pipe Sizes 2" and Larger:
 - 1. Carbon steel, adjustable clevis, standard. B-Line B3100, Grinnell 260.
- C. Multiple or Trapeze Hangers:
 - 1. Steel channels with welded spacers and hanger rods.
- D. Wall Support:
 - 1. Carbon steel welded bracket with hanger. B-Line 3068 Series, Grinnell 194 Series.
 - 2. Perforated, epoxy painted finish, 16-12 gauge, min., steel channels securely anchored to wall structure, with interlocking, split-type, bolt secured, galvanized pipe/tubing clamps. B-Line type S channel with B-2000 series clamps, Grinnell type PS 200 H with PS 1200 clamps. When copper piping is being supported, provide flexible elastomeric/ thermoplastic isolation cushion material to completely encircle the piping and avoid contact with the channel or clamp, equal to B-Line B1999 Vibra Cushion or provide manufacturers clamp and cushion assemblies, B-Line BVT series, Grinnell PS 1400 series.
- E. Vertical Support:

1. Carbon steel riser clamp. B-Line B3373, Grinnell 261 for above floor use. Grinnell 40 with bolts and concrete anchors for attachment to under side of concrete floor deck.

F. Floor Support:

1. Carbon steel pipe saddle, stand and bolted floor flange. B-Line B3088T/B3093.

G. Copper Pipe Supports:

1. All supports, fasteners, clamps, etc. directly connected to copper piping shall be copper plated or polyvinylchloride coated. Where steel channels are used, provide isolation collar between supports/clamps/fasteners and copper piping.

H. Glass Pipe Supports: All supports, clamps, etc. directly connected to glass piping shall be fully lined with 1/4" neoprene padding.

2.04 PIPE HANGER RODS

A. Steel Hanger Rods:

1. Threaded both ends, threaded one end, or continuous threaded, complete with adjusting and lock nuts.
2. Size rods for individual hangers and trapeze support as indicated in the following schedule.
3. Total weight of equipment, including valves, fittings, pipe, pipe content, and insulation, are not to exceed the limits indicated.

Maximum Load (Lbs.) (650°F Maximum Temp.)	Rod Diameter (inches)
610	3/8
1130	1/2
1810	5/8
2710	3/4
3770	7/8
4960	1
8000	1 1/4

2.05 BEAM CLAMPS

- A. MSS SP-69 Types 19 & 23 malleable black iron clamp for attachment to beam flange to 0.62-inches thick with a retaining ring and threaded rod of 3/8, 1/2, and 5/8-inch diameter. Furnish with a hardened steel cup point set screw. B-Line B3036L/B3034, Grinnell 86/92.
- B. MSS SP-69 Type 28 or Type 29 forged steel jaw type clamp with a tie rod to lock clamp in place, suitable for rod sizes to 1 1/2-inch diameter. B-Line B3054, Grinnell 228.

2.06 CONCRETE INSERTS

A. Poured in Place:

1. MSS SP-69 Type 18 wedge type to be constructed of a black carbon steel body with a removable malleable iron nut that accepts threaded rod to 7/8-inch

- diameter. Wedge design to allow the insert to be held by concrete in compression to maximize the load carrying capacity. B-Line B2505, Grinnell 281.
2. MSS SP-69 Type 18 universal type to be constructed of black malleable iron body with a removeable malleable iron nut that accepts threaded rod to 7/8-inch diameter. B-Line B3014N, Grinnell 282.

- B. Drilled Fasteners: Carbon steel expansion anchors, vibration resistant, with ASTM B633 zinc plating. Use drill bit of same manufacturer as anchor. Hilti, Rawl, Redhead.

2.07 CONTINUOUS CONCRETE INSERT CHANNELS

- A. Steel inserts with an industry standard pre-galvanized finish, nominally 1⁵/₈-inch wide by 1³/₈-inch deep by length to suit the application, designed to be nailed to concrete forms and provide a linear slot for attaching other support devices. Installed channels to provide a load rating of 2000 pounds per foot in concrete. Manufacturer's standard brackets, inserts, and accessories designed to be used with the channel inserts may be used. Select insert length to accommodate all pipe in the area.

2.08 ANCHORS

- A. Use welding steel shapes, plates, and bars to secure piping to the structure.

2.09 EQUIPMENT STANDS

- A. Use structural steel members welded to and supported by pipe supports. Clean, prime and coat with three coat rust inhibiting alkyd paint or one coat epoxy mastic. Where exposed to weather, treat with corrosive atmosphere coatings.

2.10 ROOF MOUNTED PIPE ROLLER SUPPORT

- A. Minimum height of support to be 14" above roof deck.
- B. Constructed of not less than 18 gauge galvanized steel reinforced so it is structurally capable of supporting the intended load with no penetrations through the curb flashing, inside and outside corner sections that are mitered and continuously welded, filled with 3 pound density insulation, integral deck mounting flange, nominal two-inch wood nailer, galvanized steel counterflashing with attached galvanized steel channel track for securing pipe roller and roller support. Do not use built-in metal base flashings or cants.
- C. Supports 30" or More In Height: Use structural steel members supported by pipe supports and use pipe rollers fastened to the structural member. Pipe supports to be secured to the roof structure. Treat with corrosive atmosphere coatings.

2.11 CORROSIVE ATMOSPHERE COATINGS

- A. Factory coat supports and anchors used in corrosive atmospheres with hot dip galvanizing after fabrication, ASTM A123, 1.5 ounces/square foot of surface each side. Mechanical galvanize threaded products, ASTM B695 Class 50, 2.0 mil coating. Field cuts and damaged finishes to be field covered with zinc rich paint of comparable thickness to factory coating.
- B. Corrosive atmospheres include the following locations:
 1. Exterior locations

2. Parking ramps
3. Swimming pool equipment rooms
4. Chemical storage and hazardous waste storage rooms
5. Wet wells
6. Sanitary pumping stations
7. Food service/kitchen areas
8. Walk-in coolers/freezers
9. Locker rooms
10. Greenhouses
11. Meter pits

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Size, apply and install supports and anchors in compliance with manufacturers recommendations.
- B. Install supports to provide for free expansion of the piping system. Support all piping from the structure using concrete inserts, beam clamps, ceiling plates, wall brackets, or floor stands. Fasten ceiling plates and wall brackets securely to the structure and test to demonstrate the adequacy of the fastening.
- C. Coordinate hanger and support installation to properly group piping of all trades.
- D. Where piping can be conveniently grouped to allow the use of trapeze type supports, use standard structural shapes or continuous insert channels for the supporting steel. Where continuous insert channels are used, pipe supporting devices made specifically for use with the channels may be substituted for the specified supporting devices provided that similar types are used and all data is submitted for prior approval.
- E. Size and install hangers and supports, except for riser clamps, for installation on the exterior of piping insulation. Where a vapor barrier is not required, hangers may be installed either on the exterior of pipe insulation or directly on piping.
- F. Perform welding in accordance with standards of the American Welding Society.

3.02 HANGER AND SUPPORT SPACING

- A. Install hangers to provide minimum 1/2-inch space between finished covering and adjacent work.
- B. Place a hanger within 12-inches of each horizontal elbow, valve, strainer, or similar piping specialty item.
- C. Use hangers with 1 1/2-inch minimum vertical adjustment.
- D. Where several pipes can be installed in parallel and at the same elevation, provide multiple or trapeze hangers.
- E. Support riser piping independently of connected horizontal piping.
- F. Adjust hangers to obtain the slope specified in the piping section of these specifications.

G. Space hangers for pipe as follows:

<u>Pipe Material</u>	<u>Pipe Size</u>	<u>Max. Horiz. Spacing</u>	<u>Max. Vert. Spacing</u>
Cast Iron	2" and larger	5'-0"	15'-0"
Copper	½" through ¾"	5'-0"	10'-0"
Copper	1" through 1¼"	6'-0"	10'-0"
Copper	1½" through 2½"	8'-0"	10'-0"
Copper	3"	10'-0"	10'-0"
Copper	4" and larger	12'-0"	10'-0"
Ductile Iron	All	10'-0"	00'-0"
Glass	Per Pipe Mfr.	8'-0"	12'-0"
Steel	½" through 1¼"	7'-0"	15'-0"
Steel	1½" through 6"	10'-0"	15'-0"
Steel	8" through 12"	14'-0"	20'-0"
Steel	14" and over	20'-0"	20'-0"
Plastic	Drain and Vent	4'-0"	10'-0"
Plastic	1" or less	3'-0"	5'-0"
Plastic	1¼" and over	4'-0"	6'-0"
Plastic	Pure Water 1½" or less	Continuous	5'-0"

3.03 RISER CLAMPS

A. Support vertical piping with clamps secured to the piping and resting on the building structure or secured to the building structure below at each floor.

3.04 CONCRETE INSERTS AND CONTINUOUS INSERT CHANNELS

A. Select size based on the manufacturer's stated load capacity and weight of material that will be supported. Locate continuous insert channels on 6'-0" maximum centers and 2'-0" from corners. Furnish inserts to the General Contractor for placement in concrete formwork. Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4-inch size. Where concrete slabs form finished ceiling, provide inserts that are flush with the slab surface.

3.05 ANCHORS

A. Install where indicated on the drawings and details. Where not specifically indicated, install anchors at ends of principal pipe runs and at intermediate points in pipe runs between expansion loops. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

3.06 ROOF MOUNTED PIPE ROLLER SUPPORT

A. Secure bottom of support flat on roof deck. Apply two coats of zinc rich paint to cut edges of all galvanized steel elements. Flashing and counter flashing by the General Contractor.

END OF SECTION

**SECTION 22 07 00
PLUMBING INSULATION**

PART 1 - GENERAL

1.01 GENERAL

- A. Applicable provisions of Division 00 govern work under this section.

1.02 SCOPE

- A. This section includes insulation specifications for plumbing piping and equipment.

1.03 REFERENCE STANDARDS

- A. Abbreviations of standards organizations referenced in this and other sections are as follows:

ASTM B209	Aluminum and Aluminum Alloy Sheet and Plate
ASTM C165	Test Method for Compressive Properties of Thermal Insulations
ASTM C177	Heat Flux and Thermal Transmission Properties
ASTM C195	Mineral Fiber Thermal Insulation Cement
ASTM C240	Cellular Glass Insulation Block
ASTM C302	Density of Preformed Pipe Insulation
ASTM C303	Density of Preformed Block Insulation
ASTM C449	Mineral Fiber Hydraulic Setting Thermal Insulation Cement
ASTM C518	Heat Flux and Thermal Transmission Properties
ASTM C533	Calcium Silicate Block and Pipe Thermal Insulation
ASTM C534	Preformed Flexible Elastomeric Thermal Insulation
ASTM C547	Mineral Fiber Preformed Pipe Insulation
ASTM C552	Cellular Glass Block and Pipe Thermal Insulation
ASTM C553	Mineral Fiber Blanket and Felt Insulation
ASTM C578	Preformed, Block Type Cellular Polystyrene Thermal Insulation
ASTM C591	Preformed Rigid Cellular Polyurethane Thermal Insulation
ASTM C610	Expanded Perlite Block and Thermal Pipe Insulation
ASTM C612	Mineral Fiber Block and Board Thermal Insulation
ASTM C921	Properties of Jacketing Materials for Thermal Insulation
ASTM C1136	Flexible Low Permeance Vapor Retarders for Thermal Insulation
ASTM E84	Surface Burning Characteristics of Building Materials
MICA	National Commercial & Industrial Insulation Standards
NFPA 225	Surface Burning Characteristics of Building Materials
UL 723	Surface Burning Characteristics of Building Materials

1.04 QUALITY ASSURANCE

- A. Refer to Division 00, General Conditions, Equals and Substitutions.
- B. Label all insulating products delivered to the construction site with the manufacturer's name and description of materials.

1.05 DESCRIPTION

- A. Furnish and install all insulating materials and accessories as specified or as required for a complete installation. The following types of insulation are specified in this section:

1. Pipe Insulation
2. Equipment Insulation

- B. Install all insulation in accordance with the latest edition of MICA (Midwest Insulation Contractors Association) Standard and manufacturer's installation instructions. Exceptions to these standards will only be accepted where specifically modified in these specifications, or where prior written approval has been obtained from the Engineer.

1.06 DEFINITIONS

- A. Concealed: shafts, furred spaces, space above finished ceilings, utility tunnels and crawl spaces. All other areas, including walk-through tunnels, shall be considered as exposed.

1.07 SHOP DRAWINGS

- A. Submit a schedule of all insulating materials to be used on the project, including adhesives, fastening methods, fitting materials along with material safety data sheets and intended use of each material. Include manufacturer's technical data sheets indicating density, thermal characteristics, jacket type, and manufacturer's installation instructions.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Materials or accessories containing asbestos will not be accepted.
- B. Use composite insulation systems (insulation, jackets, sealants, mastics, and adhesives) that have a flame spread rating of 25 or less and smoke developed rating of 50 or less, with the following exceptions:
1. Insulation which is not located in an air plenum may have a flame spread rating not over 25 and a smoke developed rating no higher than 150.

2.02 INSULATION AND JACKETS

- A. Manufacturers:
1. Certainteed Manson
 2. Childers
 3. Dow
 4. Extol
 5. Halstead
 6. H.B. Fuller
 7. Imcoa
 8. Knauf
 9. Owens-Corning
 10. Pittsburgh Corning
 11. Schuller or approved equal
- B. Insulating materials shall be fire retardant, moisture and mildew resistant, and vermin proof. Insulation shall be suitable to receive jackets, adhesives and coatings as indicated.
- C. Rigid Fiberglass Insulation:

1. Minimum nominal density of 3 lbs. per cu. ft., and thermal conductivity of not more than 0.23 at 75 degrees F, minimum compressive strength of 25 PSF at 10% deformation, rated for service to 450 degrees F.
2. White kraft reinforced foil vapor barrier all service jacket, factory applied to insulation with a self-sealing pressure sensitive adhesive lap, maximum permeance of .02 perms and minimum beach puncture resistance of 50 units.

D. Semi-Rigid Fiberglass Insulation:

1. Minimum nominal density of 3 lbs. per cu. ft., thermal conductivity of not more than 0.28 at 75 degrees F, minimum compressive strength of 125 PSF at 10% deformation, rated for service to 450 degrees F. Insulation fibers perpendicular to jacket and scored for wrapping cylindrical surfaces.
2. White kraft reinforced foil vapor barrier all service jacket, factory applied to insulation with a maximum permeance of .02 perms and minimum beach puncture resistance of 50 units.

E. Calcium Silicate Insulation:

1. Rigid hydrous calcium silicate, ASTM C533, Type I, minimum dry density of 12.5 lbs. per cu. ft., thermal conductivity of not more than 0.44 at 300 degrees F, maximum water absorption of 90% by volume, minimum compressive strength 140 psi at 5% deformation, rated for service range of 0 degrees F to 1, 200 degrees F. Material to be visually coded or marked to indicate it is asbestos free.

F. Elastomeric Insulation:

1. Flexible closed cell, minimum nominal density of 5.5 lbs. per cu. ft., thermal conductivity of not more than 0.27 at 75 degrees F, minimum compressive strength of 4.5 psi at 25% deformation, maximum water vapor transmission of 0.17 perm-inch, maximum water absorption of 6% by weight, rated for service range of -20 degrees F to 220 degrees F on piping and 180 degrees F where adhered to equipment.

G. Polyolefin Insulation:

1. Flexible closed cell, minimum nominal density of 1.5 lbs. per cu. ft., thermal conductivity of not more than 0.24 at 75 degrees F, minimum compressive strength of 5 psi at 25% deformation, maximum water vapor transmission of 0.0 perm-inch, maximum water absorption of 0% by weight and volume, rated for service range of -165 degrees F to 210 degrees F.

H. Phenolic Insulation:

1. Rigid closed cell, minimum nominal density of 2.2 lbs. per cu. ft., thermal conductivity of not more than 0.13 at 75 degrees F, minimum compressive strength of 31 psi parallel and 18 psi perpendicular, maximum water vapor transmission 0.117 perm-inch, maximum water absorption of .5% by volume, rated for service range of -290 degrees F to 250 degrees F.
2. Kraft reinforced foil vapor barrier laminate all service jacket, factory applied to insulation with a self-sealing pressure sensitive adhesive lap, maximum permeance of .02 perms and minimum beach puncture resistance of 50 units.

I. Extruded Polystyrene Insulation:

1. Rigid closed cell, minimum nominal density of 2.2 lbs. per cu. ft., thermal conductivity of not more than 0.2 at 75 degrees F, minimum compressive strength of 35 psi, maximum water vapor transmission of 1.1 perm-inch, maximum water absorption of .1% by volume, rated for service range of -290 degrees F to 165 degrees F.

J. Urethane Insulation:

1. Rigid closed cell polyisocyanurate, minimum nominal density of 1.8 lbs. per cu. ft., thermal conductivity of not more than 0.19 at 75 degrees F aged 180 days, minimum compressive strength of 19 psi parallel and 10 psi perpendicular, maximum water vapor transmission of 4 perm-inch, maximum water absorption of .2% by volume, rated for service range of -290 degrees F to 300 degrees F.

K. Cellular Glass Insulation:

1. Rigid closed cell, minimum nominal density of 8.5 lbs. per cu. ft., thermal conductivity of not more than 0.36 at 50 degrees F, minimum compressive strength of 100 psi, maximum water vapor transmission of 0.0 perm-inch, maximum water absorption of .2% by volume, rated for service range of -450 degrees F to 900 degrees F.

L. Fireproofing Insulation:

1. Mineral fiber with nominal density of 8 lbs. per cu. ft., flame spread index of 15, fuel contribution index of 0, and smoke developed index of 0, thermal conductivity of not more than 0.23 at 75 degrees F.
2. Jacket material shall be the same as jacket for adjacent insulation.

M. PVC Fitting Covers And Jackets:

1. White PVC film, gloss finish one side, semi-gloss other side, FS LP-535D, Composition A, Type II, Grade GU.

N. Metal Jackets:

1. .016-inch thick aluminum or .010-inch thick stainless steel with safety edge.

2.03 INSULATION INSERTS AND PIPE SHIELDS

A. Manufacturers:

1. B-Line
2. Pipe Shields
3. Value Engineered Products

- B. Construct inserts with calcium silicate, minimum 140 psi compressive strength. Piping 12" and larger, supplement with high density 600 psi structural calcium silicate insert. Provide galvanized steel shield. Insert and shield to be minimum 180 degree coverage on bottom of supported piping and full 360 degree coverage on clamped piping. On roller mounted piping and piping designed to slide on support, provide additional load distribution steel plate.

- C. Where contractor proposes shop/site fabricated inserts and shields, submit schedule of materials, thicknesses, gauges and lengths for each pipe size to demonstrate equivalency to pre-engineered pre-manufactured product described above. On low temperature systems, extruded polystyrene may be substituted for calcium silicate provided insert and shield length and gauge are increased to compensate for lower insulation compressive strength.
- D. Precompressed 20# density molded fiberglass blocks, Hamfab or equal, of same thickness as adjacent insulation may be substituted for calcium silicate inserts with one 1" x 6" block for piping through 2½" and three 1" x 6" blocks for piping through 4". Submit shield schedule to demonstrate equivalency to pre-engineered/pre-manufactured product described above.
- E. Wood blocks will not be accepted.

2.04 ACCESSORIES

- A. All products shall be compatible with surfaces and materials on which they are applied, and be suitable for use at operating temperatures of the systems to which they are applied.
- B. Adhesives, sealants, and protective finishes shall be as recommended by insulation manufacturer for applications specified.
- C. Insulation bands to be ¾-inch wide, constructed of aluminum or stainless steel. Minimum thickness to be .015-inch for aluminum and .010-inch for stainless steel.
- D. Tack fasteners to be stainless steel ring grooved shank tacks.
- E. Staples to be clinch style.
- F. Insulating cement to be ANSI/ASTM C195, hydraulic setting mineral wool.
- G. Finishing cement to be ASTM C449.
- H. Fibrous glass or canvas fabric reinforcing shall have a minimum untreated weight of 6 oz./sq. yd.
- I. Bedding compounds to be non-shrinking and permanently flexible.
- J. Vapor barrier coatings to be non-flammable, fire resistant, polymeric resin.
- K. Fungicidal water base coating (Foster 40-20 or equal) to be compatible with vapor barrier coating.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install insulation, jackets and accessories in accordance with manufacturers instructions and under ambient temperatures and conditions recommended by manufacturer. Surfaces to be insulated must be clean and dry.

- B. Do not insulate systems or equipment which are specified to be pressure tested or inspected, until testing, inspection and any necessary repairs have been successfully completed.
- C. Install insulation with smooth and even surfaces. Poorly fitted joints or use of filler in voids will not be accepted. Cover and seal exposed fiberglass insulation when insulation is terminated, no raw fiberglass insulation is allowed. Provide neat and coated terminations at all nameplates, uninsulated fittings, or at other locations where insulation terminates. Install with longitudinal joints facing wall or ceiling.
- D. Seal off raw ends of insulation and butt joints with vapor barrier mastic at intervals of not more than 20 feet of piping requiring a vapor barrier.
- E. Install fabric reinforcing without wrinkles. Overlap seams a minimum of 2-inches.
- F. Use full-length material (as delivered from manufacturer) wherever possible. Scrap piecing of insulation or pieces cut undersize and stretched to fit will not be accepted.
- G. Insulation shall be continuous through sleeves and openings. Vapor barriers shall be maintained continuous through all penetrations.
- H. Provide a complete vapor barrier for insulation on the following systems:
 - 1. Cold water
 - 2. Storm Water
 - 3. Equipment with a surface temperature below 65 degree F.

3.02 PIPING, VALVE, AND FITTING INSULATION

- A. General:
 - 1. Install insulation with butt joints and longitudinal seams closed tightly. Provide minimum 2" lap on jacket seams and 2" tape on butt joints, firmly cemented with lap adhesive. Additionally secure with staples along seams and butt joints. Coat staples with vapor barrier mastic on systems requiring vapor barrier.
 - 2. Water supply piping insulation shall be continuous throughout the building and installed adjacent to and within building walls to a point directly behind the fixture that is being supplied.
 - 3. Install insulation continuous through pipe hangers and supports with hangers and supports on the exterior of insulation. Where a vapor barrier is not required, hangers and supports may be attached directly to piping with insulation completely covering hanger or support and jacket sealed at support rod penetration. Where riser clamps are required to be attached directly to piping requiring vapor barrier, extend insulation and vapor barrier jacketing/coating around riser clamp.
- B. Insulation Inserts and Pipe Shields: Provide insulation inserts and pipe shields at all hanger and support locations. Inserts may be omitted on 3/4" and smaller copper piping provided 12" long 22 gauge pipe shields are used.
- C. Fittings and Valves: Fittings, valves, unions, flanges, couplings and specialties may be insulated with factory molded or built up insulation of the same thickness as adjoining insulation. Cover insulation with fabric reinforcing and mastic or where temperatures do not exceed 150 degrees, PVC fitting covers. Secure PVC fitting covers with tack fasteners

and 1½" band of mastic over ends, throat, seams or penetrations. On systems requiring vapor barrier, use vapor barrier mastic.

D. Elastomeric and Polyolefin: Where practical, slip insulation on piping during pipe installation when pipe ends are open. Miter cut fittings allowing sufficient length to prevent stretching. Completely seal seams and joints for vapor tight installation. For elastomeric insulation, apply full bed of adhesive to both surfaces. For polyolefin, seal factory preglued seams with roller and field seams and joints with full bed of hot melt polyolefin glue to both surfaces.

E. Pipe Insulation Schedule:

1. Provide insulation on new and existing remodeled piping as indicated in the following schedule:

Service	Insulation Types	1" and	1¼"	2½"	5"	8" and
		Smaller	to 2"	to 4"	to 6"	larger
Hot Water Supply	Rigid Fiberglass	1"	1"	1"	1.5"	1.5"
Hot Water Circulating	Rigid Fiberglass	1"	1"	1"		
Cold Water	Rigid Fiberglass	1"	1"	1"	1"	1"
Non-Potable Cold Water	Rigid Fiberglass*	1"	1"	1"	1"	1"
Non-Potable Hot Water	Rigid Fiberglass	1"	1"			
Horizontal Storm & Roof Drain Bodies	Rigid Fiberglass	1"	1"	1"	1"	1"
All PVC pipe located in ceiling plenum	Rigid Fiberglass	1"	1"	1"	1"	1"

2. The following piping and fittings are not to be insulated:

- a. Chrome plated exposed supplies and stops (except where specifically noted).
- b. Water hammer arrestors.
- c. Piping unions and flanges for systems not requiring a vapor barrier.

3.03 EQUIPMENT INSULATION

A. Do not insulate over equipment access manholes, fittings, nameplates or ASME stamps. Bevel and seal insulation at these locations.

B. Semi-Rigid Fiberglass: Apply insulation to equipment shells using weld pins, bonding adhesive, banded and wired in place. Fill all joints, seams and depressions with insulating cement to a smooth, even surface. Cover with reinforcing fabric and 2 coats of mastic. Use vapor barrier mastic on systems requiring a vapor barrier.

- C. Elastomeric/Polyolefin: Apply full cover coat of adhesive to surface to be insulated, insulation and edge butt joints. Place insulation with edge joints firmly butted pressing to surface for full adhesion. Seal seams and joints vapor tight.
- D. Equipment Insulation Schedule: Provide equipment insulation as follows:

Equipment	Insulation Type	Thickness	Remarks
Storage Tanks	Semi-Rigid Fiberglass	2"	
Water Meter	Elastomeric	1/2"	Sheet type, fabricated for ease of removal and replacement when service is required.
Water Softener	Elastomeric	1/2"	Sheet type, fabricated for ease of removal and replacement when service is required.
Water Filters	Elastomeric	1/2"	Sheet type, pipe size type or combination of both.
R.P.B.P.	Elastomeric	1/2"	Sheet type, pipe size type or combination of both. Fabricated for ease of removal and replacement when testing and servicing is required

END OF SECTION

**SECTION 22 10 00
PIPING SPECIALTIES**

PART 1 - GENERAL

1.01 GENERAL

- A. Applicable provisions of Division 00 govern work under this section.

1.02 SCOPE

- A. This section contains specifications for plumbing piping specialties for all piping systems.

1.03 REFERENCE STANDARDS

- A. Abbreviations of standards organizations referenced in this and other sections are as follows:

ASTM B650 Electrodeposited Engineering Chromium Coatings on Ferrous Substrates

1.04 SHOP DRAWINGS

- A. Required for all items in this section. Include materials of construction, dimensional data, ratings/capacities/ranges, approvals, test data, pressure drop data where appropriate, and identification as referenced in this section and/or on the drawings.

1.06 DESIGN CRITERIA

- A. All piping specialties are to be rated for the highest pressures and temperatures in the respective system in accordance with ANSI B31, but not less than 125 psig unless specifically indicated otherwise.

PART 2 - PRODUCTS

2.01 THERMOMETERS

- A. Manufacturers:

- 1. Ashcroft
- 2. Marsh
- 3. Taylor
- 4. H. O. Trerice
- 5. U. S. Gauge
- 6. Weiss
- 7. Weksler

- B. Stem Type: Cast aluminum case, nine-inch scale, clear acrylic window. adjustable angle brass stem with stem of sufficient length so the end of the stem is near the middle of a pipe without reducing the thickness of any insulation, red indicating fluid, black lettering against a white background, with scale ranges as follows:

Service	Hot Water
Scale Range, °F	30 - 180

Increment, °F 2

2.02 THERMOMETER SOCKETS

- A. Brass with threaded connections suitable for thermometer stems and temperature control sensing elements in pipeline. Furnish with extension necks for insulated piping systems.

2.03 TEST WELLS

- A. Similar to thermometer sockets except with a brass cap that threads into the inside of the test well to prevent dirt from accumulating. Secure cap to body with a short chain. Furnish with extension necks, where appropriate, to accommodate the pipeline insulation.

2.04 TEST PLUGS

- A. Brass threaded pressure and temperature test plug with neoprene self-closing valve, valve retainer, brass threaded cap, rated for 150 psi and 0-200 degrees F.

2.05 PRESSURE GAUGES

- A. Manufacturers:

1. Ametek/U. S. Gauge Division
2. Ashcroft
3. Marsh
4. Taylor
5. H. O. Trerice
6. Weiss
7. Weksler

- B. Cast aluminum case of not less than 4.5-inches in diameter, double strength glass window, black lettering on a white background, phosphor bronze bourdon tube with bronze bushings, recalibration from the front of the dial, 99% accuracy over the middle half of the scale, 98.5% accuracy over the remainder of the scale, with scale range as follows:

Service	Hot Water	Cold Water	Compressed Air
Scale Range, psig	0-100	0-100	0-200
Increment, psig	1	1	2

- C. Pressure Snubbers: Bronze construction, 300 psig working pressure, 1/4" size.
- D. Gauge Valves: Use ball valves as specified in Section 15100 - Valves.

2.06 STRAINERS

- A. Manufacturers:

1. Armstrong
2. Illinois
3. Keckley
4. Metraflex
5. Mueller Steam
6. Sarco

7. Watts

- B. Y type; cast bronze body, ASTM B62; 20 mesh stainless steel screens; bolted or threaded screen retainer tapped for a blowoff valve; sweat, threaded or flanged body rated at not less than 150 psi WOG.
- C. Y type; cast iron body, ASTM A126; 20 mesh stainless steel screens; bolted or threaded screen retainer tapped for a blowoff valve; threaded or flanged ends; rated at not less than 150 psi WOG.

PART 3 - EXECUTION

3.01 THERMOMETERS

- A. Stem Type: Install in piping systems as indicated on the drawings and/or details using a separable socket in each location.

3.02 THERMOMETER SOCKETS

- A. Install at each point where a thermometer or temperature control sensing element is located in a pipeline.

3.03 TEST WELLS

- A. Install in piping systems as indicated on the drawings and/or details wherever provisions are needed for inserting a thermometer at a later date.

3.04 TEST PLUGS

- A. Install in piping systems as indicated on the drawings and/or details wherever provisions are needed for short-term measurement of pressure or temperature.

3.05 PRESSURE GAUGES

- A. Install in locations where indicated on the drawings and/or details, with scale range appropriate to the system operating pressures.
- B. Pressure Snubbers: Install in gauge piping for all gauges used on water services.
- C. Gauge Valves: Install at each gauge location as close to the main as possible and at each location where a gauge tapping is indicated.

3.06 STRAINERS

- A. Install all strainers where indicated allowing sufficient space for the screens to be removed. Install a ball valve in the tapped screen retainer.

END OF SECTION

**SECTION 22 10 01
PLUMBING SPECIALTIES**

PART 1 - GENERAL

1.01 GENERAL

- A. Applicable provisions of Division 00 shall govern work under this section.

1.02 SCOPE

- A. This section includes specifications for floor drains, roof drains, cleanouts, backflow preventers, water hammer arrestors and other miscellaneous plumbing specialties.

1.03 REFERENCE STANDARDS

- A. Abbreviations of standards organizations referenced in this and other sections are as follows:

ANSI A112.14.1	Backwater Valves
ANSI A112.21.1	Floor Drains.
ANSI A112.21.2	Roof Drains
ANSI A112.26.1/PDI WH-201	Water Hammer Arrestors.
ASSE 1001	Pipe Applied Atmospheric Type Vacuum Breakers.
ASSE 1010	Water Hammer Arrestors.
ASSE 1011	Hose Connection Vacuum Breakers.
ASSE 1012	Backflow Preventers with Intermediate Atmospheric Vent.
ASSE 1013	Reduced Pressure Principle Backflow Preventers.
ASSE 1018	Trap Seal Primer Valves.
ASSE 1019	Wall Hydrants, Frost Proof Automatic Draining, Anti-Backflow Type.

1.04 QUALITY ASSURANCE

- A. Refer to Division 00, General Conditions, Equals and Substitutions.
- B. Plumbing products requiring approval by the State of Wisconsin Dept. of Commerce must be approved or have pending approval at the time of shop drawing submission.

1.05 SHOP DRAWINGS

- A. Include data concerning dimensions, capacities, materials of construction, ratings, certifications, weights, manufacturer's installation requirements, manufacturer's performance limitations, and appropriate identification.

PART 2 - PRODUCTS

2.01 FLOOR DRAINS

- A. Manufacturer:
 - 1. Josam
 - 2. Smith

3. Wade
 4. Zurn
- B. FD-1: 3" min. enameled cast iron two piece body with double drainage flange, weep holes, reversible clamping adjustable collar, adjustable 6" x 6" min. square polished nickel-bronze strainer with threaded collar, bottom outlet. Zurn ZN-415-S.
 - C. FD-2: 4" enameled heavy duty cast iron two piece body with double drainage flange, weep holes, heavy duty adjustable 9" round coated cast iron tractor grate strainer, with sediment bucket, bottom outlet. Zurn Z-556-Y
 - D. FD-3: 4" enameled heavy duty cast iron two piece body with double drainage flange, weep holes, heavy duty adjustable 9" round coated cast iron tractor grate strainer, with sediment bucket, with 6" round coated cast iron funnel, bottom outlet. Zurn Z-556-Y / Z-328.
 - E. FD-4: 4" enameled extra heavy duty cast iron two piece body with seepage pan , weep holes, heavy duty adjustable 13" square top, secured coated cast iron tractor grate strainer, sediment bucket, bottom outlet. Zurn Z676-Y-VP.
 - F. FD-5: 3" min. scupper drain, 6" x 7" size, cast iron body, rear outlet reversible to bottom outlet, secured flush grate, with flashing clamp. Zurn Z-187-FG.

2.02 HUB DRAINS

- A. HD-1: " cast iron hub section up 2" min. above floor level, with full-sized deep seal P-trap.
- B. HD-2: 3" min. enameled cast iron bottom outlet floor drain body with membrane clamp, adjustable collar and 3" high extension adapter (less threads on inlet). Zurn Z-415-U (modified).
- C. HD-3: same as HD-2 except with the addition of a ball float type backwater valve. Zurn Z-415-U (modified) / Z-1099 (no-hub).

2.03 ROOF DRAINS

- A. Manufacturer:
 1. Josam
 2. Smith
 3. Wade
 4. Zurn
- B. RD-1: 4" min. bottom outlet roof drain, enameled cast iron body with flashing collar and gravel stop, cast iron dome strainer, adjustable extension, underdeck clamp, 15" diameter. Zurn ZC-100-C-EA
- C. RD-2: 4" min. side outlet roof drain, enameled cast iron body with flashing collar and gravel stop, cast iron dome strainer, adjustable extension, underdeck clamp, 15" diameter. Zurn ZC-100-90-C-EA.
- D. RD-3: 4" min. bottom outlet deck drain, enameled cast iron body with flashing collar and secured vandal-proof heavy duty polished bronze heel-proof grate, 14" x 14" square, adjustable extension, underdeck clamp. Zurn ZB-150-C-EA-VP.

2.04 TRENCH DRAINS

A. Manufacturer:

1. Aco
2. Josam
3. Neenah
4. Smith
5. Tyler
6. Zurn

- B. TD-1: Modular precast polymer concrete, cast iron or polyester fiberglass trench sections with presloped 4" wide radiused interior waterways, knockouts, endcaps, cast iron frame and slotted ductile iron grate, extra heavy duty rated, stainless steel grate holdowns.

2.05 CLEANOUTS

A. Manufacturer:

1. Josam
2. Smith
3. Wade
4. Zurn

- B. Interior Concrete Floor Areas: Enameled cast iron body with round or square adjustable scoriated polished nickel bronze cover, tapered threaded PVC closure plug. Zurn ZN-1400- / ZN-1400-T.
- C. Interior Ceramic Tile Floor Areas: Enameled cast iron body with square adjustable scoriated nickel bronze cover, tapered threaded PVC closure plug. Zurn ZN-1400-T.
- D. Interior Vinyl Tile Floor Areas: Enameled cast iron body with round adjustable scoriated nickel bronze cover, tapered threaded PVC closure plug. Zurn ZN-1400.
- E. Interior Carpeted Floor Areas: Enameled cast iron body with round adjustable scoriated nickel bronze cover and secured carpet marker, tapered threaded PVC closure plug. Zurn Z-1400-CM
- F. Interior Finished Wall Areas: Line type cleanout tee with tapered threaded PVC cleanout plug, round polished stainless steel access cover secured with machine screw. Zurn Z-1446- (Note: Screw shall not pass completely through the ABS plug, trim screw as necessary)
- G. Interior Exposed Vertical Stacks: Line type cleanout tee with tapered threaded PVC closure plug. Zurn Z-1445.
- H. Interior Horizontal Lines: Cast iron hub with tapped ferrule and tapered threaded ABS or PVC closure plug, or no-hub coupling and blind plug.
- I. Exterior Paved Areas: Cast iron hub or plug with tapered threaded ABS or PVC closure plug, cast iron frost sleeve and cover set in 24" square by 4" min. thick reinforced concrete pad top or surrounding pavement, crowned for drainage. Neenah R-1976 with non-ferrous securing screw.

- J. Exterior Unpaved Areas: Cast iron hub or plug with tapered threaded ABS or PVC closure plug, cast iron or PVC frost sleeve and cover set in 24" square by 4" min. thick reinforced concrete pad top. Neenah R-1976 with non-ferrous securing screw.

2.06 BACKWATER VALVES

A. Manufacturers:

- 1. Josam 67500
- 2. Smith 7012
- 3. Zurn Z1090

- B. Hub and spigot or No-Hub inlet and outlet cast iron body, cast iron gasketed bolted access cover, bronze valve. Flapper to hang in closed position during non-operation period.

2.07 SUBSOIL DRAIN TILE RECEIVERS

A. Manufacturers:

- 1. Josam
- 2. Schier
- 3. Smith
- 4. Zurn

- B. Cast iron or polyethylene body with 3 inlets, single lowered outlet, minimum 6" diameter cleanout riser and cleanout top as noted above. Cover unused inlets with water tight caps. Where receiver connects directly to the storm building drain, provide accessible backwater valve.

2.08 WATER HAMMER ARRESTORS

A. Manufacturer:

- 1. PPP Industries
- 2. Sioux Chief
- 3. Watts

- B. ANSI A112.26.1, ASSE 1010; sized in accordance with PDI WH-201, precharged piston type constructed of hard drawn Type K copper, threaded brass adapter, brass piston with o-ring seals, FDA approved silicone lubricant, suitable for operation in temperature range 35 to 150 degrees F, maximum 250 psig working pressure, 1500 psig surge pressure. Watts series 15.

2.09 MIXING VALVES

A. Manufacturer:

- 1. Lawler

- B. MV-1: ASSE 1017 and CSA B125.3 approved; high-low thermostatic mixing valve, one piece single body valve with liquid filled thermostat, stainless steel piston and liner. Valve

shall come equipped with union end stop and check inlets with removable stainless steel strainers.

- C. MV-2: ASSE 1016 approved; point of use mechanical mixing valve, bronze body valve and integral back flow checks. Mixing valve shall have compression fittings and a means to adjust the outlet temperature.

2.10 BACKFLOW PREVENTERS

A. Manufacturers:

1. Beeco
2. Cla-Val
3. Conbraco
4. Febco
5. Watts
6. Wilkins

- B. Hose Connection Vacuum BreakeRs: ASSE 1011, brass or bronze construction, EPDM diaphragm and seat, rated for 125 psig and 180°F. Watts 8 (interior application).
- C. Lab Faucet Vacuum Breakers: ASSE 1035, brass or bronze construction, chrome plated, EPDM diaphragm and seat, stainless steel internals, rated for 125 psig and 160°F. Watts NLF9.
- D. Pipe Applied Atmospheric Type Vacuum Breakers: ASSE 1001, same size as pipe, brass or bronze construction, silicone disc, rated for 125 psig and 160°F. Watts 288A.
- E. Anti-Siphon Pressure Type Vacuum Breakers: ASSE 1020, same size as pipe, brass or bronze construction, silicone disc, plastic seat, stainless steel spring, inlet and outlet ball shutoff valves, test port ball valves, rated for 150 psig and 110°F. Watts 800M4QT
- F. High Hazard Anti-Siphon, Anti-Spill Vacuum Breakers: ASSE 1056, same size as pipe, brass or bronze construction, silicone rubber discs, stainless steel springs, inlet and outlet ball shutoff valves, with test cocks, anti-spill design, rated for 150 psig and 180 deg. F max. Watts 008QT.
- G. Dual Check With Atmospheric Vent For CO₂ POST MIX Vending Machines: 3/8", stainless steel body and parts, dual check with third ball check outlet, rated for 150 psig and 140°F. Watts 9BD.
- H. Intermediate Atmospheric Vented Backflow Preventers: ASSE 1012, same size as pipe, with intermediate atmospheric vent between independent check valves, bronze body with union ends, stainless steel springs, rated for 175 psig and 210°F. Watts 9DM.
- I. Reduced Pressure ZONE Backflow Preventers: ASSE 1013 _" reduced pressure zone backflow assembly complete with inlet strainer, inlet and outlet ball or butterfly isolation valves. Constructed of bronze or epoxy coated cast iron body with bronze and plastic internal parts, stainless steel springs, non-threaded vent outlet, 4 test cocks, rated for 175 psig and 210°F, with air gap apparatus on drain. Watts series 909-S-QT/909AG.

2.11 WALL HYDRANTS

A. Manufacturer:

1. Josam
2. Smith
3. Wade
4. Woodford
5. Zurn

- B. WH-1: Freezeproof automatic draining wall hydrant with exposed chrome plated bronze wall plate, 3/4" inlet, 3/4" hose thread ASSE 1019-93 backflow preventer outlet, copper or bronze casing, loose key operator. Woodford model 65 series
- C. WH-2: Freezeproof automatic draining wall hydrant in flush mounted cast brass wall box with locking door, 3/4" inlet, 3/4" hose thread ASSE 1019-93 backflow preventer outlet, loose key operator, polished brass finish. Woodford model B65 series.

2.12 HOSE BIBBS

- A. Bronze or brass construction hose faucet/valve, cast iron handwheel, replaceable disc, hose thread spout, with ASSE 1011 backflow preventer outlet, 3/4" size. Watts model SC-8-3.

2.13 TRAP PRIMER VALVES

- A. Manufacturers:

1. Ancon
2. PPP Industries
3. Smith
4. Watts

- B. Bronze body, O-ring seals, integral threaded outlet vacuum breaker, adjustable, in conformance with ANSI/ASSE 1018. PPP model P-1/P-2.

2.14 FIRE HYDRANTS

- A. Manufacturer:

1. Clow
2. Kennedy
3. Mueller
4. Waterous

- B. AWWA C502 dry barrel hydrant with cast or ductile iron body and standpipe, two field replaceable 2 1/2" hose nozzles and chained caps, one field replaceable pumper nozzle and chained cap, 5 1/4" compression valve, O-ring seals, sealed oil reservoir, breakaway safety flange and stem coupling, automatic bronze drain valve, red finish, 6'-0" min. bury depth. Verify thread requirements with the local fire department or authority having jurisdiction.

2.15 VENT FLASHINGS

- A. Manufacturers:

1. Semco
 2. Oatey
- B. Galvanized with elastomeric collar: one piece construction, 24 gauge steel.
- C. Single Ply Membrane Roofs: Flashing boot of material compatible with roofing membrane with base flange for adhering to membrane and stainless steel drawband for securing to vent pipe.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Coordinate location and setting of plumbing specialties with adjacent construction. Install in accordance with manufacturers recommendations.
- B. Set floor drains, roof drains, trench drains and cleanouts level and plumb adjusted to finished floor elevation, roof elevation or finished wall location. Locate where serviceable. Allow minimum of 18" clearance around cleanouts for rodding. Lubricate threaded cleanout plugs with graphite and oil, teflon tape or waterproof grease. Install trap primer connections where indicated. Provide deep seal traps on floor drains.
- C. Set backwater valves on undisturbed soil or compacted granular backfill, level and plumb with top adjusted to finished floor elevation. Test and adjust valve for proper operation. Allow minimum 18" clearance for servicing.
- D. Install subsoil drain tile receivers where indicated. Adjust receiver height to drain tile inlet and outlet elevations and cleanout to finished floor elevation. Secure subsoil drain tile with mechanical or solvent weld connections. Backfill with granular material.
- E. Install water hammer arrestors where indicated and at quick closing valve installations.
- F. Install backflow preventers in accordance with Wis. Dept. of Commerce requirements maintaining minimum clearance distances for servicing and testing. Provide indirect waste piping with air gap installation from relief opening to above hub drain or floor drain.
- G. Where backflow preventers requiring Dept. of Commerce registration are installed, provide initial registration, testing and report filing required by Dept. of Commerce. List the name and address of the building that the backflow preventer installations occur in.
- H. Mount wall hydrants recessed in exterior wall construction with valve plug extended beyond interior side of building insulation. Slope to drain to exterior. Install so discharge is 18" min. above finished grade. Set wall box in grout or caulk and fill exterior wall penetration with insulation.
- I. Mount hose bibbs securely fastened to wall where indicated. Provide water hammer arrestor in line to hose bibb.
- J. Set fire hydrants level and plumb. Secure hydrant base and back with poured concrete thrust blocking providing thrust restraint and support of hydrant independent of piping. Provide 1 cu. yd. of granular backfill material around drain valve openings for free drainage. Provide isolation valve and valve box at each hydrant. Where hydrant is located

in paved area or near traffic, provide 6" diameter by 8' long Schedule 40 painted steel pipe bollards filled with concrete around hydrant.

- K. Set valve boxes level and plumb centered over valve. Set bottom flange on undisturbed soil or compacted granular backfill. Where plastic piping is used, provide cast iron or concrete bearing pad below valve. Adjust top section to finished grade level.
- L. Excavate for manholes and catch basins setting precast bases on granular backfill and pouring cast in place bases on undisturbed soil. Seal joints between base, sections, collars and castings with gasketing material for tightly packed waterproof seals. Adjust casting to match finished grade. Form interior shelves with concrete grout for smooth flowlines conforming to the shape and slope of the sewer. Place piping into manholes providing full support of piping on exterior bedding and insuring pipe seals are properly installed and waterproof. Valve manholes and other manholes intended to remain dry must be made waterproof and are subject to infiltration testing. Where an entering sewer is 2 feet or more above the springline of a leaving sewer, provide outside drop connection encased in concrete. Where existing pipe penetrations are being removed or capped, fill opening with non-shrink portland cement grout plug. Backfill and compact soil around manhole or catch basin.
- M. Install safing at floor drains above grade. Extend 12" beyond drains in all directions. Cover entire floor in showers and extend 6" up in walls above curbs and to a height of 6' (3" wide each direction) in corners. Install on concrete floor that is smooth and free of debris. Seal all joints and connect to drain body clamp. Safing is subject to standing water leak test.
- N. Flash vent penetrations through roof. Turn down top of lead flashings into vent pipe. Tighten drawband of membrane boot to vent pipe. Adhere base flashing to deck or membrane. Provide waterproof patch around penetration on existing roofs.

END OF SECTION

**SECTION 22 30 00
PLUMBING EQUIPMENT**

PART 1 - GENERAL

1.01 GENERAL

- A. Applicable provisions of Division 00 shall govern work under this section.

1.02 SCOPE

- A. This section includes specifications for water heaters, water softeners, pumps and other equipment used for plumbing applications.

1.03 QUALITY ASSURANCE

- A. Refer to Division 00, General Conditions, Equals and Substitutions.
- B. Plumbing products requiring approval by the State Department must be approved or have pending approval at the time of shop drawing submission.

1.04 SHOP DRAWINGS

- A. Include data concerning dimensions, capacities, materials of construction, ratings, certifications, weights, pump curves with net positive suction head requirements, manufacturer's installation requirements, manufacturer's performance limitations, and appropriate identification.

PART 2 - PRODUCTS..

2.01 POINT OF USE ELECTRIC WATER HEATER

- A. Manufacturers:
 - 1. A.O. Smith
 - 2. In-Sink-Erator
 - 3. Bradford White
- B. Type: Under counter point of use electric water heater. Design to be UL listed with 1 year tank and parts warranty.
- C. Tank: Construct tank of red brass rated for 150 psig with polystyrene insulation, steel jacket, temperature and relief valve, drain valve and wall bracket.
- D. Element: Heating element to be replaceable threaded copper element with adjustable thermostat control, energy cutoff, on-off switch and 3-1/2' cord with grounded plug.

2.02 RESIDENTIAL ELECTRIC WATER HEATER

- A. Manufacturers:
 - 1. A.O. Smith
 - 2. American

3. Rheem
 4. Ruud
 5. Lochnivar
 6. Bradford-White
- B. Type: Electric storage domestic water heater. Design to be UL listed with 3 year commercial use tank warranty and 1 year parts warranty.
 - C. Tank: Steel glass lined tank rated for 150 psig complete with removable magnesium anode rod, plastic diffuser type dip tube, inlet and outlet heat trap fittings, minimum R-20 polyurethane foam insulation, painted steel jacket, drain valve and temperature and pressure relief valve.
 - D. Elements: Dual 4500 watt heating elements to be replaceable threaded low watt density incoloy sheath with adjustable thermostat control, energy cutoff and wired for non-simultaneous operation.
 - A. Warranty: Non-prorated 10 year warranty for heat exchanger, shell and load anticipator controls against any failure. Provide factory warranty with shop drawing submittals and operation and maintenance manuals.

2.03 DOMESTIC WATER BOOSTER PUMPS

- A. Manufacturer:
 1. Aurora
 2. Bell and Gossett
 3. Paco
 4. Systecon
 5. Taco
 6. Weil
 7. Armstrong
- B. General: Factory packaged [duplex] [triplex] domestic water booster pumps with all components fully frame mounted, piped, painted, wired and tested at factory.
- C. Type: Vertical close-coupled end suction pumps, 125 psig maximum working pressure at operating temperature of 225°F. continuous. The manufacturer shall certify all pump ratings. All pumps to operate without excessive noise or vibration.
- D. Casings: Top pullout design with gray iron volute, backplate and bronze wearing rings.
- E. Impellers: Brass or bronze, keyed to the shaft, single suction enclosed type, hydraulically and dynamically balanced.
- F. Shafts: Stainless or carbon steel with stainless steel or bronze sleeve, integral thrust collar.
- G. Seals: Mechanical type, carbon rotating against a stationary ceramic seat, 225°F maximum continuous operating temperature.
- H. Motors: Provide pumps with open dripproof motor sized for non-overloading over the entire pump curve. Furnish each pump and motor with a nameplate giving the

manufacturer's name, serial number of pump, capacity in GPM and head in feet at design condition, horsepower, voltage, frequency, speed and full load current.

- I. Pressure Regulating Valves: Cast iron body, bronze fitted, hydraulically operated, pilot controlled diaphragm globe type combination pressure regulating non-slam check valve at each pump discharge.
- J. Isolation Valves: [Butterfly] [ball valves] at inlet and outlet of each pump.
- K. Manifold Piping: Galvanized Schedule 40 steel (**Type "L" copper**), flexible suction and discharge braided pipe connectors, suction and discharge pressure gauges and common thermal relief valve piped to floor drain.
- L. Controls: Current sensing control mounted in UL labeled NEMA 1 control panel with the following components: magnetic across the line motor starters with 3 leg overload protection and external resets, starter failure interlocks, H-O-A switches for each pump, single door interlocked disconnect with individual fuses, control circuit transformer with protected secondary, time delays, minimum run timers, adjustable solid state current sensing relays, low suction pressure cutout, pump 2 & 3 automatic alternation, high suction pressure shutdown, 2 sensor differential temperature no-flow shutdown, operating and warning lights, warning alarm.

The use of a compression tank with minimum 30 gallon acceptance volume is recommended to carry building through periods of small demand without inefficient excessive pump cycling. The compression tank should be located at the top of the building to minimize tank air volume and size.

2.04 EXPANSION TANKS

- A. Manufacturer:
 - 1. Amtrol
 - 2. Bell and Gossett
 - 3. Wessels
 - 4. Armstrong
- B. Pre-charged, in-line, expansion tank, 150 psi working pressure, complete with polypropylene liner, butyl diaphragm, stainless steel system connection fitting, factory prime and enamel painted exterior finish. Materials exposed to water to be NSF or FDA approved for potable water service
- C. Vertical steel precharged hydro-pneumatic expansion tank, 125 psi ASME labeled construction, complete with replaceable flexible butyl rubber bladder, system connection fitting, Schrader type air charge fitting, steel base ring stand, factory prime and enamel painted exterior finish, ASME relief valve. Materials exposed to water to be NSF or FDA approved for potable water service.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install plumbing equipment where indicated in accordance with manufacturer's recommendations. Coordinate equipment location with piping, ductwork, conduit and equipment of other trades to allow sufficient clearances. Locate equipment and arrange plumbing piping to provide access space for servicing all components.

- B. Set commercial water heaters, commercial water softeners, storage tanks, and booster pumps on concrete housekeeping pads. Adjust and level equipment.
- C. Set sumps on compacted granular backfill adjusting for plumb and level. Backfill in even layers around sump with granular backfill.
- D. Connect equipment to water and drain piping using unions or flanges and isolation valves.
- E. Connect pneumatic controls to compressed air source.
- F. Pipe temperature and pressure relief valves to floor drain or floor as indicated.
- G. Startup and test equipment adjusting operating and safety controls for proper operation.
- H. Cycle softeners and adjust for specified exchange rate, regeneration time, consumption, backflow rate, etc. Provide initial salt fill of brine tank.
- I. Lubricate pumps before startup. Adjust pumps for rated flow. Clean and blowdown strainers after 8 hours of operation.
- J. Adjust compression tank precharge to scheduled minimum operating pressure prior to connecting to system.

END OF SECTION

**SECTION 22 40 00
PLUMBING FIXTURES**

PART 1 - GENERAL

1.01 GENERAL

- A. Applicable provisions of Division 00 shall govern work under this section.

1.02 SCOPE

- A. This section includes specifications for plumbing fixtures, faucets and trim.

1.03 REFERENCE STANDARDS

- A. Abbreviations of standards organizations referenced in this and other sections are as follows:

ANSI A112.6.1M-88	Supports for Off-the Floor Plumbing Fixtures for Public Use.
ANSI A112.18.1-94	Finished and Rough Brass Plumbing Fixture Fittings.
ANSI A112.19.1-90	Enameled Cast Iron Plumbing Fixtures.
ANSI A112.19.2M-82	Vitreous China Plumbing Fixtures.
ANSI A112.19.5-79 (R1990)	Trim for Water Closet Bowls, Tanks and Urinals.
ANSI Z124.1-87	Plastic Bathtub Units.
ANSI Z124.2-87	Plastic Shower Receptors and Shower Stalls.
ARI-1010-94	Drinking Fountains and Self-Contained Mechanically Refrigerate Drinking Water Coolers.
ASSE 1011-93	Hose Connection Vacuum Breakers.
ASSE 1014-90	Handheld Showers.
ASSE 1035-93	Laboratory Faucet Backflow Preventers.

1.04 QUALITY ASSURANCE

- A. Refer to Division 00, General Conditions, Equals and Substitutions.
- B. Plumbing products requiring approval by the State Department must be approved or have pending approval at the time of shop drawing submission.

1.05 SHOP DRAWINGS

- A. Include data concerning sizes, utility sizes, rough in-dimensions, capacities, materials of construction, ratings, weights, trim, finishes, manufacturer's installation requirements, manufacturer's performance limitations, and appropriate identification.

PART 2 - PRODUCTS

2.01 PLUMBING FIXTURES

- A. Manufacturers: Fixture descriptions establish fixture type, quality, materials, features and size. Products of the following manufacturers determined to be equal by the Architect/Engineer will be accepted.

- 1. Water Closets, Urinals and Lavatories - American Standard, Crane, Kohler.

2. Water Closet Seats - Bemis, Olsonite, Kohler.
3. Faucets - Chicago Faucet, Kohler, Speakman, Symmons, T&S Brass, Zurn.
4. Drains - Chicago Faucet, Engineered Brass Co., Kohler, McGuire.
5. Stops and Supplies - Chicago Faucet Co., T&S Brass, McGuire.
6. Flush Valves - Coyne & Delany, Sloan, Zurn.
7. Traps - Kohler, McGuire, Dearborn, Engineered Brass Co. (17 gauge Min.)
8. Carriers and Supports - Josam, Smith, Wade, Watts Drainage, Zurn.
9. Sinks - American Standard, Elkay, Just, Kohler.

B. Water Closets:

1. WC-1 - Floor mount bottom outlet white vitreous china siphon jet water closet with elongated bowl, 1½" top spud, 2¼" passageway, 17½" rim height and 1.6 gallon flush. Flush valve handle 13" above rim, located to the wide side of the stall and be ADA compliant for activation force.
 - a. Fixture: Kohler Highcliff K-4368-ET.
 - b. Flush Valve: Sloan Optima 8111
 - c. Seat: Kohler K4670 CA

C. Lavatories

1. L-1 - Wall mount white vitreous china lavatory drilled for concealed arm carrier with 4" on center faucet openings.
 - a. Fixture: Kohler 2007
 - b. Faucet: Sloan Optima EAF 150 ISM.
 - c. Drain: McGuire 155A and 1¼" tailpiece.
 - d. Trap: 1¼"x1½" 17 ga. cast brass trap and tubular wall bend.
With C.O. plug.
 - e. Supplies & Stops: McGuire 2165CC.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install plumbing fixtures in accordance with manufacturers instructions. Set level and plumb. Secure in place to counters, floors and walls providing solid bearing and secure mounting. Bolt fixture carriers to floor and wall. Secure rough-in fixture piping to prevent movement of exposed piping.
- B. Install each fixture with trap easily removable for servicing and cleaning. Install fixture stops in readily accessible location for servicing.
- C. Install barrier free fixtures in compliance with COMM 52, 69 and Federal ADA Accessibility Guidelines. Install barrier free lavatory traps parallel and adjacent to wall and supplies and stops elevated to 27" above floor to avoid contact by wheelchair users.
- D. Each fixture shall have a stop valve installation to control the fixture. Stop valves shall be heavy duty type with brass stems and screwed or sweat inlet connections. Compression type inlets are not acceptable.

- E. Cover pipe penetrations with escutcheons. Exposed traps, stops, piping and escutcheons to be chrome plated brass, same items in concealed locations may be of rough brass finish.
- F. Set floor mounted water closets, floor mounted service sinks; counter mounted lavs and sinks; lav and sink faucets and drains with full setting bed of flexible non-staining plumber's putty. Cover exposed water closet bolts with bolt covers.
- G. Seal openings between walls, floors and fixtures with mildew-resistant silicone sealant same color as fixture.
- H. Test fixtures to demonstrate proper operation. Replace malfunctioning units or components. Adjust valves for intended water flow rate to fixtures without splashing, noise or overflow. Adjust self-closing lavatory faucets to 15 second cycle. Adjust shower valve temperature limit stops to 110 degree maximum outlet temperature.
- I. Protect fixtures during construction. At completion clean plumbing fixtures and trim using manufacturer's recommended cleaning methods and materials.

END OF SECTION

MECHANICAL TABLE OF CONTENTS

DIVISION 23 - MECHANICAL:

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SECTION 23 05 03	PIPING AND FITTINGS
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SECTION 23 55 23	INFRARED RADIANT HEATERS
SECTION 23 55 33	GAS FIRED UNIT HEATERS

SECTION 23 05 00

GENERAL HVAC REQUIREMENTS

PART 1 – GENERAL

1.1 SCOPE

- A. Furnish and install a complete building HVAC system as per drawings and enclosed specifications. Provide a competent supervisor, foreman, etc. to expedite all phases of the HVAC Project.
- B. Requirements specified herein shall govern applicable portions of all mechanical work sections, whether so stated therein or not. Where items specified in mechanical work sections conflict with requirements in this specification, the former shall govern.
- C. Heating Contractor shall provide temporary heating devices as needed until new building heating system is operational, and can be used to maintain minimum temperatures in new construction.
- D. Job site to be seen to ascertain existing field conditions. Failure to visit the job site does not limit the contractual responsibility of any aspect of the HVAC project.
- E. Items To Include:
 - 1. *Scope*
 - 2. *Abbreviations*
 - 3. *References*
 - 4. *Definitions*
 - 5. *Quality Assurance*
 - 6. *Shop Drawings, Wiring Diagrams and Descriptive Data*
 - 7. *Substitution of Equipment and Materials*
 - 8. *Related work of Mechanical Trades*
 - 9. *Electrical Requirements and Provisions*
 - 10. *Coordination*
 - 11. *Temporary Services*
 - 12. *Codes, Permits and Fees*
 - 13. *Transportation, Storage and Protection of Equipment and Materials*
 - 14. *Materials and Equipment Installation*
 - 15. *Sleeves, and Openings*
 - 16. *Flashing*
 - 17. *Sealing and Fire stopping*
 - 18. *Cutting and Patching, Holes and Sleeves*
 - 19. *Equipment Access*
 - 20. *General Pressure Piping Specification*
 - 21. *Painting*
 - 22. *Inspection and Tests*
 - 23. *Cleaning and Flushing*
 - 24. *Operating Test*
 - 25. *Operation and Maintenance Manuals*
 - 26. *Record Drawings*
 - 27. *Identification*
 - 28. *Testing and Balancing*
 - 29. *HVAC System Commissioning*

1.2 ABBREVIATIONS

- A. The following abbreviations are used throughout all mechanical work sections.
 - amp ampere
 - bhp brake horsepower

Btu	British Thermal Unit
c to c	center to center or on center
cfm	cubic feet per minute
deg	degree (angle)
F	degree Fahrenheit
fpm	feet per minute
ft.	foot
gal	gallon
gph	gallons per hour
gpm	gallons per minute
hp	horsepower
hr	hour
in. or "	inch
ID	inside diameter
ips	iron pipe size
kw	kilowatt
max	maximum
min	minimum
oz	ounce
OD	outside diameter
os & y	outside screw & yoke
lb.	pound
psi	pounds per square inch
rpm	revolutions per minute
sec	second
std	standard
sp	static pressure
temp	temperature
wwp	water working pressure

1.3 REFERENCES

- A. References to standards, codes or specifications shall mean the latest edition of such publication adopted and published at date of invitation to submit proposals.
- B. References to technical societies, trade organizations and governmental agencies are made in accordance with the following abbreviations.

1.	AFI	Air Filter Institute
2.	AGA	American Gas Association, Inc.
3.	ANSI	American National Standards Institute
4.	ASHRAE	Amer. Society of Heating, Refrigeration & Air Conditioning Engineers
5.	ASME	American Society of Mechanical Engineers
6.	AMCA	Air Moving & Conditioning Association, Inc
7.	ASTM	American Society for Testing Materials
8.	AWWA	American Water Works Association
9.	BOCA	Building Officials and Code Administrators
10.	CS	Commercial Standard
11.	FM	Factory Mutual
12.	IBR	Institute of Boiler & Radiator Manufacturers
13.	IRI	Industrial Risk Insured
14.	ISOW	Insurance Services of Wisconsin
15.	NAFM	National Association of Fan Manufacturers
16.	NFPA	National Fire Protection Association
17.	NBS	National Bureau of Standards
18.	PDI	Plumbing and Drainage Institute

19.	SBI	Steel Boiler Institute
20.	SMACNA	Sheet Metal & Air Conditioning Contractors National Assoc. Inc
21.	UL	Underwriter's Laboratories, Inc

1.4 DEFINITIONS

The following are definitions of terms and expressions used in mechanical work Sections.

- A. Provide means furnish and install in place.
- B. Herein means contents of a particular section where this term appears.
- C. Indicated means indicated on contract drawings.
- D. Section denotes "trade section" or basic unit of work.
- E. Division denotes a group of related sections. All Mechanical Work falls into Div. 23.
- F. Concealed means any pipe, duct, conduit or accessories hidden from sight as in trenches, chases, furred spaces, pipe shafts or hung ceilings.
- G. Exposed means they are "not concealed" as defined herein above.
- H. Piping includes in addition to pipe, fittings, valves, hangers and accessories.

1.5 QUALITY ASSURANCE

- A. Comply with manufacturer's instructions in full detail, including each step in sequence. Should instructions conflict with contract documents, request clarification from Architect/Engineer before proceeding.
- B. Where equipment or accessories are used which differ in arrangement, configuration, dimensions, ratings, or engineering parameters from those indicated in the contract documents, the contractor is responsible for all costs involved in integrating the equipment or accessories into the system and for obtaining the performance from the system into which these items are placed. This may include changes found necessary during the testing, adjusting and balancing phase of the project.

1.6 SHOP DRAWINGS, WIRING DIAGRAMS AND DESCRIPTIVE DATA

- A. Submit shop drawings, wiring diagrams and descriptive data on all equipment, apparatus, fixtures and specialties to be provided. Manufacturer shall prepare these drawings or his franchised dealer for this specific installation unless equipment is stock design then standard shop drawing may be submitted. Drawings shall show all physical sizes and required services, installation instructions, description of operation including recommended testing and adjusting procedures shall be included.

1.7 SUBSTITUTION OF EQUIPMENT AND MATERIALS

- A. Assume all responsibility for any and all changes made to the HVAC system due to substitutions. Manufacturers listed first in the Specifications were used in preparing the drawings. Other Manufacturers listed are considered substitutions, but may be submitted for approval as potentially equal to the initial manufacturer identified. Manufacturers not listed in the Specification will not be considered "As Equal" to the design equipment or material.
- B. Notify all Contractors of substitutions made prior to their involvement with the substitution installation. Provide all modifications to ductwork and other Construction necessary due to substitutions. Equipment must be accessible for servicing filters, bearings, motors, belts, etc.

1.8 RELATED WORK OF MECHANICAL TRADES

The following tabulation of items of work are not all inclusive but are set forth to establish a pattern to be maintained should items occur which are not specifically covered in the various divisions of the work.

- A. Plumbing - Any equipment provided by other trades requiring water, compressed air or drainage piping thereto shall have these services provided by that other Trade. Provide a gate valve or stop valve and union at point of connection to such equipment. Provide traps and vents or open sight drains to satisfy drainage requirements of equipment.
- B. Heating - Any equipment provided by other trades requiring condensate thereto shall have these services provide by that other Trade.
 - 1. If regulators or mechanical devices for control of services are necessary, Contractor supplying equipment for installation by this Contractor shall furnish these items.
 - 2. Gas piping shall be completed by the heating contractor. Contractor whose scope of work includes gas piping will serve all equipment requiring gas. Special valves, pressure-regulators, etc., if required, will be provided with equipment.
- C. Ventilating - Provide sheet metal vents or ducts on any equipment furnished by other trades making final connection thereto using flexible connectors in case of ductwork only. Install pre-heat and/or re-heat coils furnished by others. Install temperature control dampers.
- D. Temperature Controls - Any equipment provided by other trades requiring temperature control work shall be provided by this Contractor unless specifically exempted in specifications. Provide schematic diagrams as specified and include pneumatic or electrical work necessary to connect all components to function as a complete system. The Temperature Controls Contractor shall wire control wiring specified in Temperature Control Section.

1.9 ELECTRICAL REQUIREMENTS AND PROVISIONS

- A. For electrically operated equipment provide all motors. Starters, controllers, and disconnects which are an integral part of unit equipment shall be provided with that equipment. Starters, controllers and disconnects which are not included as part of the equipment shall be provided as a separate item as part of the electrical work of Division 16, unless otherwise indicated. All control devices and sensors associated with the electrically operated equipment shall be provided as part of the work of Division 15, unless otherwise indicated.

1.10 COORDINATION

- A. Verify that all devices are compatible for the surfaces on which they will be used. This includes, but is not limited to, diffusers, registers, grilles and recessed or semi-recessed heating and/or cooling terminal units installed in/on architectural surfaces.
- B. Coordinate all work with other contractors prior to installation. Any installed work that is not coordinated and that interferes with other contractor's work shall be removed or relocated at the installing contractor's expense.

1.11 TEMPORARY SERVICES

- A. Whenever temporary services are required to maintain operation of equipment, it is understood that the Contractors responsible for final connections to permanent services shall do this temporary work. All temporary material shall be removed after it has served its use. See Special Conditions for temporary services required during construction of project.

1.12 CODES, PERMITS AND FEES

- A. All Mechanical work shall conform with all Federal, State and Local Codes and regulations. If codes or regulations conflict, the most stringent shall apply. Permits and inspection fees are to be secured in fulfilling the requirements of these Specifications.

1.13 TRANSPORTATION, STORAGE AND PROTECTION OF EQUIPMENT AND MATERIALS

- A. Transport and handle equipment by methods to avoid damage. Promptly inspect shipments to assure that equipment complies with requirements, quantities are correct and equipment is undamaged.
- B. Cover equipment and materials to eliminate rust and corrosion while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade. Protect pipe, tube and fitting ends to avoid damage.
- C. Provide access for inspection of all stored equipment. Periodically inspect to assure equipment is undamaged and are maintained under required conditions.
- D. Offsite storage agreements will not relieve contractor from using proper storage techniques.

1.14 MATERIALS AND EQUIPMENT INSTALLATION

- A. Materials and equipment shall be new and of the make, type, size and quality specified. See Instructions for Bidders for bidding procedure.
- B. Erect equipment in neat workmanlike manner, align, level and adjust for satisfactory operation; install for easy maintenance, inspection, operation, and replacement. Minor deviation from indicated arrangements may be made as approved.
- C. Mechanical equipment shall operate without objectionable noise or vibration. Ductwork and piping shall be provided with flexible couplings to prevent noises or vibration transmission.

1.15 SLEEVES, AND OPENINGS

- A. Pipe Sleeves:
 - 1. Provide galvanized sheet metal sleeves for pipe penetrations through interior walls to provide a backing for sealant or firestopping.
 - 2. Provide schedule 40 steel pipe for pipe penetrations through exterior walls, non-rated beams, footings and potentially wet applications to provide backing for sealant and firestopping.
 - 3. Sleeves for piping in new poured concrete construction shall be schedule 40 steel pipe, cast in place.
 - 4. In all piping floor penetrations, fire rated and non-fire rated, top of sleeve shall extend 1" above the adjacent floor. Caulk sleeves full depth and provide floor plate.
 - a) Sleeves in non-rated floor penetrations shall be 18 gauge galvanized steel.
 - b) Sleeves in rated floor penetrations shall be UL listed prefabricated sleeve including seals.

- c) If the pipe penetrating the sleeve is supported by a pipe clamp resting on the sleeve, weld a collar or struts to the sleeve to transfer weight to floor structure.
 - 5. In finished spaces where pipe penetration through wall is exposed, provide chrome plated steel escutcheons installed flush with face of penetrated surface.
 - 6. Size sleeves large enough to allow for expansion and contraction. Provide for continuous insulation wrapping.
- B. Duct Sleeves:
 - 1. Duct sleeves are not required in non-rated floors or partitions.
 - 2. Provide sleeve required for fire dampers in fire-rated partitions and floors. Install sleeve per manufacturer's recommendation.
- C. Openings:
 - 1. Any opening over 12" in width penetrating masonry or concrete construction requires additional structural support. Mechanical contractor shall be responsible for coordinating with the General Contractor for sizes and locations of openings.
- D. Furnish sleeves to General Contractor for placement into formwork

1.16 FLASHING

- A. Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors and roofs.
- B. Flash pipes projecting 3" minimum above finished roof surface with lead worked one inch minimum into hub, 8" minimum clear on sides with 24x24 sheet size. For pipes through outside walls, turn back into wall and caulk, metal counterflash and seal.
- C. Provide welded curbs for mechanical roof installation 12" minimum high above roofing surface. Flexible sheet flash and counterflash with sheetmetal; seal watertight.
- D. Metal Flashing: 26 gauge galvanized steel.
- E. Lead Flashing: 5 lbs./sq. ft. sheet lead for waterproofing; one lb./sq. ft (5 kg/sq. m) sheet lead for soundproofing.
- F. Flexible Flashing: 47 mil thick sheet butyl; compatible with roofing.
- G. Caps: Steel, 22 gauge minimum; 16 gauge at fire resistant elements.

1.17 SEALING AND FIRESTOPPING

- A. Sealing and Fire stopping of sleeves/openings between ductwork, piping, etc. and the sleeve, structural or partition opening shall be the responsibility of the contractor whose work penetrates the opening. The contractor responsible shall hire individuals skilled in such work to do the sealing and fireproofing.
- B. FIRE AND/OR SMOKE RATED PENETRATIONS:
 - 1. Provide material and perform work in compliance with the following:
 - a) Wisconsin Administrative Code
 - b) Provide materials tested and listed by Underwriters Laboratories.
 - c) Provide materials which have been tested in accordance with ASTM E814-88: Standard Test Method for Fire Tests of Through-Penetration Firestops.

- d) Materials shall have been tested to provide fire rating at least equal to that of the construction being penetrated and shall comply with the T-ratings as required by applicable building code.
2. Contractor shall submit product data for each firestop system in accordance with Div 07 - 07 84 00 – Firestopping.
3. Contractor shall use firestop putty, caulk sealant, intumescent wrapstrips, intumescent firestop collars, firestop mortar or a combination of these products to provide a UL listed system for each application required for this project. Provide mineral wool backing where specified in manufacturer's application detail. Use product that has a rating not less than the rating of the wall or floor being penetrated.
4. Install approved product in accordance with the manufacturer's instructions where the pipes and ductwork penetrate a fire/smoke rated surface. When pipe or ductwork is insulated, use a product which maintains the integrity of the insulation and vapor barrier.

C. NON-RATED PENETRATIONS

1. Pipe Penetrations Through Below Grade Walls: In exterior wall openings below grade, use a modular mechanical type seal consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the uninsulated pipe and the wall sleeve.
2. Pipe Penetrations: At pipe penetrations of non-rated interior partitions, floors and exterior walls above grade, use urethane caulk in annular space between pipe and insulation and sleeve.
3. Duct Penetrations: Annular space between duct (with or without insulation) and the non-rated partition or floor opening shall not be larger than 2". Where existing openings have an annular space larger than 2", the space shall be patched to match existing construction to within 2" around the duct. Coordinate with the General Contractor for this work.
4. Where shown or specified, pack annular space with fiberglass batt insulation or mineral wool insulation. Provide sheet metal escutcheon around duct on both sides of partition or floor to cover annular space.
5. In finished spaces where duct penetrations are exposed, pack annular space with fiberglass batt insulation or mineral wool insulation. Patch annular space to match adjacent construction for a finished appearance. Coordinate with General Contractor for this work.

1.18 CUTTING AND PATCHING, HOLES AND SLEEVES

- A. It shall be the responsibility of the Mechanical Contractor to furnish the applicable contractor with all opening dimensions where required for installing the mechanical work. All dimensions must be verified with equipment shop drawings.
- B. All required core drilling of holes in floors or walls necessary to install piping and conduit is the responsibility of the Mechanical Contractor. All core drilled holes must be drilled carefully as to avoid spalling, and unnecessary damage or weakening of structural members. Avoid chopping or breaking out.

1.19 EQUIPMENT ACCESS

- A. Install all piping, conduit, ductwork, and accessories to permit access to equipment for maintenance and service.

1.20 GENERAL PRESSURE PIPING SPECIFICATION

The following piping practice shall be followed in installing all steel or copper piping:

- A. Full length of pipe shall be used wherever possible; short lengths of pipe with couplings will not be permitted.
- B. All pipes shall be cut to exact measurements and shall be installed without forcing or springing so as not to cause excess stress in valves or equipment.
- C. All piping shall slope a minimum of 1" in 50'-0" in the direction of flow unless otherwise noted on drawings.
- D. All branch connections shall be made into top of mains unless otherwise noted on drawings.
- E. All changes in direction shall be made by using pipe and fittings or by shop fabricated pipe bends. Field pipe bends are prohibited.
- F. Unions shall be installed in all pipe connections to equipment, control valves, controllers, and wherever necessary to facilitate the dismantling of piping and removal of other items requiring maintenance.
- G. Exposed piping shall be neatly arranged, straight, run parallel, and at right angles to walls and shall be so graded that the entire system can be drained. Drain valves shall be installed at low points of piping.
- H. Install pipe anchors and expansion bends or swing connections where so indicated on drawings.
- I. Installed piping shall not interfere with the operation or accessibility of doors or windows, shall not encroach on aisle passageways and equipment, and shall not interfere with the servicing or maintenance of any equipment.
- J. When pipe size is reduced, reducing fittings are required. No bushings shall be used.

1.21 INSPECTION AND TESTS

- A. See section 23 05 03 – Pipe and Fittings

1.22 OPERATING TEST

- A. General:
 - 1. Perform tests as outlined below and submit test results to the Architect before Owner operates equipment.
 - 2. Equipment shall be complete with all components connected before making tests.
 - 3. Make adjustments, repairs, and alterations, as required to meet specified test results. Correct defects disclosed by tests or inspection; replace defective parts when directed.
 - 4. In replacing defective parts use only new materials; in case of pipe, replace with same length as defective piece.
 - 5. Caulking of screwed joints or peening of welds, will not be permitted.

6. Repeat tests after defects have been corrected and parts replaced, as directed, until pronounced satisfactory.
 7. Tests all alarms, flow switches, level controls, low and high-pressure cut outs and all other safety devices. Test results submittal shall list items tested.
 8. Bear costs of repairs and restoration of work of other trades damaged by the tests or cutting that had to be done in connection with the tests.
- B. Heating System:
1. Adjust and regulate heating system to circulate freely, noiselessly, and to distribute heating media proportionately to all heating surfaces. Adjust automatic temperature controls for satisfactory operation.
 2. Operate system for tests during heating season of the first year of operation at times when directed, for proper setting and adjusting. Furnish copies of test data as directed.
- C. Testing and Balancing:
1. Provide the services of a qualified independent firm engaged in the business of air balance to adjust and balance ventilating systems as specified in Division 15.

1.23 OPERATION AND MAINTENANCE MANUALS

- A. Maintenance manuals shall be prepared covering the HVAC systems of the building, including refrigeration and temperature controls.
- B. Submit manuals in the quantity and format as specified in Division 1 section Contract Closeout.
- C. These manuals shall include the following information:
1. Name and address and telephone number of installing General Contractor and Subcontractors
 2. Description of Systems
 3. Test results and reports
 - a) Installation checks on fans and related equipment
 - b) Air balance
 - c) Results of all pressure tests with witness signature, data made, etc.
 4. General Operating Instructions: Instructions shall include locations of equipment or controls, which will require periodic adjustment.
 5. Maintenance Instruction: These shall include manufacturer's maintenance for all equipment.
- D. The above information including equipment shop drawings, fixture cuts, etc. shall be placed in three ring loose-leaf hard cover binders with section tabs labeled with project name and contents. Submit to Architect prior to final billing.

1.24 RECORD DRAWINGS

- A. Prepare and submit to Architect/Engineer a complete layout of piping and duct systems as actually installed showing location, size changes, and elevations for permanent record

drawings. Drawings must be provided in AutoCad .dwg format for reproduction along with (1) hard copy.

1.25 IDENTIFICATION

A. General:

1. Do not label equipment such as cabinet heaters, convectors, radiation, ceiling fans or any other equipment in occupied spaces.

B. Pipe:

1. All piping shall be color-coded using legend markers and directional arrows after piping has been covered (if specifications call for insulation) and after piping has been painted.
2. Use Setmark System pipe markers with arrows as manufactured by Seton Name Plate Corp. Pipe stencils are not acceptable.
3. Install markers as recommended by the manufacturer.
4. Locate pipe identification as follows:
 - a) Within 1'-6" of each valve
 - b) Within 3'-0" of each 90° elbow
 - c) Within 3'-0" of piping connection to equipment
 - d) Within 3'-0" of where pipe enters shafts and penetrates floor and outside walls.
 - e) Maximum 20'-0" intervals along all piping (exposed and concealed). Not less than one label shall be installed per room.
 - f) Within 1'-6" of any access door or panel
 - g) At all tees within 3'-0" of both mains and branch piping.
 - h) Where new piping meets existing piping, place one additional label on existing piping as specified in items 'a' through 'f'.
 - i) On remodeling projects, contractor shall include in bid, one extra (case or roll) of all ordered system colors and/or bands to turn over to owner.
 - j) Stenciling of piping is not acceptable.

1.26 TESTING, ADJUSTING AND BALANCING

- A. See requirements in Section 23 05 93 – Testing, Adjusting, and Balancing
- B. Include the complete cost of air system testing and balancing in the Bid.
- C. T & B procedures, methods and instrumentation shall be in strict accordance with the established standards of the National Environmental Balancing Bureau (NEBB) or the Associated Air Balance Council (AABC).

- D. Provide the services of a qualified independent NEBB or AABC certified firm engaged in the business of air balance to adjust and balance ventilating systems as specified in Division 15.
- E. Mechanical Contractor shall assume the responsibility for the following:
 - 1. Purchase and installation of any replacement component of equipment drive assemblies as directed by the Test and Balance Contractor.
 - 2. Filter replacement and installation.
 - 3. Adjustment of isolation devices.
 - 4. Equipment conformity to sound level requirements.
 - 5. Purchase and replacement of motor starter heater elements, as directed.
 - 6. Proper adjustment and calibration of temperature control instruments and devices.
 - 7. Leak testing of piping.
 - 8. Installation of volume dampers where shown, or where required as directed by the Test and Balance Contractor.
 - 9. Instruction to owner on system operation.
 - 10. Furnishing of ladders and or scaffolding as directed by the Test and Balance Contractor.
 - 11. Furnish the Test and Balance Contractor with one set of "As-built" drawings and one complete set of certified shop drawings at least two weeks prior to commencement of work.

1.27 HVAC SYSTEM COMMISSIONING

- A. Submit an HVAC Building Commissioning Certification, which states that the Heating, Ventilating and Air Conditioning System has been installed according to and is in compliance with the intent of the design parameters of the Division 15B HVAC Specification.
- B. This Commissioning Certification shall include, but not be limited to, adjusting air quantities and control of heating units, fan interlocks, damper positions and fan operation.
- C. Submit the HVAC Commissioning Certification to the Architect prior to the final payment request.

END OF SECTION

SECTION 23 05 03

PIPING AND FITTINGS

PART 1 – GENERAL

1.1 SCOPE

- A. All work in this section is subject to the provisions of the General HVAC Requirements, and all other parts of the Contract Documents applicable to this Section of Work.

1.2 WORK INCLUDED

- A. Natural Gas Piping

1.3 RELATED WORK

- A. Section 23 05 15 - Piping Specialties
- B. Section 23 05 29 - Supports and Anchors
- C. Section 23 07 01 - Piping Insulation

1.4 REFERENCES

- A. ANSI/ASME - Boiler and Pressure Vessel Code
- B. ANSI/ASME Sec 9 - Welding and Brazing Qualifications
- C. ANSI/ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings - DWV
- D. ANSI/ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV
- E. ANSI B31.1 - Code for power piping (over 125 psig)
- F. ANSI/ASME B31.9 - Building Services Piping
- G. ANSI/AWS A5.8 - Brazing Filler Metal
- H. ANSI Z49.1 - Safety in Welding and Cutting
- I. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless
- J. ASTM A120 - Pipe, Steel, Black and Hot-Dipped Zinc Coated (Galvanized), Welded and Seamless, for Ordinary Uses
- K. ASTM A234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
- L. ASTM B32 - Solder Metal
- M. ASTM B88 - Seamless Copper Water Tube
- N. AWS D1.1 - Structural Welding Code

1.5 QUALITY ASSURANCE

- A. Welder Qualifications:
 - 1. Welding procedures, welders, and welding operators for all building service piping and steam piping less than or equal to 15 psig to be in accordance with certified welding procedures of the National Certified Pipe Welding Bureau.
 - 2. Welding procedures, welders, and welding operators for all steam system piping at service pressures above 15 psig to be qualified complying with the provisions of the latest revision of ANSI/ASME B31.1 Power Piping or Section IX of the ASME Boiler and Pressure Vessel Code for boiler external piping.
 - 3. Before any metallic welding is performed, Contractor to submit his/her Standard Welding Procedure Specification together with the Procedure Qualification Record as required by Section IX of the ASME Boiler and Pressure Vessel Code and/or the National Certified Pipe Welding Bureau.

4. Before any polyethylene fusion welding is performed, Contractor to submit certification that the welders to be used on this project have successfully demonstrated proper welding procedures in accordance with the Code of Federal Regulations, Title 49, Part 192, Section 192.285.
5. The Architect/Engineer reserves the right to test the work of any welder employed on the project, at the Contractor's expense. If the work of the welder is found to be unsatisfactory, the welder shall be prevented from doing further welding on the project.
6. Note: In addition to requirements described above, contractor shall submit the following information to architect/engineer for review:
 - a) Provide a project summary listing contractors' standard welding procedure specification.
 - b) List all welders scheduled to work on the project.
 - c) List all pipe sizes to be welded.
 - d) Provide continuity record of each welder for every six month interval after passing the qualification test.

1.6 SUBMITTALS

- A. Submit product data under provisions of Section 23 05 00.
- B. Include data on pipe materials, pipe fittings, and accessories.

PART 2 – PRODUCTS

2.1 NATURAL GAS

- A. 2" and smaller: ASTM A53, type E or S, standard weight (schedule 40) black steel pipe with ASTM A197/ANSI B16.3, Class 150, black malleable iron threaded fittings or ASTM A234 grade WPB/ANSI B16.9 standard weight, seamless, carbon steel weld fittings.
- B. 2 ½" and larger: ASTM A53, type E or S, standard weight (schedule 40) black steel pipe with ASTM A234 grade WPB/ANSI B16.9 standard weight, seamless, carbon steel weld fittings.
- C. Underground Gas Piping: All sizes shall be ASTM A53, standard weight (schedule 40) X-TRU-COAT plastic coated steel pipe. All fitting shall be welded.

PART 3 – EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment with flanges or unions.
- D. After completion, fill, clean, and treat systems.

3.2 INSTALLATION

- A. General:
 1. Install all piping plumb and parallel to building walls and ceilings and at heights which do not obstruct any portion of windows, doorways, stairways, or passage

ways. Where interferences develop in the field, offset or reroute piping as required to clear such interferences

2. Group piping whenever practical at common elevations.
3. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
4. Provide clearance for installation of insulation, and access to valves and fittings.
5. Do not route piping through transformer vaults, or above transformers, panel boards, or switchboards including the required service space for this equipment, unless the piping is serving this equipment.
6. Do not route piping through elevator equipment rooms unless piping is serving equipment in this room.
7. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors.
8. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain bottom of pipe level.
9. Install unions downstream of valves and at equipment or apparatus connections.
10. Welding is required on all black piping 2 1/2" and larger.
11. Copper piping may be used for heating water service in lieu of Schedule 40 Black on piping 2" and smaller. Install brass ball valve at junction of dissimilar piping.

B. Welded Pipe Joints:

1. Make all welded joints by fusion welding in accordance with ASME Codes, ANSI B31, and State Codes where applicable.

C. Threaded Pipe Joints:

1. Use a thread lubricant or Teflon tape on threaded pipe joints; no hard setting pipe thread cements or caulking is allowed.

D. Copper Pipe Joints:

1. Remove all slivers and burrs remaining from the cutting operation by reaming and filing both pipe surfaces. Clean all fittings and tube with emery cloth or sandpaper. Remove residue from the cleaning operation, apply flux and assemble joints. Use 95-5 solder or brazing to secure joint as specified for the specific piping service.

E. Natural Gas Piping

1. Entire gas piping installation shall be in accordance with the latest requirements of the AGA, NFPA 54 – National Fuel Gas Code, State, and Local Codes.

2. Permissible Assemblies for Welding Piping Systems:

- a) The following specification covers permissible assemblies for welded pipe lines for all services operating at 160 psig or less.

- 1) Mitered tees will not be permitted in welded lines. Connections shall be made with welding tees. The use of lines provided they

are installed in prefabricated assemblies and the pipe interior is cleaned of slag. Field installation of weldolets will be permitted in lines 5" and larger if the installation is cleaned inside after welding.

- 2) The use of mitered elbows in welded lines will not be permitted. Welding elbows shall be used for bends.
 - 3) Mitered reducers will not be permitted in welded lines.
 - 4) The pipe ends in tees, laterals, and reducers shall be carefully prepared to provide for proper weld penetration.
 - 5) Steel and iron piping, 2-1/2" in size and larger, shall have joints welded, except joints obviously intended to be connected by means of bolted flanges. End to end joints of the same size pipe sizes 3/4" through 1" may be butt welded provided that an internal welding ring is used.
3. Do not install gas piping below a building or its foundation.
 4. Gas piping shall be installed with plugged drip pockets at low points.
 5. Valves, gas cocks, and unions shall be installed on inlet pipe to equipment including safety valves where required or noted to be installed.
 6. Connect gas piping to gas meter provided by local gas company.
 7. All gas piping in inaccessible areas and piping 2 1/2" and larger shall have welded joints. Provide pre-weld type fittings. Paint welded areas with primer.
 8. Pitch horizontal piping down 1 inch in 60 feet in the direction of flow. Install full size dirt leg at the bottom of each vertical run and at each appliance. When installing mains and branches, cap gas tight each tee or pipe end which will not be immediately extended. All branch connections to the main shall be from the top of the main.
 9. Prime coat and apply rust resistant finish enamel coat to all gas piping exposed to weather. Paint gas piping to blend in with adjacent wall or roof color. Color is subject to approval by architect.
 10. All interior gas piping shall be prime coated and painted with rust resistant finish enamel coat. Paint color shall be yellow and labeled "Natural Gas" with flow directional arrows.

F. Leak Testing

1. Verify that the piping system being tested is fully connected to all components and that all equipment is properly installed, wired and ready for operation. If required for additional pressure load under test, provide temporary restraints at expansion joints or isolate them during test.
2. For air tests, gradually increase pressure to not more than one half of test pressure and increase pressure in steps of approximately one tenth of the test pressure until test pressure is reached.
3. Natural gas piping shall be air tested at 100 psig for 24 hours with no drop in pressure or as dictated by local codes or ordinances if greater.

END OF SECTION

SECTION 23 05 29

SUPPORTS AND ANCHORS

PART 1 – GENERAL

1.1 SCOPE

- A. All work in this section is subject to the provisions of the General HVAC Requirements, and all other parts of the Contract Documents applicable to this Section of Work.

1.2 WORK INCLUDED

- A. Pipe, duct, and equipment hangers, supports, and associated anchors
- B. Equipment bases and supports

1.3 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS

- A. Furnish hanger and support inserts to General Contractor for placement into formwork.

1.4 RELATED WORK

- A. Section 23 05 03 – Piping and Fittings
- B. Section 23 05 48 – Vibration Isolation

1.5 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 23 05 00.
- B. Indicate hanger and support framing and attachment methods.

PART 2 – PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

- A. MANUFACTURERS
 - 1. Grinnell
 - 2. B-Line
 - 3. Mason
 - 4. Michigan Hanger
 - 5. Unistrut
- B. Hangers for Pipe Sizes 1/2" to 1-1/2": Carbon steel, adjustable swivel, split ring.
- C. Hangers for Pipe Sizes 2" to 4" and Cold Pipe Sizes 5" and Over: Carbon steel, adjustable, clevis.
- D. Wall Support for Pipe Sizes to 3" (76 mm): Cast iron hook.
- E. Vertical Support: Steel riser clamp.
- F. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
- G. Shield for Insulated Piping 2" and Smaller: 18 gauge galvanized steel shield over insulation in 180 degree segments, minimum 12" (300 mm) long at pipe support.
- H. Shield for Insulated Piping 2-1/2" and Larger: Pipe covering protective saddles.

I. Shields for Vertical Copper Pipe Risers: Sheet lead.

2.2 HANGER RODS

A. Steel Hanger Rods: Threaded both ends, threaded one end, or continuous threaded.

B. Size rods for individual hangers and trapeze support as indicated below:

<u>Max. Load (Lbs.)</u>	<u>Rod Diameter</u>
610	3 / 8"
1130	1 / 2"
1810	5 / 8"
2710	3 / 4"
3770	7 / 8"
4960	1"
8000	1-1 / 4"

Total weight of equipment, including valves, fittings, pipe, pipe content and insulation are not to exceed the limits indicated. Provide rods complete with adjusting and lock nuts.

2.1 BEAM CLAMPS

A. Malleable black iron clamp for attachment to beam flange to 0.62" thick with a retaining ring and threaded rod of 3/8", 1/2", and 5/8" diameter. Furnish with a hardened steel cup point set screw.

2.2 INSERTS

A. Inserts: Malleable iron case of steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.3 ANCHORS

A. Use welding steel shapes, plates and bars to secure piping to structure.

2.4 FABRICATION

A. Design hangers without disengagement of supported pipe.

B. Provide copper plated hangers and supports for copper piping.

2.5 FINISH

A. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

PART 3 – EXECUTION

3.1 INSERTS

A. Provide inserts to General Contractor for placement in concrete formwork.

B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

- C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4".

3.2 PIPE HANGERS SUPPORTS, AND ANCHORS:

- A. Support horizontal piping as follows:

<u>PIPE SIZE</u>	<u>MAX. HANGER SPACING</u>	<u>HANGER DIAMETER</u>
Nat. Gas Pipe (1/2")	6'-0"	3/8"
Nat. Gas Pipe (3/4")	8'-0"	3/8"
Nat. Gas Pipe (1" and over)	10'-0"	3/8"
PVC (All Sizes)	6'-0"	3/8"
Copper Pipe (1/2" to 1-1/4")	5'-0"	3/8"
Copper Pipe (1-1/2" & Over)	10'-0"	1/2"

- B. Install hangers to provide minimum 1/2" space between finished covering and adjacent work.
- C. Use hangers with 1-1/2" minimum vertical adjustment.
- D. Support vertical piping with clamps secured to the piping and resting on the building structure at each floor. Piping 5" or greater, of lengths exceeding 30 feet, shall be additionally supported on base elbows secured to the building structure, with flexible supporting hangers provided at the top of riser to allow for expansion and contraction.
- E. Support riser piping independently of connected horizontal piping.
- F. Do not hang piping directly from a metal deck or run piping so it rests on the bottom cord of any truss or joist.
- G. Install hangers and supports to provide for free expansion of the pipe system. Support all piping from the structure using concrete inserts, beam clamps, ceiling plates, wall brackets or floor stands. Fasten ceiling plates and wall brackets securely to the structure.
- H. Install anchors where indicated on drawings. Where not specifically indicated, install anchors at ends of principal pipe runs and at intermediate points in pipe runs between expansion loops.

END OF SECTION

SECTION 23 05 48

VIBRATION ISOLATION

PART 1 - GENERAL

1.1 SCOPE

- A. All work in this section is subject to the provisions of the General HVAC Requirements, and all other parts of the Contract Documents applicable to this Section of Work.

1.2 REFERENCES

- A. ASHRAE - Guide to Average Noise Criteria Curves

1.3 QUALITY ASSURANCE

- A. Maintain ASHRAE criteria for average noise criteria curves for all equipment at full load condition.

1.4 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 23 05 00.
- B. Indicate vibration isolator locations, with static and dynamic load on each, on shop drawings and described on product data.
- C. Submit manufacturer's installation instructions under provisions of Section 23 05 00.

1.5 CERTIFICATES

- A. Submit manufacturer's certificate under provisions of Section 23 05 00 that isolators are properly installed and properly adjusted to meet or exceed specified requirements.

1.6 DESCRIPTION

- A. Isolate all motor driven mechanical equipment from the building structure and from the systems which they serve to prevent equipment vibrations from being transmitted to the structure. Consider equipment weight distribution to provide uniform isolator deflections.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Use materials that will retain their isolation characteristics for the life of the equipment served. Use industrial grade neoprene for elastomeric materials.
- B. All isolators shall be treated to resist corrosion. For isolation devices exposed to the weather or used in high humidity areas, hot dip galvanize steel parts, apply neoprene coating on all steel parts, or use stainless steel parts; include limit stops to resist wind.
- C. Use isolators with a ratio of lateral to vertical stiffness not less than 1.0 or greater than 2.0.

2.2 VIBRATION ISOLATORS

- A. Acceptable Manufacturers
 - 1. Mason Industries
 - 2. Krueger Manufacturing

3. Peabody
 4. Tech Products
- B. Type A: Neoprene Pad
1. Neoprene waffle pad, 40 durometer with 16 gauge shims between layers
 2. Mason Type W, WM or WMW
- C. Type B: Neoprene Pad
1. Double deflection neoprene mount having a minimum static deflection of 0.35 inches. Cover all metal surfaces with neoprene to resist corrosion. Include friction pads on both top and bottom surfaces so mounts need not be bolted to the floor, but include bolt holes for those areas where bolting is required. For equipment such as close coupled pumps, include steel rails for use between the isolator and the equipment to accommodate equipment overhang.
 2. Mason Type ND or DNR
- D. Type C: Unhoused Spring with Neoprene
1. Combination freestanding, unhoused spring and neoprene with rib molded antifriction base. Include leveling bolts for securing to the equipment. Springs to be laterally stable under load and selected so they have an additional travel to solid equal to 50% of the rated deflection. Use height saving brackets when appropriate to the application.
 2. Mason Type SLF
- E. Type D: Restrained spring with neoprene
1. Combination spring and neoprene with rib molded base similar to type C, but with a housing that includes vertical limit stops to prevent spring extension when weight is removed such that the installed and operating heights are the same. Maintain a minimum clearance of 1/2" around restraining bolts, and between the housing and the spring, so as not to interfere with the spring action. Design isolator so limit stops are out of contact during normal operation. Use height saving brackets when appropriate to the application.
 2. Mason type SLR
- F. Type E: Spring Hanger with neoprene
1. Vibration hanger with steel spring and 0.3" deflection neoprene element in series. Use neoprene element molded with a rod isolation bushing that passes through the hanger box. Select spring diameters and size hanger box lower holes large enough to permit the hanger rod to swing through a 30 degree arc before contacting the hole and short circuiting the spring. Select springs so they have a minimum additional travel to solid equal to 50% of the rated deflection.
 2. Mason type 30N
- G. Type F: Precompressed spring hanger with neoprene
1. Vibration hanger similar to type E but precompressed to the rated deflection to keep the piping or equipment at a fixed elevation during installation. Hanger shall have release mechanism to free the spring after the installation is complete and the hanger is subjected to full load.
 2. Mason type PC30N

PART 3 – EXECUTION

3.1 PERFORMANCE

- A. Select vibration devices as indicated below or to provide not less than 95% isolation efficiency, whichever is greater.

Equipment Type	-----Floor span or Column Spacing -----							
	On Grade		Up to 20 Feet		20 to 30 feet		40+ Feet	
	Type	Min. Defl. In.	Type	Min. Defl. In.	Type	Min. Defl. In.	Type	Min. Defl. In.
Suspended Centrifugal Blowers, Tubular Centrifugal, Axial, and Cabinet Fans (unless internally isolated)	175-224 RPM	E	3.50	E	4.50	E	4.50	
	225-299 RPM	E	3.50	E	3.50	E	3.50	
	300-364 RPM	E	2.50	E	2.50	E	2.50	
	375-499 RPM	E	1.50	E	2.50	E	3.50	
	500 RPM+	E	0.75	E	1.50	E	2.50	

3.2 INSTALLATION

- A. Install vibration isolation devices to motor driven equipment in accordance with the manufacturer's installation instructions.
- B. Do not allow installation practices to short circuit or bind any isolation device.

END OF SECTION

SECTION 23 05 93

TESTING, ADJUSTING AND BALANCING

PART 1 – GENERAL

1.1 SCOPE

- A. All work in this section is subject to the provisions of the General HVAC Requirements, and all other parts of the Contract Documents applicable to this Section of Work.

1.2 WORK INCLUDED

- A. Testing, adjusting and balancing of air heating systems.

1.3 REFERENCE STANDARDS

- A. Wisconsin Administrative Code – Chapter Comm 64.53
- B. AABC – National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems
- C. NEBB – Procedural Standards for Testing, Adjusting and Balancing or Environmental Systems
- D. ASHRAE Handbook, 1999 HVAC Applications, Chapter 36, Testing, Adjusting and Balancing

1.4 DESCRIPTION

- A. Provide total mechanical systems testing, adjusting, and balancing. Requirements include the balance of air and water distribution, adjustment of new and or existing systems to provide design quantities indicated on drawings, electrical measurement and verification of performance of all equipment, all in accordance with standards published by AABC or NEBB and in accordance with Wisconsin Administrative Code – Chapter Comm 64.53.
- B. Test, adjust, and balance all air and hydronic systems so that each room, piece of equipment or terminal device is using quantities indicated on the drawings and in the specifications.
- C. Accomplish testing, adjusting and balancing work in a timely manner with completion of work in the time stated in the Instruction to Bidders and in accordance with the completion schedule established for this project.

1.5 SUBMITTALS

- A. Submit (4) sets of testing, adjusting and balancing reports bearing the seal and signature of the NEBB or AABC Certified Test and Balance Supervisor to Architect's office. The reports to be certified proof that the systems have been tested, adjusted and balanced in accordance with the referenced standards; are an accurate representation of how the systems have been installed and are operating; and are an accurate record of all final quantities measured to establish normal operating values of the systems.
- B. Provide the following information, forms and data:
 - 1. General Information: Inside cover sheet identifying Test and Balance Contractor, Mechanical Contractor, and Project Name. Include addresses, contact names and telephone numbers. Also include a certification sheet containing the seal and signature of the Test and Balance Supervisor.

2. Provide full air system and hydronic system test results.
3. Summary: Provide summary sheet describing mechanical system deficiencies. Describe objectionable noise or drafts found during testing, adjusting and balancing. Provide recommendation for correcting unsatisfactory performances and indicate whether modifications required are within the scope of the contract, are design related or installation related. List instrumentation used during testing, adjusting and balancing procedures.
4. Forms: Provide appropriate standard NEBB or AABC forms for each respective item and system. Fill out forms completely. Where information cannot be obtained or is not applicable, indicate same.

C. PRODUCTS

1. Provide all required instrumentation to obtain proper measurements. Application of instruments and accuracy of instruments and measurements to be in accordance with the requirements of NEBB or AABC Standards and Instrument manufacturer's specifications.

1.6 GENERAL PROCEDURES

- A. Test and Balance contractor shall be responsible for obtaining any applicable construction addendums, construction bulletins, applicable change orders and approved shop drawings pertaining to this work.
- B. Check all filters for cleanliness, dampers and valves for correct positioning, equipment for proper rotation and belt tension, temperature controls for completion of installation and hydronic systems for proper charge and purging of air.
- C. Do not proceed until systems are fully operational with all components necessary for complete testing, adjusting and balancing. Installing contractors are required to provide personnel to check and verify system completion, readiness for balancing and assist Testing and Balancing Contractor in providing specified system performance.
- D. In areas containing ceilings, remove ceiling tile to accomplish testing and balancing work; replace all tile when work is complete and provide new tile to any tile damaged by this procedure.
- E. Cut insulation, ductwork and piping for installation of test probes to the minimum extent necessary for adequate performance of procedures. Patch using materials identical to those removed, maintaining vapor barrier integrity and pressure rating of systems.
- F. Contact the temperature control contractor for assistance in operation and adjustment of controls. Cycle controls and verify operation and set points. Include in report description of temperature control operation and deficiencies found.
- G. Permanently mark equipment settings, including damper and valve positions, control settings, and similar devices allowing settings to be restored. Set and lock all memory stops.
- H. Leave systems in proper working order, replacing belt guards, closing access doors and electric boxes, and restoring temperature controls to normal operating settings.

1.7 TESTING, ADJUSTING AND BALANCING PROCEDURES

- A. Air System Balancing:
 1. Identify each mechanical fan system by tag and location.

2. Identify each terminal device by tag and as to location and fan system
3. In air systems employing filters, blank off sufficient filter area to simulate a pressure drop that is midway between that of a clean filter and that of a dirty filter.
4. Measure, adjust and record fan speed to design requirements.
5. Measure and record motor full load amperage and calculated BHP.
6. Measure and record static air pressure conditions across fans, coils and filters.
7. Measure, adjust and record all main supply air ducts, return air ducts and zones to proper design airflows.
8. Measure and record all air temperatures; supply air, return air, mixed air, and outside air including dry and wet bulb temperatures.
9. Adjust outside air, return air and relief air dampers for design conditions at both the minimum and maximum settings and record both sets of data.
10. Balance variable air volume systems at full cooling flow rate, minimum flow rate, and heating flow rate; record all data.
11. Balance all modulating dampers at extreme conditions and record both sets of data.
12. Adjust grilles, diffusers and registers to achieve proper air distribution patterns and uniform space temperatures free from objectionable noise and drafts with the capabilities of the installed system.
13. Provide fan and motor drive sheave adjustments necessary to obtain design performance. Include in scope of services cost of new sheaves and belts if it becomes necessary to attain design performance.
14. Adjust fan drives, dampers, terminals and controls to maintain pressure relationships in areas or rooms designed to maintain positive, negative or neutral air pressures with respect to adjacent spaces, as indicated by the design air quantities.
15. The Contractor shall include in the bid the cost of new sheaves and belts if it becomes necessary to change the drives during balancing of system.
16. Final air system measurements to be within the following range of specified cfm:

a)	Fans	0% to +10%
b)	Supply grilles, registers, diffusers	0% to +5%
c)	Return/exhaust grilles	0% to -5%
d)	Room pressurization air	-5% to +5%

1.8 QUALITY ASSURANCE

- A. All work performed under this Section shall be under the direction of the supervisor who is designated and qualified under the certification requirements of NEBB and/or AABC.
- B. Coordinate system balancing requirements with Section 23 09 23, 23 09 00 and Division 26.
- C. Acceptable Contractors:
 1. Balco Balancing, Inc.

2. NEW TAB of GREEN BAY, INC.

END OF SECTION

SECTION 23 55 23

INFRARED RADIANT HEATERS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Infrared radiant heating tubes
- B. Reflector shields and hanger assemblies
- C. Controls

1.2 RELATED WORK

- A. Section 23 05 00 - General Mechanical Requirements
- B. Section 23 09 00 - Temperature Controls

1.3 QUALITY ASSURANCE

- A. Comply with applicable regulations and have A.G.A. approval.
- B. Factory test to check construction, controls, and operation of unit and provide certification.

1.4 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 23 05 00 showing dimensions, connections, arrangement, accessories, and controls.
- B. Submit manufacturer's installation instructions under provisions of Section 23 05 00.

1.5 OPERATION AND MAINTENANCE DATA

- A. Submit manufacturer's descriptive literature, operating instructions, and maintenance and repair data under provisions of Section 23 05 00.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Re-Verber-Ray
- B. Solaronics

2.2 INFRARED RADIANT HEATERS

- A. Infrared radiant heaters shall be a complete system with all components furnished by the unit manufacturer. Components to include reflectors as called out on the plans, tube sections, burner, exhaust and inlet collar.
- B. Heater Construction:
 - 1. The material used in the heaters combustion chamber shall be black coated titanium. Radiant tubes shall be black coated aluminized steel.
 - 2. The radiant tube emitter shall be 16 gauge aluminized steel, 4" O.D., coated with Pyromark Series 1200 high temperature corrosion resistant black paint with an emissivity rating of .95.
 - 3. Certification requirements: CSA, IAS, CE (GTD).
 - 4. Warranty requirements: 1/5/10 (Components/Tube/Burner).

- C. Manufacturer to include a complete control package with all necessary safety operating controls required for safe and complete operation. Unit manufacturer shall provide thermostat with remote sensing bulb which will energize burner on a call for heat. An air flow switch at burner will in turn fire the burner. Burner shall be power draft type with electric ignition and shall be A.G.A. certified for natural gas fuel. Thermostat to be capable of receiving contact closures from door operator control panel to turn heaters off when the main hangar door is open and to turn them on (if calling for heat) when the main hangar door is closed.
- D. Burner to include the following: Flame sensor, operation indicator lights, flame inspection window, air flow switch, automatic regulator valve, transformer and gas pressure regulator suitable for 14" W.C. gas inlet pressure.
- E. Provide complete installation instructions.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Electrical Contractor shall make 120V, 1 phase power connection to unit.

END OF SECTION

SECTION 23 55 33

GAS FIRED UNIT HEATERS

PART 1 - GENERAL

1.1 SCOPE

- A. All work in this section is subject to the provisions of the General HVAC Requirements, and all other parts of the Contract Documents applicable to this Section of Work.

1.2 WORK INCLUDED

- A. Indoor separated combustion unit heaters (Condensing)

1.3 RELATED WORK

- A. Section 23 05 29 – Supports and Anchors
- B. Section 23 05 48 – Vibration Isolation
- C. Section 23 09 00 – Temperature Controls

1.4 REFERENCES

- A. A.G.A. – American Gas Association

1.5 QUALITY ASSURANCE

- A. Conform to requirements of UL, A.G.A. Certified, and applicable codes.

1.6 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 23 05 00 showing dimensions, connections, arrangement, accessories, and controls.
- B. Submit manufacturer's installation instructions under provisions of Section 23 05 00.

1.7 OPERATION AND MAINTENANCE DATA

- A. Submit manufacturer's descriptive literature, operating instructions, and maintenance and repair data under provisions of Section 23 05 00.

1.8 WARRANTY

- A. Provide manufacturer's standard warranty on complete unit under provisions of Section 23 05 00.

PART 2 - PRODUCTS

2.1 INDOOR, SEPARATED COMBUSTION, UNIT HEATERS

- A. Propeller Fan Type
 - 1. Provide high-efficiency, sealed combustion, gas-fired unit heaters designed for a minimum of 91% thermal efficiency, complete with intermittent spark-ignited pilot with timed lockout. Units shall be design-certified by the American Gas Association and bear the A.G.A. label.
 - 2. Construct unit casing of zinc grip steel with factory applied baked on enamel finish. Unit shall have full safety fan guards.

3. The heat exchanger shall be constructed of 409 stainless steel. Die-formed burners shall be of aluminized steel and include flared ports and a stainless steel insert.
4. Units to include all fan and limit safety controls, including a combustion air pressure switch to verify proper vent flow before allowing operation of the gas valve, and 24V control transformer.
5. Unit heaters shall be equipped for use with natural gas of capacity as scheduled on plans. Provide redundant single-stage combination gas valve. Provide manual shut-off valve and union for field installation.
6. Direct drive motor shall be high efficient type and shall have internal overload protection and motor contactor.
7. Provide horizontal combustion air inlet/vent terminal assembly to allow single building penetration for both exhaust and combustion air. Vent terminal assembly shall be arranged to provide preheating of the combustion supply air.
8. Units shall include 60° downturn air nozzles to control direction of air delivery.
9. Manufacturer: Reznor, Sterling or Modine

PART 3 – EXECUTION

3.1 INSTALLATION

- A. General: Install gas-fired, sealed combustion type unit heaters as indicated, and in accordance with manufacturer's published installation instructions.
- B. Vent all gas fired unit heaters in strict accordance with manufacturers recommendations. Provide manufacturer recommended vent termination.
- C. Hang units from substrate using vibration isolators, threaded rods and building attachments, secure rods to unit hanger attachments. Adjust hangers so unit is plumb and level.
- D. Furnish and install condensate piping to drain provided by plumbing contractor.
- E. Connect gas piping to unit with dirt leg, union and gas shut-off valve.

END OF SECTION

SECTION 26 05 00 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 – GENERAL

1.1 RELATED REQUIREMENTS

- A. Applicable provisions of Division 1 shall govern work under this section.

1.2 WORK INCLUDED IN THE ELECTRICAL CONTRACT

- A. The mention of any Article, operation or method required that the Contractor shall provide same and perform each operation in complete accordance with the conditions stated. The Contractor shall provide all material, labor, equipment and transportation as necessary to complete the project in compliance with the Contract Documents. In general, this work includes everything essential for a complete electrical system in operating order as shown on the drawings and indicated in the specifications.
- B. All work shall be installed in accordance with all State and Local Inspection Authorities having jurisdiction together with the recommendations of the manufacturer whose equipment is to be supplied and installed under this Contract.
- C. Before submitting a bid, each bidder shall examine the drawings relating to their work and shall become fully informed as to the extent and character of the work required and its relation to other work in the building.
- D. The Contractor, in conjunction with the Architect's representative, shall establish exact locations of all materials and equipment to be installed. Consideration shall be given to construction features, equipment of other trades and requirements of the equipment proper.
- E. The Contractor shall furnish all scaffolding, rigging, hoisting and services necessary for deliver, erection and installation of all equipment and apparatus required to be installed by the Contractor. All such equipment shall be removed by the Contractor upon completion of the project.
- F. The Contractor shall provide all necessary temporary lighting, distribution and electrical service as required for project.
- G. The Contractor shall be responsible for all work identified on the plans and in Divisions 26, 27 & 28 and include all costs in bid.

1.3 DEFINITIONS

- A. The Owner: The individual who the Owner selects as the project representative.
- B. The Architect: Omni Associates, Appleton, Wisconsin.
- C. The Engineer: Powrtek Engineering, Inc., Consulting Engineers, Waukesha, Wisconsin.
- D. This Contractor: The Electrical Contractor, also referred to as "The Contractor".
- E. Provide: Furnish, install and wire complete and ready for service.

- F. Exposed: Exposed to view in any room, corridor or stairway.
- G. Code: National, State and Local Electrical codes including OSHA requirements.
- H. Equals: Manufacturers or methods listed by name in the specifications, on the drawings or in an addendum are considered to be equals.
- I. Substitution: Any manufacturer or method other than those listed by name in these specifications, on the drawings, or in an addendum.
- J. NEC: National Electrical Code.
- K. Signal Voltage: NEC class 1, 2, or 3 remote control, signaling or power limited circuits.
- L. Low Voltage: 50 to 600 volts.

1.4 PERMITS AND LICENSES

- A. The Contractor shall prepare and submit all applications and working drawings, as required, to authorities having jurisdiction over the project. All licenses and permits required shall be secured and paid for by the Contractor.
- B. Pay for all fees incident thereto.
- C. Comply with local ordinances, laws, regulations and codes in effect at job site.
- D. Pay all applicable taxes associated with electrical work.

1.5 STANDARDS AND CODES

- A. All work shall be installed in accordance with National, State and Local codes, ordinances, laws and regulations. Comply with applicable OSHA regulations.
- B. All materials shall have a UL or ETL label where a UL or ETL Standard and/or test exist.

1.6 DIMENSIONS AND DEFINITE LOCATIONS

- A. The drawings depicting electric work are diagrammatic and show, in their approximate location, symbols representing electrical equipment and devices. The exact location of such equipment and devices shall be established in the field in accordance with instructions from the Architect and/or established by manufacturer's installation drawings and details.
 - 1. The Contractor shall refer to shop drawings and submittal drawings for all equipment requiring electrical connections to verify rough-in and connection locations.
 - 2. Unless specifically stated to the contrary, no measurement of an electric drawing derived by scaling shall be used as a dimension to work by. Dimensions noted on the electric drawings are subject to measurements of adjacent and previously completed work. All measurements shall be performed prior to the actual installation of equipment.

1.7 DRAWINGS

- A. The Contractor shall keep a detailed up-to-date record, of the manner and location in which all installations are actually made, indexing each feeder, pull box and protective device.
- B. As Built Drawings – See General Requirements – Division 1. The contractor shall provide final as-built (record) drawings at completion of project to the Engineer (electronic copy only) and Owner (full size hardcopy and electronic copy). Electronic files shall be in AutoCad 2010 format delivered on CD-R. The record drawings shall indicate device locations, equipment as-circuited, all interior feeder and significant branch circuit runs and junction boxes, exterior circuit runs and pull boxes. All interior feeders and exterior circuits shall include conductors/conduits installed information.
- C. The engineer will make available to the contractor a complete set of electronic AutoCad files. Each electronic copy requested will be sent via e-mail for a cost of \$150 to cover technician time and mailing costs. Any requests shall be made in writing to the engineer with a certified check or money order payable to the engineer. The disk(s) will be sent out within 7 days of receipt of the request and payment in full.
- D. In the event of a conflict between the drawings and specifications, this Contractor shall base their bid on the greater quantity, cost or quality of the item in question, unless such conflict is resolved by an addendum. The Contractor shall be responsible for all existing field conditions, review existing field conditions prior to bid and shall take into account in bid proposal. No additional compensation will be allowed due to Contractor's failure to include all necessary work in the bid proposal.
- E. Provide 100 percent complete and operational electrical systems and subsystems as specified herein and as shown on the drawings. Electrical systems shall include all materials, labor, taxes, mark-ups, overhead, profit, equipment, accessories and incidentals. All materials shall be new and not discontinued.
- F. The drawings and specifications are schematic and scope in nature. All required light fixtures, devices, conduit, wiring, supports, etc., shall be included in the base bid to accommodate actual field conditions. Final locations of all electrical work shall be coordinated in the field and installed where directed by the Engineer. The Contractor shall follow the intent of the plans and specifications when bidding and completing the design of the required building electrical systems.

1.8 MATERIALS AND EQUIPMENT

- A. All materials and equipment required shall be new.
- B. All equipment supplied shall be based on materials and equipment of manufacturers specified. No substitutions will be allowed except as permitted in this specification.
- C. All items specified shall be the latest type or model produced by the manufacturer specified. If descriptive specification or model number is obsolete, substitute the current product.

1.9 SUBSTITUTIONS

- A. In any case where the Contractor wishes to use equipment or methods other than those listed by name, such equipment shall be considered a substitution and must be approved by the Engineer. To gain approval for substitutions, the Contractor shall submit the following to the Engineer for his review.
1. Documentation from the equipment manufacturer indicating where this equipment meets and does not meet the specifications or drawings as written. This documentation shall state all exceptions taken to the specification and the reasons for such exceptions. All documentation relative to the request for substitution shall be submitted on the manufacturer's letterhead and signed by a representative of the manufacturer.
 2. Manufacturer's Cut Sheets: Cut sheets shall be originals as are contained in the manufacturer's catalog. Photocopies of these sheets will not be accepted for review (Furnish 3 copies).
 3. Lighting Fixtures: Request for substitutions shall include photometric test reports performed by an independent testing laboratory.
 4. The Contractor shall provide samples of the proposed equipment for the Engineer's review, if requested by the Engineer.
 5. The Contractor shall furnish any other information or materials as requested by the Architect/Engineer to establish equality.
 6. The Contractor shall acknowledge that they have reviewed the submission criteria for the request for substitution by stamping the submission with a review stamp or acknowledgment by an accompanying letter.
 7. Equipment and materials submitted for review without proper documentation will be rejected without review.
 8. A check for \$400 to cover Engineer's time in reviewing substitution.
- B. Any substitution submittal, including samples, shall be received in the Engineer's office a minimum of ten days prior to the Bid due date to allow adequate time for review.
- C. Materials, equipment or methods of installation other than those named, will be accepted only if such articles are in accordance with the general requirements and are similar in composition, dimension, construction, capacity, aesthetics, finish and performance.

1.10 SHOP DRAWINGS AND EQUIPMENT BROCHURES

- A. Submit to Engineer for review, the manufacturer's shop drawings and/or equipment brochures in quantities determined by the Architect for the following:
1. Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables
 2. Section 26 05 33 – Raceways, special boxes and composite boxes only
 3. Section 26 09 43 – Network Lighting Control
 4. Section 26 24 16 – Panelboards (Include panelboard overcurrent devices with this submittal)
 5. Section 26 27 13 – Metering Equipment
 6. Section 26 27 26 – Wiring Devices
 7. Section 26 27 28 – Disconnect switches (include related fuses with this submittal)
 8. Section 26 43 13 – Surge Protection Devices
 9. Section 26 50 00 – Lighting Fixtures (including lamps)

10. Plans – Surge Protectors

- B. Shop drawings shall be submitted in advance of construction and installation so as to not cause delay in other Contractor's work.
- C. All data submitted for Engineer's review shall be numbered consecutively, shall be noted to correlate with the electrical drawings and shall bear:
 - 1. The name and location of the project.
 - 2. The name of the Contractor.
 - 3. The date of submittal.
 - 4. The date of the drawings and the date of each correction and revision.
 - 5. If more than one type of lighting fixture (or other material) is on a submitted sheet, the proposed equipment shall be conspicuously checked with red pen by the Electrical Contractor.
- D. Shop drawings for different systems and equipment shall be bound separately by specification section. Submittals which contain different systems bound together shall be returned un-reviewed for re-submittal.
- E. The Contractor shall examine shop drawings and equipment brochures prior to submission. The Contractor shall verify that the materials and equipment depicted will properly fit into the construction. The Contractor shall also review all previously completed work related to the installation of the equipment depicted to insure that it has been properly installed.
- F. The contractor is allowed up to two submittals for approval. If additional submittals are required for approval the contractor will be required to submit payment with certified check or money order in the amount of \$250 with each section resubmitted to cover additional engineering time and mailing costs.
- G. No materials or equipment subject to prior review by the Engineer shall be fabricated or installed by the Contractor, without approval. The Engineer's review of shop drawings shall not relieve the Contractor of responsibility for deviations from the requirements of the drawings and specifications, unless prior approval for such deviations has been granted.

1.11 MAINTENANCE MANUALS

- A. The Electrical Contractor shall assemble and submit to the Architect for subsequent submission to the Owner, three complete sets of a Manual of Operation and Maintenance for each of the electrical and communications systems.
- B. Each manual shall consist of a loose leaf bound volume instructing the Owner's personnel in the use, operation and maintenance of the system in question. The manual shall cover all phases of operation of the equipment and shall be illustrated with photographs, drawings, wiring diagrams, etc. Manuals shall accurately describe the operation, construction and adjustable features of the complete system and its component parts. The manual shall be complete with an equipment parts listing to facilitate the ordering of spare and replacement parts.
- C. Each manual shall contain two sets of final shop drawings depicting equipment as installed.

1.12 CLEANING AND PAINTING

- A. All rubbish resulting from this work shall be removed and disposed of on a daily basis in such manner as to be acceptable to the Architect.
- B. The Contractor shall clean all exposed iron work, the interior and exterior of cabinets and pull boxes, etc., and remove all rubbish and debris resulting from the work.
- C. Where painted surfaces of equipment have been damaged or rusted during construction, the Contractor shall paint same to match final.
- D. Clean other equipment as indicated in other sections of the specification for specific equipment.

1.13 TESTS AND ACCEPTANCE

- A. The operation of the equipment and electrical systems does not constitute an acceptance of the work by the Owner. The final acceptance is to be made after the Contractor has adjusted his equipment and demonstrated that it fulfills the requirements of the drawings and the specifications.
- B. After the work is completed and prior to acceptance, the Contractor shall conduct the following tests, tabulate data, date, sign and submit to the Engineer.
 - 1. Standard megger insulation test on each feeder.
 - 2. Ground resistance test.
 - 3. Clamp ammeter test on each feeder conductor with all utilization equipment energized. The load current in each phase conductor of the feeder or the portion thereof supplying the panel shall not differ from the average connected load currents in the feeder conductors by more than 7½ %. If the load currents in the feeder conductors by more than 7½ %, the Contractor shall change phase loading to same or receive written approval from the Engineer that this is not required due to the nature of the load.
- C. Upon completion of the installation, the Contractor shall furnish certificates of approval from all authorities having jurisdiction. The Contractor shall demonstrate that all work is complete and in perfect operating condition, with race way and conduit system properly grounded, all wiring free from grounds, shorts, and that the entire installation is free from any physical defects.
- D. In the presence of the Engineer and the Owner, the Contractor shall demonstrate the proper operation of all miscellaneous systems.
- E. Perform other test as specifically directed in other sections of the specifications for specific equipment.

1.14 GUARANTEE

- A. All work shall be provided with a one year materials and labor warranty. Warranty period shall begin after the Owner's final acceptance of the work.
- B. See other Division 26 specification sections for equipment with extended warranties.

- C. See General Conditions.
- 1.15 ACCESS PANELS
- A. All access panels required by code or otherwise to electrical service equipment shall be supplied and installed by Electrical Contractor.
- 1.16 OWNER TRAINING
- A. The contractor shall give the owner's personnel verbal and written operating instructions for all electrical systems.
- 1.17 COORDINATION BETWEEN TRADES
- A. Coordination Meetings: Attend coordination meetings with the construction manager and all other trades for the purpose of coordinating the locations of all plumbing, HVAC and electrical work for the entire project. The goal of these meetings is to avoid conflicts between trades in the field and to assure that all necessary power and control requirements are accounted for.
 - B. Conflicts Between Trades: Resolve all conflicts between trades at no additional cost to the Owner or Architect.
 - C. Ceiling Heights: Maintain all ceiling heights indicated on the architectural drawings. Ceiling heights will not be lowered to accommodate installation of HVAC or electrical work. Install all work so that there is at least eight (8) inches clearance above the ceiling grid, in all areas, to facilitate installation of light fixtures. If installed work does not comply with the ceiling height requirements stated above, then the contractor shall remove and re-install work to comply with the stated requirements above at no additional cost to the Owner or Architect.
 - D. Ceiling Grid Priority: Lighting fixture locations take priority over diffuser locations.
- 1.18 ELECTRICAL INSTALLATIONS
- A. General: Sequence, coordinate and integrate the various elements of electrical systems, materials and equipment. Comply with the following requirements:
 - B. Coordinate electrical systems, equipment and materials installation with other building components, including transferring of 'overlay' plans to verify clearances, etc.
 - C. Verify all dimensions by field measurements.
 - D. Arrange for chases, slots and openings in other building components during progress of construction, to allow for electrical installations.
 - E. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed. All pipes passing through cast-in-place concrete walls and floors shall be sleeved.
 - F. Sequence, coordinate and integrate installations of electrical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.

- G. Where mounting heights are not detailed or dimensioned, install systems, materials and equipment to provide the maximum headroom possible.
- H. Coordinate connection of electrical systems with exterior underground utilities and services. Comply with requirements of governing regulations, franchised service companies and controlling agencies. Provide required connection for each service.
- I. Install systems, materials and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.
- J. Install systems, materials and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
- K. Install electrical equipment to facilitate servicing, maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
- L. Units concealed behind finished surfaces shall be installed behind an access panel or door as required.
- M. Install systems, materials and equipment giving right-of-way priority to systems required to be installed at a specified slope.

1.19 CUTTING AND PATCHING

- A. General: Perform cutting and patching in accordance with Division 1 Section "CUTTING AND PATCHING." In addition to the requirements specified in Division 1, the following requirements apply:
 - 1. Perform cutting, fitting and patching of electrical equipment and materials required to:
 - a. Uncover Work to provide for installation of ill-timed Work.
 - b. Remove and replace defective Work.
 - c. Remove and replace Work not conforming to requirements of the Contract Documents.
 - d. Remove samples of installed Work as specified for testing.
 - e. Install equipment and materials in existing structures.
 - f. Upon written instructions from the Architect, uncover and restore Work to provide for Architect observation of concealed Work.
 - 2. Cut, remove and legally dispose of selected electrical equipment, components and materials as indicated, including but not limited to removal of electrical items indicated to be removed and items made obsolete by the new Work.
 - 3. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.
 - 4. Patch existing finished surfaces and building components using new materials matching existing materials and experienced Installers.

- Installer's qualifications refer to the materials and methods required for the surface and building components being patched.
5. Patch finished surfaces and building components using new materials specified for the original installation and experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.

PART 2 – PRODUCTS

Not Used.

PART 3 – EXECUTION

Not Used.

END OF SECTION

SECTION 26 05 04 - CLEANING, INSPECTION AND TESTING ELECTRICAL EQUIPMENT

PART 1 – GENERAL

1.1 RELATED REQUIREMENTS

- A. Applicable provisions of Division 1 shall govern work under this section.

1.2 SCOPE

- A. Prior to energizing equipment, retain services of a recognized independent testing contractor for purpose of performing inspections and tests herein specified.
- B. Assure that electrical equipment is operational within industry and manufacturer's tolerances and is installed in accordance with design specifications.

1.3 ITEMS TO BE TESTED

- A. Circuit Breakers
- B. Ground Fault Systems
- C. Grounding Systems

1.4 RELATED WORK

- A. Section 26 05 26 – Grounding and Bonding for Electrical Systems
- B. Section 26 24 16 – Panelboards

1.5 QUALITY ASSURANCE

- A. Comply with the requirements of the following regulatory agencies:
 - 1. National Fire Protection Association (NFPA) Chapter 70 - National Electric Code (NEC) and Wisconsin Amendments thereto.
 - 2. Underwriters Laboratories (UL) Approval
- B. Conform to the standards of the following agencies:
 - 1. National Electrical Manufacturers Association (NEMA)
 - 2. American Society for Testing and Materials (ASTM)
 - 3. Institute of Electrical and Electronic Engineers (IEEE)
 - 4. National Electrical Testing Association (NETA)
 - 5. Insulated Power Cable Engineers Association (IPCEA)
- C. Inspections and test shall utilize the following references:
 - 1. Project design specifications.
 - 2. Project design drawings.
 - 3. Manufacturer's instruction manuals applicable to each particular apparatus.

1.6 TESTING AGENCY

- A. Meet federal, state and local safety requirements for accreditation of testing laboratories, Title 29, Part 1907 membership in National Electrical Testing Association constitutes proof of meeting such criteria.
- B. Meet Federal Department of Commerce requirements for nationally independent testing laboratory certification.
- C. Permanently record checks and tests and make available to Engineer and Owner.

1.7 TEST REPORT SUBMITTALS

- A. Seven copies of complete testing report.
- B. Submit report no later than 30-days after completion of testing.
- C. Submit proof of testing agency qualification.

1.8 JOB CONDITIONS

- A. Electrical contractor's responsibilities.
 - 1. Supply a source of test power to test laboratory at each test site.
 - 2. Notify testing Subcontractor when equipment becomes available for acceptance tests.
 - 3. Coordinate work to minimize project delay.
 - 4. Supply a complete set of electrical drawings, specifications and pertinent change orders to testing contractor prior to commencement of testing.
- B. Testing subcontractor's responsibilities.
 - 1. Notify Engineer 72-hours prior to commencement of testing.
 - 2. Provide material, equipment, labor and technical supervision to perform such tests and inspections.
 - 3. Recommendations for acceptance or rejection shall be given upon consultation of Engineer, Owner, Contractor and testing laboratory's representative.

PART 2 – PRODUCTS

Not Used.

PART 3 – EXECUTION

3.1 GENERAL

- A. Test work and equipment installed to ensure its proper and safe operation in accordance with intent of drawings and specifications.
- B. Check interlocking and automatic control sequences and test operation of safety and protective devices.

- C. Correct defects.
- D. Cooperate with supplier's and manufacturer's representatives in order to achieve proper and intended operation of equipment.
- E. Test, adjust and record operating voltages at each system level before energizing branch circuits.
- F. Replace devices and equipment damaged due to failure to comply with this requirement.
- G. Balance load among feeders conductors at each panelboard and reconnect loads as may be necessary to obtain a reasonable balance of load on each phase. Electrical unbalance shall not exceed 7½% between phases.

3.2 GENERAL INSPECTION AND CLEANING OF ALL ELECTRICAL EQUIPMENT

- A. Inspect for physical damage and abnormal mechanical and electrical conditions.
- B. Any item found to be out of tolerance, or in any other way defective as a result of the required testing, shall be reported to the Engineer. Procedure for repair and/or replacement will be outlined. After appropriate corrective action is completed the item shall be re-tested.
- C. Compare equipment nameplate information with the latest single line diagram and report any discrepancies.
- D. Verify proper auxiliary device operation and indicators.
- E. Check tightness of accessible bolted electrical joints. Use torque wrench method.
- F. Make a close examination of equipment and remove any shipping brackets, insulation, packing, etc. that may not have been removed during original installation.
- G. Make a close examination of equipment and remove any dirt or other forms of debris that may have collected in existing equipment or in new equipment during installation.
- H. Clean All Equipment:
 1. Vacuum inside of panelboards, comm/data, security panel, etc.
 2. Loosen attached particles and vacuum them away.
 3. Wipe all insulators with a clean, dry, lint free rag.
 4. Clean insulator grooves.
 5. Re-vacuum inside surfaces as directed by the Engineer or Inspector
- I. Inspect equipment anchorage.
- J. Inspect equipment and bus alignment.
- K. Check all heater elements for operation and control.
- L. Lubricate non-electrical equipment per manufacturer's recommendations.

3.3 GROUNDING SYSTEMS

- A. Inspect the ground system for adequate termination at all devices.

3.4 METERING

- A. Examine all devices for broken parts, damage and wire connection tightness.

- B. Meter selector switches shall be inspected for proper application and operation.

3.5 GROUND FAULT SYSTEMS

- A. Inspect for physical damage.
- B. Inspect the neutral main bonding connection to assure:
 - 1. Zero sequence system is grounded upstream of sensor.
 - 2. Ground strap systems are grounded down stream from the sensing device.
 - 3. Ground connection is made ahead of the neutral disconnect link.
- C. Monitor panels (if present) shall be manually operated for:
 - 1. Trip tests
 - 2. No trip tests
 - 3. Nonautomatic reset
- D. Ground fault device circuit nameplate identification shall be verified by device operation.
- E. Insure control circuit has disconnectable fuse device with current limiting fuses.

3.6 CABLES

- A. Visual and Mechanical Inspections:
 - 1. Inspect exposed sections for physical damage.
 - 2. Verify cable is supplied and connected in accordance with single line diagram.
 - 3. Inspect for shield grounding, cable support and termination.
 - 4. If cables are terminated through window type C.T.'s make an inspection to verify that neutrals and grounds are properly terminated for normal operation of protective devices.
 - 5. Inspect for visual jacket and insulation condition.
 - 6. Visible cable bends shall be checked against ICEA or manufacturer's minimum allowable bending radii -- 12 times the diameter for tape shielded cables.
 - 7. Inspect for proper fireproofing in common cable areas.
 - 8. There shall be NO tests performed on existing cable without specific direction from the Engineer.
- B. Electrical Tests -- Below 600 Volts:
 - 1. All secondary cables from the substation transformers to the secondary switchboards shall be subjected to insulation tests using a 500 vdc megger.
 - 2. Visually inspect cables, lugs, connectors and all other components for physical damage and proper connections
 - 3. Check all cable connectors for tightness(with a torque wrench) and clearances. Torque test conductor and bus terminations to manufacturer's recommendations.
 - 4. Check for proper grounding resistance at all services and at transformers. Resistance shall be 2 ohms maximum.

3.7 MANHOLES

- A. Check cable racking and system grounding in all manholes.
- B. Refer to the drawings for additional specific requirements in selected manholes.
- C. Verify all cable labels.

3.8 PANELBOARDS

- A. Torque all the connections per the manufacturers spec. Verify phase wires, color coding, separate neutral and mechanical bonding. Verify circuit breaker operation. Verify the directory.

3.9 LIGHT FIXTURES

- A. Check the bonding and proper lamping. Verify that recessed fixtures are installed with hold down clips. Confirm operation of the fixture with the proper switch or sensor.

3.10 OCCUPANCY SENSORS

- A. Confirm operation of the sensor per the manufacturers spec.

3.11 BATTERY PACK EMERGENCY LIGHTING

- A. Verify the operation per the manufacturers spec and run all of the diagnostic steps. Confirm proper grounding and location.

3.12 MOTOR STARTERS

- A. Verify the control circuits. Confirm the fusing and the grounding of the control transformers. Torque all of the connections. Confirm the overload elements and the circuit breakers(fuse) for proper sizing. Verify all grounding. Operate and test each motor starter for proper operation.

END OF SECTION

SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 – GENERAL

1.1 RELATED REQUIREMENTS

- A. Applicable provisions of Division 1 shall govern work under this section.

1.2 SCOPE

- A. Provide conductors and connectors as specified herein.

1.3 RELATED WORK

- A. Section 26 05 04 – Cleaning, Inspection and Testing Electrical Equipment
- B. Section 26 05 26 – Grounding and Bonding for Electrical Systems
- C. Section 26 05 33 – Raceway and Boxes for Electrical Systems
- D. Section 26 05 53 – Identification for Electrical Systems
- E. Section 26 27 26 – Wiring Devices

1.4 QUALITY ASSURANCE

- A. Reference Standards of the following associations:
 - 1. National Electrical Contractor's Association (NECA) – Standard of Installation.
 - 2. Insulated Cable Engineers Association (ICEA).
 - 3. National Fire Protection Association (NFPA) 70 – National Electrical Code (NEC) and Wisconsin amendments thereto.

PART 2 – PRODUCTS

2.1 CONDUCTORS

- A. Copper Conductor only.
- B. Insulated with 600 V insulation and color code conductors for low voltage (secondary feeders and branch circuits) as required by code.
- C. Type THHN Solid or Stranded: Single conductor No. 10 AWG and smaller, No. 12 AWG minimum.
- D. Type THHN Stranded: Single conductor No. 8 AWG and larger. Conductor triple rated for use as types THHN, THWN and MTW is approved.
- E. Conductors installed in exterior wet locations and areas with high humidity shall be type XHHW.
- F. Conductors shall not be installed at temperatures below the manufacturer's minimum installation temperature.

2.2 JOINTS, TAPS AND SPLICES

- A. Interior Conductors No. 10 AWG and Smaller: Standard wire connectors.
- B. Interior Conductors No. 8 AWG and Larger: NSI Polaris or equal Insulated multi-cable connector blocks.
- C. Exterior Conductors No. 10 AWG and Smaller: King Silicon Filled ProLine Underground/direct bury rated wire connectors.
- D. Exterior Conductors No. 8 AWG and Larger:
 - 1. Non-underground (light pole) locations: Splices shall be accept (4) #14-#2 conductors, be underground/overhead rated and include gel filled hinged splice closure. Utilize NSI Easy-Splice Gel Tap Splice Kit series connectors (ESGTS-2) or equal. Provide two layers of electrical tape around closure.
 - 2. Underground (pull box) locations: Splices shall accept quantity and size of conductors required at individual pull boxes (which may be of differing configurations), be direct burial and submersible rated. Utilize multi-cable compression connectors with the splice encased in a Scotchcast 85 series multi-mold compound or equal. Split bolts are not allowed. No splices are allowed in pull boxes, unless indicated on the plans.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Run conductors in conduit unless otherwise indicated on drawings.
- B. Install in accordance with manufacturer's written instructions and in accordance with recognized industry practices.

3.2 INSPECTION

- A. Examine areas and conditions under which feeders and branch circuits are to be installed and notify Engineer, in writing, of conditions detrimental to proper and timely completion of work.
- B. Do not proceed with work until unsatisfactory conditions have been corrected.

3.3 JOINTS, TAPS AND SPLICES

- A. Cable splices shall be made only in distribution and junction boxes.

3.4 FIXTURE OUTLETS

- A. Use conductor with insulation suitable for current, voltage and temperature to which conductor will be subjected.
- B. No. 12 wire size minimum for conductors supplying power to a single fixture. 600V insulation minimum.

- C. Insulation suitable for operation at 90° C. minimum for lighting fixtures with integral ballast, mogul base sockets, quartz lamps or otherwise where subject to excessive temperatures.
- D. Fixture wiring shall be continuous wiring system to lampholder or to ballast and from ballast to lampholder.

3.5 FEEDER CIRCUITS

- A. Extend feeders at full capacity from origin to termination.
- B. Each conduit raceway shall contain only those conductors constituting a single feeder circuit.
- C. Where feeder conductors are run in parallel, conductors shall be of same length, same material, circular-mil area, insulation type and terminated in same manner.
- D. Where parallel feeder conductors shall be run in separate raceways, each raceway shall have same physical characteristics.
- E. Feeders shall follow most accessible routes, concealed in construction in finished areas, exposed to the minimum temperature gradient and to minimum temperature fluctuation.
- F. Confine feeders to insulated portions of building, unless otherwise specified.
- G. Trapped feeder runs without facilities for continuous drainage are not acceptable.
- H. Do not draw conductors into conduits until building is enclosed and watertight, and until work which may cause conductor damage has been completed.
- I. Feeder conduits shall not be routed in concrete floor slabs.

3.6 BRANCH CIRCUITS

- A. Conductors shall be size 12 AWG minimum (unless otherwise noted) for branch circuit wiring, including motor circuits.
- B. Size 120V branch circuits for length of run on following basis:
 - 1. 0 to 75 feet run from panelboard to first outlet: No. 12 AWG minimum.
 - 2. 75 to 125 feet run: increase one wire size, i.e. No. 12 AWG becomes No. 10 AWG.
 - 3. 126 to 200 feet run: increase two wire sizes, i.e. No. 12 AWG becomes No. 8 AWG.
 - 4. 201 and above: wiring to be sized for 3% maximum voltage drop.
- C. Voltage drop for branch circuits and feeder circuit combined shall not exceed requirements of NEC Article 215.
- D. Route branch circuits and switch legs as dictated by construction, these specifications, or instructions from the Engineer.
- E. Size conduit, outlet boxes and other raceway system components in accordance with NEC requirements as minimum.

- F. Do not draw conductor into conduits until building is enclosed and watertight, and work which may cause conductor damage has been completed.
- G. Circuit numbers as shown on drawings are for Contractor to plan his wiring and for estimating purposes and are not necessarily the exact circuit numbers to be used in that panel for that particular load. Exact circuit numbers for each load are to be selected by the Contractor at their option. Balanced load on panelboard bus is to be the determining factor in arrangement of circuits. Panelboards average load shall not differ from phase to phase by $\pm 7\text{-}1/2\%$.

3.7 MOTOR AND EQUIPMENT WIRING

- A. Furnish and install motor circuits in accordance with schedules on drawings and code requirements, from source of supply to associated motor starter, and from starter to motor terminal box, including necessary and required intermediate connections.
- B. Conductor and conduit size for motor branch circuits, if shown on drawings, are sized for motor requirement only.
- C. Motors shall have proper feeders as per NEC and nameplate ratings. Contractor is responsible for verification of ratings of motors and installing proper branch circuits.
- D. Obtain manufacturer's wiring diagrams and shop drawings for equipment requiring electrical connections.
- E. Check drawings and specifications of other divisions of work for equipment and work which shall be included in order to provide a complete electrical installation.
- F. Motor connections shall be made by compression type connectors using proper tools and fittings to assure good electrical continuity and low resistance joint.

END OF SECTION

SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 RELATED REQUIREMENTS

- A. Applicable provisions of Division 1 shall govern work under this section.

1.2 SCOPE

- A. Provide all material, labor and incidentals necessary for the completion of this section of the work.

1.3 RELATED WORK

- A. Section 26 05 00 – Common Work Results for Electrical
- B. Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables

1.4 QUALITY ASSURANCE

- A. Follow the requirements of the following regulatory agencies:
 - 1. National Fire Protection Association (NFPA, NFPA-70 - National Electrical Code (NEC) and Wisconsin amendments thereto.
 - 2. Local Codes and Ordinances

1.5 REFERENCE STANDARDS

- A. Conform to the standards of the National Electrical Contractors Association (NECA), Standard of Installation.

PART 2 – PRODUCTS

2.1 GROUND CLAMPS

- A. Ground clamp fittings shall be interlocking clamp type fabricated from high strength corrosion-resistant metal with high strength silicon bronze U-bolt, nuts and lock washers.

2.2 GROUND RODS

- A. Thick copper covering inseparably welded to a strong steel core.
- B. $\frac{3}{4}$ in. diameter minimum.
- C. Ten-feet long minimum.

2.3 GROUND WIRES

- A. Copper only.
- B. Size as shown on drawings, or as required by NEC.

- C. No. 6 AWG minimum.

PART 3 – EXECUTION

3.1 GENERAL

- A. Ground electrical systems and equipment as required by code, utility, local ordinances and to requirements herein.
- B. Install separate code rated grounding conductors to special equipment and activity areas as required by code.
- C. Bond all metallic piping systems and service equipment as required by NEC.
- D. Cable connections and joints shall be thermo-welded.

3.2 SYSTEM GROUND

- A. Attach grounding electrode conductor to point ahead of water meter or service shut-off valve. Grounding electrode conductor shall be permitted to be attached to other grounding electrodes where available in the building as defined in NEC Article 250-81 in lieu of attaching to water service.
- B. Water piping system ground shall be augmented by 2 NEC approved grounding electrodes so as to achieve an effective ground resistance as required by code and as shown on the plans. Building steel shall be used where available.
- C. Drive ground rods to a depth of 4 inches below finished grade.
- D. Grounding electrode conductor.
 - 1. Continuous without splice from nearest building grounding electrode. Ground to service equipment.
 - 2. Install bonding jumper around water meter.
 - 3. Install in rigid metal conduit securely fastened to pipe.
 - 4. Attach non-ferrous metal tag to warn against removal.
 - 5. Make connections to ground electrodes with approved molded exothermic weld process.

3.3 EQUIPMENT GROUND

- A. Bond metallic conduits, supports, cabinets and other equipment so ground will be electrically continuous from service to outlet boxes.
- B. Install grounding conductor in nonmetallic and flexible conduit to complete equipment ground continuity. Ground wire shall be bonded at equipment and at first junction box of conduit system on line side of flexible conduit to the system.
- C. Install grounding conductors to permit shortest and most direct path from equipment to ground. When grounding conductor runs through metallic conduit, bond to conduit at entrance and exit with a bolted clamp.
- D. Ground neutral at service only.

- E. Install an insulated equipment grounding conductor in each conduit. Conduit will not be relied upon as the grounding path.
- F. Provide an insulated dedicated green equipment grounding conductor (in addition to equipment grounding conductor) with all circuits serving isolated ground receptacles (connected to isolated ground terminal on device).
- G. Green ground bar in panels, where required to be similar to neutral bar, except tinted green and isolated from panel tub.
- H. Connections shall be accessible for inspection and checking. No insulation shall be installed over ground connections.
- I. Ground connection surfaces shall be cleaned and all connections shall be made so that it is impossible to move them.
- J. Attach grounds permanently before permanent building service is energized.
- K. Ground metal lighting poles. Install a ground lug on wall of pole directly across from handhole.
- L. Attach ground wire neatly and firmly to walls.

3.4 FIELD QUALITY CONTROL

- A. Contractor shall make ground resistance measurements. Measure in normally dry conditions, not less than 48 hours after rainfall.

END OF SECTION

SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 RELATED REQUIREMENTS

- A. Applicable requirements of Division 1 shall govern work under this section.

1.2 SCOPE

- A. Provide equipment for the support of electrical equipment as detailed or indicated on the drawings and as specified herein.

1.3 QUALITY ASSURANCE

Reference standards of the following agencies:

- A. National Electrical Contractors Association (NECA), Standard of Installation.
- B. National Electrical Manufacturers Association (NEMA).
- C. American National Standards Institute (ANSI).

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Kindorf
- B. Elcen Co.
- C. Steel City
- D. Unistrut
- E. B-Line

2.2 GENERAL

- A. Metal supporting devices shall be zinc galvanized or cadmium plated steel or malleable iron.

2.3 LIGHTING FIXTURE SUPPORT

- A. Items such as stems, hickies, bar hangers and clips required to securely attach fixtures to ceilings or walls.
- B. Studs and unistrut support for fixture outlet and ceiling support.
- C. Fixture grid hangers for mounting surface fluorescent units to exposed grid ceiling.
- D. Drilled expansion insert type anchors suitable for load and application requirements such as sleeve anchors, lag shields, and plastic anchors.

- E. Provide auxiliary supports so that fixtures can be drawn up tightly, cannot be tilted or rotated and will not be affected by vibrations.

2.4 SUPPORTING STRUCTURES

- A. Rack supports of galvanized steel channel sections with adequate feet to allow secure mounting.
- B. Weld sections, do not use bolts.

2.5 MOUNTING PANELS

- A. Size mounting panels to mount necessary equipment, of $\frac{3}{4}$ " exterior grade plywood as specified on drawings.
- B. Provide mounting panels for all surface mounted electrical cabinets and enclosures.
- C. Provide uniform mounting panels as far as practical. Preferred sizes being 12" X 18", 18" X 24", 18" X 30", and 24" X 30".

2.6 CONDUIT SUPPORTS

- A. Two hole galvanized steel straps.
- B. Continuous slot or T-slot galvanized steel concrete insert channel.

PART 3 – EXECUTION

3.1 PREPARATION

- A. Install hangers, supports and anchors only after structural work, where work is to be installed, has been completed. Correct inadequacies such as proper placement of inserts, anchors and other building structural attachments.
- B. Examine areas and conditions under which equipment and associated components are to be installed and notify Architect, in writing, of conditions detrimental to proper and timely completion of work. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 LIGHTING FIXTURES

- A. Install channel supports across main grid runners or grid supports, securely tied down or anchored for fixtures and devices mounted in suspended ceiling systems so as not to cause tile to sag and so that fixture or device cannot be lifted, rotated or displaced. Provide additional support of ceiling grid or tees at those locations where tiles and ceiling grid sags.
- B. Install grid troffer support clips in accordance with NEC 410-16(c).

3.3 INSTALLATION OF BUILDING ATTACHMENTS

- A. Install building attachments at required locations within concrete or on to structural steel or raceway and equipment support.

- B. Install additional building attachments where support is required for additional concentrated loads.
- C. Install concrete inserts before concrete is placed

3.4 INSTALLATION OF ANCHORS

- A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ANSI B31 and to prevent the transfer of loading and stresses to connected equipment.
- B. Installation methods shall conform with the manufacturer's recommendations for maximum holding power, but in no case shall the depth of hole be less than four bolt diameters. Minimum distance between the center of any expansion anchor and an edge of exterior corner of concrete shall be not less than $4\frac{1}{2}$ times the diameter of the hole in which it is installed.

3.5 SUPPORT OF CONDUIT

- A. Fasten conduit to structural parts of building in a manner acceptable to Engineer.
- B. Do not use perforated hanger iron.
- C. Install concrete insert channel as required, with spacings as recommended by manufacturer. Install with anchor and caps, insert joiner clips and closer seals as required.
- D. Support conduit as follows:
 - 1. Single Conduit Runs
 - a. Vertical Surfaces: Galvanized, heavy duty, sheet steel straps; back straps to be provided for all exposed conduit and conduit on exterior walls.
 - b. Horizontal Surfaces: Galvanized, heavy duty, 2-hole steel pipe straps.
 - 2. Multiple Conduit Runs
 - a. Vertical Surfaces: Horizontal or vertical rack channel with conduit straps as required.
 - b. Horizontal Surfaces: Single or double rack channel trapeze, complete with conduit straps as required; all supported with threaded hanger rods.
 - 3. Passing Between Floors and Through Roof
 - a. $1\frac{1}{4}$ " and larger conduit runs passing through floors shall be supported at each floor with riser pipe clamps.
 - b. Conduit extending through roof shall pass through a ceiling box at roof lines.
 - c. Provide 14 ga minimum copper box complete with watertight soldered seams and flanged to serve as pitch pocket for each conduit.
 - d. Conduit and pitch pocket shall be installed in advance of roofing work.

3.6 VERTICAL CABLE SUPPORT

- A. Conductors in vertical raceways shall be supported using suitable cable supports. Locate supports so that each 25 ft.-0 in. length of conductor in a vertical raceway will be complete with support.

END OF SECTION

SECTION 26 05 33 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 RELATED REQUIREMENTS

- A. Applicable provisions of Division 1 shall govern work under this section.

1.2 SCOPE

- A. Provide conduit systems, boxes and fittings for all power wiring and communication systems as specified.

1.3 RELATED WORK AND REQUIREMENTS

- A. Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables
- B. Section 26 05 26 – Grounding and Bonding for Electrical Systems
- C. Section 26 05 29 - Hangers and Supports for Electrical Systems
- D. Section 26 27 26 – Wiring Devices.

1.4 QUALITY ASSURANCE

- A. National Electrical Contractor's Association (NECA) Standard of Installation
- B. National Electrical Code (NEC) including State of Wisconsin and local supplements.

PART 2 – PRODUCTS

2.1 GALVANIZED RIGID CONDUIT (GRC) AND INTERMEDIATE METAL CONDUIT (IMC)

- A. Manufactured lengths, full weight, heavy wall, rigid steel conduit, protected inside and out by hot-dipped galvanized or electro-galvanized coating.
- B. Minimum conduit size shall be ½ inch.
- C. Connectors and Couplings
 1. Threaded.
 2. Liquid tight.
 3. Insulated throat.

2.2 ELECTRICAL METALLIC TUBING (EMT)

- A. Standard lengths and sizes.
- B. Minimum conduit size shall be ½ inch.
- C. Connectors and Couplings
 1. Threaded with insulated throat for box connections.
 2. Gland compression on conduit connections.
 3. Steel.

- D. Colors (factory finished):
 - 1. Red – Fire Alarm Systems
 - 2. Green – Emergency power systems.
 - 3. Purple - Security
 - 4. Blue - Telecommunications
 - 5. Standard Silver (no special finish) - Normal power systems

2.3 POLYVINYL CHLORIDE CONDUIT (PVC)

- A. Standard lengths and sizes.
- B. Minimum size ½“, with the exception that the minimum size conduit for underground site lighting circuits shall be 1”.
- C. Schedule 40, heavy wall rigid plastic (PVC) conduit manufactured to NEMA TC-2 standards, UL listed and as required by NEC. Sunlight resistant.
- D. Connectors and Couplings
 - 1. To match conduit.
- E. PVC conduit is NOT allowed to be run in any area that is in direct sunlight.

2.4 PVC COATED RIGID METAL CONDUIT

- A. Per NEMA Standards Publication No. RN 1 – 1980 and ANSI C80.1.
- B. Rigid steel galvanized conduit with PVC coating.
- C. Full weight 40 mil thick PVC coating, bonding to galvanized metal shall be stronger than plastic tensile strength.
- D. Minimum conduit diameter shall be ½ inch.
- E. Connectors and Couplings
 - 1. Full weight 40 mil PVC jacket.
 - 2. PVC gasketed for mating surfaces.
 - 3. Same as for rigid conduit.

2.5 FIBERGLASS CONDUIT

- A. Per UL 1684, rigid conduit and associated condulets and fittings shall be carbon black reinforced thermosetting resin suitable for above ground installation.
- B. Minimum conduit size shall be ¾ inch.
- C. Connectors and Couplings
 - 1. To mach conduit.

2.6 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

- A. Galvanized spiral strip flexible steel.

- B. Standard conduit sizes.
- C. Heavy wall sunlight resistant PVC jacket.
- D. Minimum size ½ inch.
- E. Connectors and Couplings
 - 1. Liquid-tight.
 - 2. Suitable for grounding.
 - 3. Suitable for wet locations.
 - 4. Tapered threaded hub.
 - 5. Non-metallic materials.

2.7 FLEXIBLE METAL CONDUIT

- A. Galvanized spiral strip flexible steel.
- B. Standard conduit sizes.
- C. Minimum size ½" with the exception that 3/8" diameter may be used to serve individual lighting fixtures installed in a suspended accessible ceiling system.
- D. Connectors and Couplings
 - 1. Threaded.
 - 2. Grounding type.
 - 3. Insulated throat.
 - 4. Two screw clamp type with locknuts.
 - 5. Externally secured.

2.8 SURFACE METAL RACEWAYS

- A. Raceways shall be two piece. Front cover shall be removable to provide access to wiring compartment.
- B. Raceways shall be galvanized steel.
- C. Raceways shall be provided with multiple knockouts and screw holes along back channel.
- D. All additional accessories required for a complete installation shall be provided.
- E. Raceways shall be ivory.
- F. Raceway Types
 - 1. Wiremold 500 Series minimum, or approved equal, to feed individual power and/or telecommunications wiring devices.
 - 2. Wiremold 4000 Series or approved equal: Shall not be less than 4-3/4" x 1-3/4" in size. Where plans call for telecommunications and power wiring to be run in the same raceway, the raceway shall be provided with a metal barrier. 4000 raceway shall be used wherever the multi-receptacle assembly symbol is shown on the floor plans.

2.9 EXPANSION FITTINGS

- A. Expansion fittings: Copper bonding jumper, Crouse-Hinds Type XJ.
- B. Expansion/deflection fittings: Copper bonding jumper, Crouse-Hinds Type XD.

2.10 CONDUIT BODIES

- A. Galvanized or cadmium plated.
- B. Threaded hubs.
- C. Removeable cover with gasket.
- D. Corrosion-resistant screws.

2.11 SEALS

- A. Wall entrance seals: Link seal type as manufactured by Thunderline Corporation.

2.12 INTERIOR WALL OUTLET BOXES – FLUSH MOUNTED

- A. Stud wall construction. Stamped steel, four-inch square, 2-1/8" deep, with square corners. Provide with raised device rings, height as required for wall finish thickness. Mounting accessories as required. Larger width boxes as required for ganging requirements indicated on plans.
- B. Masonry wall construction. Stamped steel. Face of box flush with wall, 3-1/2" deep box minimum. Width as required for ganging requirements shown on plans.

2.13 INTERIOR WALL OUTLET BOXES – SURFACE MOUNTED – DRY LOCATION

- A. In public areas: Cast malleable aluminum with threaded conduit hubs. Two inches deep minimum. Internal mounting ears. Boxes shall be coated with electroplated zinc, a dichromate coating and an aluminum polymer enamel finish.
- B. Other areas: Stamped steel, four-inch square, 2-1/8" deep, with round corners. Provide rounded corner raised box covers with openings as required for devices being installed.

2.14 INTERIOR WALL OUTLET BOXES-SURFACE MOUNTED-DAMP OR WET LOCATION

- A. Cast malleable aluminum with threaded conduit hubs. Two inches deep minimum. Internal mounting ears. Boxes shall be coated with electroplated zinc, a dichromate coating and an aluminum polymer enamel finish.

2.15 EXTERIOR WALL OUTLET BOXES - SURFACE MOUNTED

- A. Single or two gang as indicated on the plans. Cast malleable iron with threaded conduit hubs. Two inches deep minimum. Internal mounting ears. Boxes shall be coated with electroplated zinc, a dichromate coating and an aluminum polymer enamel finish.

2.16 CEILING BOXES - FLUSH MOUNTED - FOR SURFACE AND PENDANT LIGHT FIXTURES

- A. Dropped ceiling construction. Stamped steel four-inch octagon box set flush with finished surface, complete with 3/8" fixture stud.
- B. Cast in place concrete construction. Stamped steel four-inch octagonal, galvanized concrete boxes, having a minimum depth of 3", complete with 3/8" fixture stud.

2.17 ELECTRICAL BOXES IN CORROSIVE LOCATIONS

- A. PVC coated cast steel boxes compatible with conduit system installed. Coating shall cover both interior and exterior surfaces. See floor plans for identification of corrosive areas.

2.18 SPECIAL BOXES

- A. Provide special boxes fabricated by the manufacturer of fixtures and other devices where standard outlets are not applicable.

2.19 INTERIOR GENERAL PURPOSE JUNCTION AND PULL BOXES

- A. Fabricated from code gauge galvanized steel with covers held in place by corrosion resistant machines screws.
- B. Size as required by code for number of conduits and conductors entering and leaving box.
- C. Provide with welded seams, where applicable and equip with corrosion-resistant nuts, bolts, screws and washer.

2.20 ACCESS PANELS

- A. Furnish type necessary for the particular wall or ceiling construction in which they occur.
- B. Panels to be completed with screwdriver cam locking device.

2.21 EXTERIOR JUNCTION BOXES

- A. Stainless steel or cadmium plated malleable iron cast type with threaded hubs, cast cover and neoprene gasket. Provide NEMA 4X rating.

2.22 BETWEEN STUD BOX SUPPORT BRACKETS

- A. Stamped and fabricated steel bracket designed to support 4" or 4-11/16" electrical boxes between wall studs.
- B. Manufactured by Erico, RBS series or equivalent.

2.23 EXTERIOR PULL BOXES

- A. Pull boxes shall be constructed of a composite material as shown on the plans. The composite boxes shall be constructed of polymer concrete and reinforced by a heavy-weave fiberglass as manufactured by Quazite or approved equal. The

pull boxes shall be rated for 15,000 lbs. over a 10" x 10" area at a temperature of -50°F and be UL listed.

- B. The box shall be furnished with a cover having a skid resistant surface with a minimum coefficient of friction of .5 and concrete gray color. The cover fasteners shall be stainless steel captive 3/8-inch hex head bolts with stainless steel inserts. The cover for the pull box shall have an "ELECTRIC", "LIGHTING" or "COMMUNICATIONS" logo corresponding with system, unless otherwise noted on the plans.

PART 3 – EXECUTION

3.1 GENERAL

- A. Interior conduits for wiring systems rated 0 to 600 volts shall be electrical metallic tubing (EMT). Exceptions to the requirements stated above are as follows.
 - 1. Poured concrete: PVC.
 - 2. Motor connection: Flexible conduit of appropriate type.
 - 3. Hazardous and corrosive locations: PVC coated Rigid Metal Conduit.
 - 4. Corrosive locations only: PVC.
 - 5. Damp/wet areas (i.e. crawl spaces): PVC.
 - 6. Areas subject to damage shall (i.e. loading docks): GRC.
 - 7. Where otherwise stated in these specifications or on the floor plans.
- B. Exterior underground conduits, service entrance conduits and conduits embedded in concrete lighting fixture pole bases shall be heavy wall schedule 40 PVC except as follows:
 - 1. Underground conduit runs which enter or exit the building envelope shall utilize galvanized rigid conduit from the point of penetration of the building envelope and the next 5' portion of the run in direct contact with the earth. Where conduits pass through poured concrete walls the EC shall install sleeves prior to the walls being poured.
- C. Conduits below the building slab shall be heavy wall schedule 40 PVC.
 - 1. When PVC conduit is stubbed-up above the slab, it shall only extend between 4"-6" above the top of the slab and be transitioned to the appropriate conduit allowed.
- D. Conduits encased in concrete as part of an underground electrical duct package shall be Schedule 40 HW PVC except that conduits shall be PVC coated rigid galvanized steel within 5' of the building envelope or for bends greater than 30 degrees.

3.2 UNDERGROUND AND EXTERIOR CONDUIT

- A. Exterior underground conduit shall be buried at a depth of not less than 24 in., nor more than 36" below grade or pavement.
- B. Provide conduits or ducts terminating below grade with means to prevent entry of dirt or moisture.

- C. Underground conduits shall slope 1/8" per foot for proper drainage. Conduits shall drain toward manholes and junction boxes, not the electrical equipment.
- D. Conduit that rises from below grade to an exposed above grade termination shall have conduit from the bend below grade (including bend) to termination point constructed with rigid steel conduit or fiberglass conduit. An expansion fitting shall be installed if the conduit above grade is 24" or longer.

3.3 PROCEDURES AND PRACTICES

- A. All conduits shall be routed concealed in finished spaces and shall not be visible at any point within the finished space or from the building's exterior. This requirement also applies to new conduits installed in existing construction. Exposed raceway may be used only where physically impossible to route concealed in construction. In such cases where exposed raceway is allowed it shall be surface type in public areas as dictated by the wiring quantities. In each case the specific raceway type and routing shall be submitted to the Architect for approval. Where allowed, the general installation requirements are as follows:
 - 1. Raceways shall be routed horizontally along the corners of walls and ceilings, directly above edges of base molding at floors, or along the tops of window and door frames.
 - 2. Raceways shall be routed vertically along corners of adjacent walls and along the edges of window and door frames.
 - 3. Raceways shall not be routed down or across open wall surfaces except in portions of runs not exceeding 12" in length.
 - 4. Raceways shall be painted to match wall finishes. EC is responsible for painting of all raceways.
 - 5. Fittings and boxes used with raceways shall be specifically designed and approved for use with the raceways.
- B. Cut joints shall be square, reamed smooth and drawn up tight.
- C. Keep conduit plugged, clean and dry during construction.
- D. Cap spare conduits.
- E. Provide riser clamps around all conduits 1-1/4" or larger that are routed between floors. Provide conductor support in vertical risers greater than 20' as appropriate.
- F. Provide a watertight conduit system where installed in wet locations such as underground, or where embedded in concrete.
- G. Route conduit runs above suspended acoustical ceilings so as not to interfere with ceiling tile removal. Conduit supports shall be attached to building structural elements. Conduits shall not be supported by or attached to the suspension systems for dropped ceiling systems unless specifically detailed on the drawings.
- H. Conduits may be routed exposed in mechanical equipment rooms and utility rooms.
- I. Route all conduits (including conduits routed above ceilings) parallel to or at right angles with lines of the building construction and structural members except conduit runs routed concealed in pour-in-place concrete floor slabs may be run in direct line from source load.

- J. Make bends and offsets without kinking or destroying smooth bore of conduit. Arrange bends and offsets in parallel conduits to present a neat symmetrical appearance.
- K. Secure conduits in place with malleable corrosion-proof alloy straps or hangers. Conduit straps used in corrosive areas shall be PVC coated.
- L. The use of perforated strapping as a conduit hanging method is not approved.
- M. Conduit runs that extend through areas of different temperature or atmospheric conditions shall be sealed, drained and installed in a manner that will prevent drainage of condensed or entrapped moisture into cabinets and equipment enclosures.
- N. Route conduits within poured concrete construction parallel to each other and spaced on center of at least three times conduit trade diameter with minimum two (2) inches of concrete covering. Conduits over 1 ¼" may not be installed in slab without the approval of the Architect. Conduits embedded in a structural frame slab shall comply with applicable provisions of American Concrete Institute (ACI), Standard 318. Conduits used for feeders shall not be embedded in concrete floor slabs.
- O. In areas constructed of pre-cast concrete, run conduits in insulation space or in floor topping slabs without crossing other conduits, using ¾" maximum conduit size.
- P. Install flexible steel conduit whips from an independent junction box mounted above ceiling to recessed ceiling mounted lighting fixtures. Allow for positioning of equipment to tile increments.
- Q. Connections to Motors and Equipment Subject to Vibration:
 - 1. Flexible steel conduit not over three (3) feet long for connection to motorized equipment.
 - 2. Liquid-tight flexible conduit not over three (3) feet long where exposed to moisture, dirt, fumes, oil, corrosive atmosphere with connectors to assure a liquid-tight, permanently grounded connection. Locate so it is least subject to physical abuse. Corrosive areas are identified on the floor plans.
 - 3. Use double locknuts and insulated bushings with threads fully engaged.
- R. Install bushings with ground lugs and integral plastic linings at equipment with open bottom conduit entrances.
- S. Install conduit expansion fittings where conduits cross expansion joints.
- T. Install No. 12 pull wire in empty conduit.
- U. All wiring in raceways shall be provided with a separate green grounding conductor.
- V. All conduits that terminate in free air (no connection to equipment or box) shall be provided with an insulated bushing.

- W. All wiring in walls shall have a raceway within the wall with an enclosed outlet box regardless if the remaining portion of the particular system is installed in raceway or free-air.

3.4 FIRE STOPS AND PENETRATION SEALS

- A. All penetrations through fire rated floors and walls due to the electrical installation shall be sealed with CHASE-FOAM PR-855 Fire Resistant Foam Sealant, to prevent the spread of smoke, fire, toxic gas or water through the penetration either before, during or after a fire. The fire rating of the penetration seal shall be at least that of the floor or wall into which it is installed, so that the original fire rating of the floor or wall is maintained as required by Article 300-21 of the National Electrical Code. Equivalent foam sealant manufactured by Dow Corning approved.
- B. The sealant shall remain soft and pliable to allow for the removal and/or addition of cables without the necessity of drilling holes. It shall adhere to itself perfectly to allow any all repairs to be made with the same material. It shall permit the vibration, expansion and/or contraction of anything going through the penetration without the seal cracking or crumbling.
- C. When damming materials are to be left in place after the seal is complete then all such materials shall be non-flammable.
- D. When sealant is injected into a penetration, the foam shall expand to surround all the items within the penetration and maintain pressure against the walls of the penetration. The foam shall cure within five minutes and be fire resistant at that time. No heat shall be required to further expand the foam to block the passage of fire and smoke or water.
- E. All wall or floor penetrations openings shall be as small as possible.
- F. The foam sealant shall meet all fire test and hose stream test requirements of ASTM E119-73 and shall be UL Classified as a Wall Opening Protective Device.
- G. All penetrations through non-fire rated walls shall be sealed with an appropriate sealant.

3.5 CUTTING AND PATCHING

- A. Provisions for opening, holes and clearances through walls, floors, ceilings and partitions shall be made in advance of construction.
- B. Provide cutting, patching and painting necessary for the installation of electrical systems.
- C. Where conduits need to penetrate concrete or masonry construction below grade, the EC shall install PVC sleeves with integral waterstop, one (1) inch larger in diameter than the conduit being installed. Install sleeves before walls and/or slabs are poured or constructed.
- D. Where conduits need to penetrate concrete or masonry construction above grade, the EC shall install 22 gauge galvanized steel pipe sleeves, one (1) inch larger in diameter than the conduit being installed. Sleeves shall extend 2" above and below the floor slab penetrated. Install sleeves before walls and/or slabs are poured or constructed.

- E. The Electrical Contractor shall prepare drawings indicating size and location of all anticipated floor sleeves for the installation of electrical conduits. Such drawings shall be made available to the General Contractor 10 days prior to any scheduled concrete work.

3.6 RESTRICTIONS

- A. Conduits routed parallel to steam lines, hot water pipes, high temperature piping or ducts shall be routed at least 12" from such and shall be a minimum of 12" clear when crossing same.
- B. Do not route conduit over boiler, incinerator or other high temperature equipment.
- C. Where conduits must cross or follow the same path as water, steam or other fluid piping, run electrical conduits above such piping wherever possible.

3.7 ADJUSTMENT AND CLEANING

- A. Restore damaged areas on PVC jacketed, rigid conduit with spray type touch-up coating compound or as directed by manufacturer.
- B. Pull cleaning plug through conduits to clear of dirt, oil and moisture.

3.8 CONDUIT SYSTEMS

- A. Where raceways are required, separate raceway systems shall be provided for each wiring system as follows:
 - 1. 208 volt normal power wiring systems.
 - 2. 208 volt code required emergency power wiring systems.
 - 3. Voice/data communications raceway systems.

3.9 CONDUIT FITTINGS

- A. Install electrical fittings in accordance with the manufacturer's written instructions and with recognized industry practices to ensure that fittings serve intended purposes.
- B. Rigidly secure connectors at cabinets and boxes with galvanized lock nut and bushing.
- C. Seal conduits that run through different temperature or atmospheric conditions to prevent condensation or moisture from entering electrical equipment and devices.
- D. Install wall entrance seal where conduits or direct burial conductors pass through foundation walls below grade.
- E. Install conduit expansion fittings complete with bonding jumper in following locations:
 - 1. Conduit runs which cross a structural expansion joint.
 - 2. Conduit runs where movement perpendicular to axis of conduit may be encountered.

- F. Locate conduit bodies so as to assure accessibility of electrical wiring.
- G. Install fittings designed for use with flexible liquid-tight conduit to ensure continuity of ground throughout the fittings and conduit, and prevent entrance of moisture.
- H. Exposed PVC runs, subject to temperature changes of more than 20 degrees, and longer than 10 feet shall have an expansion fitting (long or short type as appropriate) installed in middle of run.

3.10 BOX INSTALLATION

- A. Install electrical boxes as indicated in compliance with NEC requirements, in accordance with the manufacturer's written instructions and with recognized industry practices to ensure that the boxes serve the intended purposes.
- B. Seal conduit at entrance to weatherproof boxes for interior and exterior locations exposed to weather or moisture.
- C. Install knockout closures to cap unused knockout holes where blanks have been removed.
- D. Locate boxes so as to assure accessibility of electrical wiring. Relocate boxes rendered inaccessible by the installation of work by other trades.
- E. Secure boxes rigidly to the substrate upon which they are being mounted or solidly embed boxes in concrete or masonry. Do not support from conduit.
- F. Set boxes, in concealed conduit runs, flush with wall surfaces, with or without covers, as required.
- G. Do not install boxes back to back or through wall. Offset outlet boxes on opposite sides of wall a minimum of 12 inches.
- H. Set outlet boxes parallel to construction, securely mounted and adjusted to set true and flush with the finished surface.
- I. Do not burn conduit holes, use knock-out punches or hole saws.
- J. Use "no-bolt" studs where specifically detailed on the drawings.
- K. Boxes shall be sized per code to accommodate the number and size of conduit entrances to the box and to accommodate the number of conductors, splices, fittings, etc., within the box. Do not use box extensions to create additional volume to meet NEC requirements for the number of conductors contained in a box.

3.11 EXPOSED OUTLET AND JUNCTION BOXES

- A. Install non-rusting metal weatherproof cover on recessed junction box in new walls or non-rusting surface mounted metal junction boxes on existing walls outdoors and in any area where drawings show weatherproof (WP) or weatherproof-while-in-use (WPIU) wiring devices. Provide non-rusting metal WPIU covers anywhere required by code, even if not indicated on plans.

3.12 INTERIOR OUTLET BOX ACCESSORIES

- A. Provide outlet box accessories as required for each installation, such as mounting brackets, wallboard hangers, extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, compatible with outlet boxes being used and meeting requirements of individual wiring situations.

3.13 LIGHTING FIXTURE OUTLET BOXES

- A. Securely mount with approved type bar hangers spanning structural members to support weight of fixture.
- B. Do not support from conduit.
- C. Equip with 3/8" fixture studs and tapped fixture ears for surface mounted or pendant mounted lighting fixtures. Fixture studs shall be provided for mounting of all lighting fixtures exceeding 25 lbs in weight. Fixture studs shall be attached through knockouts at the top of the box.
- D. Provide additional attachments from structure for outlet boxes supporting lighting fixtures weighting in excess of 25 lbs.

3.14 OUTLET BOX LOCATIONS

- A. Locate flush mounted wall boxes in corner of nearest brick or block to keep cutting to a minimum.
- B. Location of outlets and equipment as shown on drawings is approximate, and exact location is to be verified and shall be determined by:
 - 1. Construction or code requirements
 - 2. Conflict with equipment of other trades.
 - 3. Equipment manufacturer's drawings.
- C. Where receptacles and communication outlets are shown grouped next to each other on the drawings, the boxes for these outlets shall be mounted next to each other and shall not be located according to stud spacings. The Contractor shall utilize between stud box supports to assist in mounting boxes proximal to one another on a consistent spacing between wall studs.
- D. Minor modification in the location of outlets and equipment is considered incidental up to a distance of 10 feet, provided the change in location is requested prior to rough-in. **Outlets shall not have their locations significantly altered from that shown on the plans unless approved by the engineer – relocations necessary to relocate and install in the intended position due to unapproved relocations shall be at the sole cost to the electrical contractor.**
- E. Mounting heights for devices and equipment to be measured from finished floor to center line of device.

END OF SECTION

SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 RELATED REQUIREMENTS

- A. Applicable provisions of Division 1 shall govern work under this section.

1.2 SECTION INCLUDES

- A. Nameplates
- B. Labels

1.3 RELATED WORK

- A. Section 26 05 00 – Common Work Results for Electrical

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Nameplates:
 - 1. Engraved three-layer laminated plastic, white letters on a black background. Emergency system shall use white letters on a red background.
- B. Tape (phase identification only):
 - 1. Scotch #35 tape in appropriate colors for system voltage and phase.
- C. Adhesive type labels shall be typed with black text on white background for boxes in non-public areas and black text on clear background for wiring device faceplates.
- D. Embossed tape is not permitted.

PART 3 – EXECUTION

3.1 GENERAL

- A. Where mixed voltages are used in one building (e.g. 4160 volt, 480 volt, 208 volt) each switch, switchboard, junction box, equipment, etc., on each system shall be labeled for voltage in addition to the other requirements listed herein.
- B. All branch circuit and power panels shall be identified with the same name used at the main distribution panel.
- C. Handwriting is not acceptable for any identification, including any additional identification required by inspectors or other code officials.

3.2 INSTALLATION

- A. Clean and degrease surfaces to receive labels or nameplates.
- B. Install nameplates parallel to equipment lines.
- C. Secure nameplates to equipment using screws, rivets or adhesive.
- D. Provide nameplate for each switchboard, panelboard, contactor, telephone cabinet, time switch, motor starter, transformer, fire alarm panel or disconnect switch.
 - 1. Identification shall be on the exterior of the unit, except for flush equipment in public areas which shall have the identification inside the door or cover.
- E. Label each end of empty conduit runs to indicate the use of the conduit and the location of opposite end and plug conduit ends. Use room numbers that are permanently assigned.

3.3 EQUIPMENT IDENTIFICATION

A. TYPICAL EQUIPMENT

- 1. Identify using nameplates for lighting and appliance panelboards, lighting relay panels, motor starters, disconnect switches, contactors and TVSS's: ½ inch: identify equipment designation (upper line); ¼ inch: identify voltage rating and source (lower line).

3.4 JUNCTION BOX/PULL BOX IDENTIFICATION

A. Junction Boxes and Pull Boxes for power distribution systems:

- 1. Normal Power: Cover shall indicate voltage using ½" text; source(s) and circuit(s) contained within using ½" text. Identification shall be by means of adhesive labels.
- 2. Emergency Power: Cover shall be painted red; cover shall indicate voltage with "EM" added (i.e. 120EM) using ½" text; source(s) and circuit(s) contained within using ½" text. Identification shall be by means of adhesive labels.

B. Junction boxes for communications, signal and control systems: Identify system source and equipment serviced, labeled with ½" text in black on cover or engraved nameplates as follows:

- 1. Voice/Data Communications – V/D
- 2. Closed Circuit TV – CCTV
- 3. Security System – SEC

3.5 CONDUCTOR IDENTIFICATION

- A. Install label tags on conductors in junction boxes, pull boxes, wireways, pole handholes and wiring gutters of panels.
- B. Line voltage conductors shall be identified by panel and circuit number using sleeve type adhesive markers.

- C. Each phase conductor of each feeder shall be identified at both ends and at all accessible locations with colored plastic tape, as well as typed identification labeling. Each phase shall be identified by a different color per industry standards. Painted identification is not acceptable.
- D. Where wires of different system junction in a common box each cable shall be grouped with its own system and identified using tags or identification strips.

3.6 BRANCH CIRCUIT IDENTIFICATION

- A. Each distribution and lighting panel shall be equipped with a typewritten directory describing the loads served. Directory shall be contained in a steel frame mounted on the inside face of the panel's door and shall be covered with a sheet of clear plastic.
- B. Circuit descriptions shall be complete and include device/equipment type and relative location.
- C. Minimum font size shall be 10pt.

3.7 WIRING DEVICE IDENTIFICATION

- A. Each receptacle and light switch faceplate shall indicate circuit (source and circuit number) using 1/4" text. Identification shall be by means of adhesive labels located on bottom of faceplate.

END OF SECTION

SECTION 26 09 43 - NETWORK LIGHTING CONTROL

PART 1 – GENERAL

1.1 RELATED REQUIREMENTS

- A. Applicable requirements of Division 1 shall govern work in this section.
- B. Contractor shall coordinate all of the work in this section with all the trades covered in the other sections of the specification to provide a complete and operative system.

1.2 DESCRIPTION OF WORK

- A. The system shall include but not be limited by the following list: Pre-wired, microprocessor controlled relay panels with electrically held, electronically latched relays panels controlled via a complete list of communication based accessories including digital switches, digital photocells, digital SmartBreaker panelboards, Digital Time Clock (DTC) and interface cards to dimming systems, building automation systems, thermostats, and other devices. The type of lighting control equipment and wiring specified in this section is covered by the description: Microprocessor Controlled Digital Relay Lighting Control system with RS 485 Bus communications.
- B. Requirements are indicated elsewhere in these specifications for work including, but not limited to raceways and electrical boxes and fittings required for installation of control equipment and wiring.
- C. All panels shall be networked.
- D. The programmer of the system shall consult with the Owner's representative prior to any programming to coordinate system operation requirements. All time necessary for verifying system connections, load definitions, system programming, training, etc. as required from the system supplier/representative to provide a completely operational system shall be included.

1.3 QUALITY ASSURANCE

- A. Products shall be manufactured by Lighting Control & Design, Los Angeles, CA, 800.345.4448 or approved equal. Such firms shall be regularly engaged in manufacturing of lighting control equipment and ancillary equipment, of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years. Any product other than those listed in this specification must be pre-approved a minimum of two weeks before bid time. No exceptions.
- B. Control wiring shall be in accordance with the NEC requirements for Class 2 remote control systems, Article 725 and manufacturer specification.
- C. A licensed electrician shall functionally test each system component after installation, verify proper operation and confirm that all relay and dimming panels and switch wiring conform to the wiring documentation. The Electrical Contractor (EC) is required to phone LC&D a minimum of 7 days before turnover for system checkout. At time of LC&D contact, all components including phone line to modem must be installed, powered and operational.

- D. Comply with NEC and all local and state codes as applicable to electrical wiring work.
- E. Lighting control panels shall be UL 916 Listed. LCPs controlling emergency circuits shall be ETL listed to UL 924. Relay panels shall also be listed to comply with CSA C22.2#205 Emergency source circuits controlled in normal operation by a relay panel shall fully comply with NEC 700-9(b). Electrical contractor is responsible for verifying compliance.
- F. The lighting control system shall be listed, approved and comply as required with all national, state and local energy codes to include but not limited to California Title 24 and ASHRAE 90.1-2004.

1.4 SUBMITTALS

- A. Shop Drawings: Submit dimensioned drawings of lighting control system and accessories including, but not necessarily limited to, relay panels, switches, DTC, photocells and other interfaces. Shop drawings shall indicate exact location of each device or a RFI to confirm location. Plans are diagrammatical. EC to verify all lighting control material requirements from approved shop drawings. "Cut Sheet" submittal not acceptable.
- B. Product Data: Submit for approval 6 copies of manufacturer's data on the specific lighting control system and components. Submittal shall be in both electronic and hard copy formats. To prevent departures from approved system operation, electronic file submitted shall be able to be directly downloaded to the specified system at manufacturer facility. Submit a complete bill of materials with part numbers, description and voltage specifications.
- C. One Line Diagram: Submit a one-line diagram of the system configuration indicating the type, size and number of conductors between each component if it differs from that illustrated in the riser diagram in these specifications. Submittals that show typical riser diagrams are not acceptable.

1.5 MAINTENANCE MATERIALS

- A. Division 1 - Execution Requirements: Spare parts and maintenance products.
- B. Provide 10% spare relays per LCP, up to the maximum capacity of the LCP.
- C. Provide CD version of manufacturers operating software to include graphical interface software.
- D. Provide 2 extra sets of as-built and operating manuals.

1.6 SUBSTITUTIONS

- A. Substitutions are permitted as voluntary alternates. Base bid must reflect the specified equipment.
- B. A product must go through the substitution process.

1.7 SYSTEM DESCRIPTION

- A. The lighting control system is a networked system that communicates via RS485. The system must be able to communicate with fully digital centralized relay panels, small distributed relay panels (Available with 0-10VDC dimming outputs), (also called Micro Panels), Fully distributed fixture level control by bus connected relays or dimmers, (also called X-Point) smart breaker panels, digital switches, photocells, various interfaces and operational software. The intent of the specification is to integrate all lighting control into one system. Distributed lighting control shall be provided using networked micro relay panels or bus connected fixture level control (X Point.) Lighting control system shall include all hardware and software. Software shall be resident within the lighting control system. System shall provide local access to all programming functions at the master LCP and remote access to all programming functions via dial up modem and through any standard computer workstation. Lighting control system shall have the capability to be remotely controlled via the internet or building wide Ethernet LAN. Desktop computers are not part of this section and will be provided by others.
- B. System software shall provide real time status of each relay, each zone and each group.
- C. Lighting control system shall be able to be monitored by and take commands from a remote PC. At any time, should the remote PC go off-line all system programming uploaded to the lighting control system shall continue to operate as intended. Systems requiring an on line PC or server for normal operation are not acceptable
- D. All devices shall be pre-addressed at the factory. Field addressing is not acceptable.
- E. All programs, schedules, time of day, etc, shall be held in non-volatile memory for a minimum of 10 years at power failure. At restoration of power, lighting control system shall implement programs required by current time and date.
- F. System shall be capable of warning of an impending off sweep by flashing lights Off/On once or twice (programmable) by relay or by zone prior to the lights being turned off. The warning interval times between the flash and the final lights off signal shall be definable for each zone. Additionally an audible signal shall be able to be programmed that gives a mild note on the first flash and a more insistent signal on the second one. Occupant shall be able to override any scheduled Off sweep using local wall switches within the occupied space. Occupant override time shall be locally and remotely programmable and not exceed 2-hours.
- G. The system shall be capable of implementing On commands, Off commands, Raise (dimming) commands, Lower (dimming) commands for any relay, group or zone by means of digital wall switches, contact closure switches, time clock schedules including offsets from dusk and dawn by up to 10 hours, photocell, pc software or other devices connected to programmable inputs in a lighting control panel.

- H. The lighting control system shall provide the ability to control each relay and each relay group per this specifications requirement. All programming and scheduling shall be able to be done locally at the master LCP and remotely via dial up modem and via the Internet. Remote connection to the lighting control system shall provide real time control and real time feedback.
- I. System may consist of centralized relay panels, micro relay panels, smart breaker panels, digital switches, photocells and various digital interfaces. Verify exact components specified. Micro relay panels, smart breaker panels, centralized relay panels and digital switches shall communicate as one network via RS485. Micro relay panels, mounted in each local area, per plans shall control all lighting fixtures in that space, provide power to occupancy sensors and take input from daylight sensor and occupancy sensors. Micro relay panels shall be capable of taking inputs from standard, line voltage type switches and outputting up to 8 independent 0v to 10v dimming signals. All micro relay panels and all devices connected to micro relay panels (switches, photocells and occupancy sensors, etc) shall be wired per lighting control manufacturers instructions.
- J. See Section 26 27 26 for device types.

PART 2 – PRODUCTS

2.1 MATERIAL AND COMPONENTS

- A. Relay Panels:
 - 1. NEMA 1 rated enclosure with screw cover or hinged door. Other NEMA rated types where indicated on the plans.
 - 2. A barrier shall separate the high voltage and low voltage compartments of the panel and separate 120VAC and 277VAC.
 - 3. LCP input power shall be capable of accepting 120v or 277v without rewiring
 - 4. Control electronics in the low voltage section shall be capable of driving 2 to 48 latching relays, control any individual or group of relays, provide individual relay overrides, provide a master override for each panel, store all programming in non-volatile memory, after power is restored return system to current state, provide programmable blink warn timers for each relay and every zone, and be able to control relays that default to Open, Normally Open Latching (NOL) or relays that default to Closed, Normally Closed Latching (NCL).
 - 5. Lighting control system shall be digital and consist of a Master LCP, Remote LCPs, Micro LCPs with up to 8 individual relays, X Point Router and associated relays or dimmers emulating standard or Micro LCPs, digital switches, digital interface cards and if required, SmartBreaker panelboards. All system components shall connect and be controlled via Category 5, 4 twisted pair cable with RJ45 connectors, providing real time two-way communication with each system component. All Micro LCP's shall provide multiple inputs for photocells and occupancy sensors. Analog systems are not acceptable.

B. Micro Relay Panels

1. Micro relay panels shall have from 2 to 8 latching relays per section 2.1.C and shall control all lighting in the designated area indicated on the plans and be part of the lighting control network. Each micro relay panel shall provide minimum 300ma at 12/24VDC for powering occupancy sensors. Micro relay panels that require a separate occupancy sensor power pack are not acceptable.
2. Micro relay panel shall provide a minimum of 4-programmable photocell inputs, a minimum of 8-programmable occupancy sensor contact closure inputs. This requirement is to insure integration of entire lighting system into one networked, lighting control system.
3. Micro relay panels shall be capable of outputting minimum 4 and up to 8 independent 0-10VDC dimming signals, one independent dimming signal for each of 8 relays. In order to maximize daylight harvesting and minimize disruption to occupants, each dimming output shall provide adjustment for baseline, start point, mid point, end point, trim, fade up rate, fade down rate, time delay and enable/disable masking. All photocell settings must be remotely accessible. Systems providing On, Off with Time Delay only, and system that do not provide remote access are not acceptable.
4. MicroPanels shall have built in capability to take commands from a fully compatible wireless switch. Wireless switch shall contain no battery; have 32-bit unique ID and a minimum 90-foot range line of sight.

C. Output relays

1. Standard relays shall be UL Listed 30A @277VAC Ballast and HID, 20A Tungsten at 120VAC and 347VAC Ballast and HID at 20A Latching Relay with 18,000A SCCR @277VAC.
2. Relays shall be individually replaceable. Relay terminal blocks shall be capable of accepting two (2) #8AWG wires on both the line and the load side. Systems that do not allow for individual relay replacement or additions are not acceptable. Relays to be rated for 250,000 operations minimum at a full 30A lighting load. Standard relay shall default to closed at normal power loss, Normally Closed Latching (NCL).
3. Additional available relay types (where required by the plans) shall include relays rated for 250,000 operations, dimming relay (0-10V), a 600VAC 2-pole NO or NC, and a Single Pole, Double Throw (SPDT) relay.

D. Low Voltage Switches

1. All switches shall be digital and communicate via RS 485. Contact closure style switches, except as specified for connection to the micro relay panel programmable contact closure inputs, shall not be acceptable. The programming for a digital switch shall reside in the switch itself, via double EPROM memory. Any digital switch button function shall be able to be changed locally (at the DTC or a PC) or remotely, via modem, Internet or Ethernet.
2. Digital low voltage switch shall be a device that sits on the lighting control system bus. Digital switch shall connect to the system bus using the same cable and connection method required for relay panels. Each button shall be capable of being programmed for On only, Off only, Mix (Some on some off), On/Off (toggle), Raise (Dim up) and Lower (Dim down). Further each button shall be able to be enabled or disabled over

- the bus. An audible alarm shall be available on all switches that can be programmed to beep on button push or with warning light blinks. Standard switches shall be Chelsea CH series with quantity of buttons indicated as required by the plans. Color of buttons and faceplates to match switches/plate color used on project, except for indicated below.
3. Keyed switches shall be similarly programmable and connect to the lighting control system bus. Keyed switches shall be available for ON/OFF (KS series) operation or DISABLES/ENABLED (KE series) operation. Color to match switches/plate color used on project.
 4. Digital switches for high abuse areas shall be vandal resistant, contain no moving parts, and be touch sensitive and available with up to two buttons in a single gang. Multi gang versions shall also be available. Touch pads shall be Stainless Steel and capable of handling both high abuse and wash down locations. High abuse switches shall connect to the lighting control system digital bus. Each high abuse touch button shall be able to be programmed in the same way as other digital switch buttons. Switches must be capable of handling electrostatic discharges of at least 30,000 volts (1cmspark) without any interruption or failure in operation. Switches shall be SBDS series.
 5. Digital switches for wet locations shall be waterproof Chelsea CHWP series switches with quantity of buttons as required on the plans. Buttons shall be black with stainless steel faceplate.
 6. Provide engraved identification on each button to indicate area being controlled. Text shall be included in shop drawing submittal for review.

E. DTC - Digital Electronic Time Clock

1. A Digital Time Clock (DTC) shall control and program the entire lighting control system and supply all time functions and accept modem (RS232) inputs.
2. DTC shall be capable of up to 32 schedules. Each schedule shall consist of one set of On and Off times per day for each day of the week and for each of two holiday lists. The schedules shall apply to any individual relay or group of relays.
3. The DTC shall be capable of controlling digital devices at up to 127 addresses on a single bus and capable of interfacing digitally with other buses using manufacturer supplied interface cards.
4. The DTC shall accept control locally using built in button prompts and use of an 8 line 21-space display or from a computer or modem via an on-board RS 232 port. All commands shall be in plain English. The DTC shall be run from non-volatile memory so that all system programming is retained indefinitely and time of day is battery backed for up to 10 years.
5. Unity™ lighting control software shall provide via local or remote PC a visual representation of each device on the bus, show real time status and the ability to change the status of any individual device, relay or zone. System shall be capable of running optional Unity GX lighting control software. Unity GX shall provide for importing vector based graphics and a simple interface that allows users or a factory programmer to overlay color "controls" that are associated with relays or collections of relays. Clicking on the overlays changes the color and the status of the relays for visual display of large systems.
6. System shall come with a pre-installed modem that allows for remote programming from any location using a PC and free remote control software.

7. DTC shall provide system wide timed overrides. Any relay, group or zone that is overridden ON, before or after hours, shall automatically be swept OFF by the DTC a maximum of 2 hours later.
- F. PHOTOCELLS: Photocells to be mounted in location indicated on the plans. Photocells used for exterior lights shall provide multiple trips point from 1 roof mounted unit. All trips points shall be able to be changed remotely via Internet or dial up modem. Photocells requiring manual trip point adjustment are not acceptable. Photocell used for interior lighting control shall have multiple settings such as start-point, mid-point, off-point, fade-up, fade-down, etc. All settings shall be remotely accessible and adjustable. Systems providing local adjustment only are not acceptable. Photocells to be certified to comply with the current energy code covering this project at time of submittal of plans for building permit.
1. Exterior photocell shall be #PCO 2400.
- G. Interfaces: For future expansion capability, system to have available all of the following interfaces. Verify and install only those interfaces indicated on the plans.
1. A dry contact input interface card that provides 14 programmable dry contact closure inputs. Use shielded cable to connect input devices to interface card on runs over 200ft.
 2. Uplink Interface card that allows a single bus to be part of a greater system connected together by a Back Bone Bus. The back Bone bus requires a server for the Modem and Ethernet connections to such a large system.
 3. An interface card (T-LINK) that allows the DTC to control up to 32 digital XCI brand thermostats. Programming of thermostats is to be capable of being done locally (at the DTC) or remotely, via modem, Internet or Ethernet.
 4. When Unity GX software is specified, full graphic pages shall be designed to the owner's specifications. Owner is to provide to manufacturer all necessary files and criteria. Provide quantity of GX graphics pages as needed for the project, with not less then one for the site and one per floor.
 5. Direct digital interface to SmartBreaker panelboards. Relay panel and SmartBreaker panelboard circuits shall appear on the system software as similar, yet distinct, items and maintain all functions and features of the system software.
 6. Direct digital interface to DMX 512 based systems. DMX interface shall provide 14 global commands, each of which can be modified locally or remotely using lighting controls manufacturer supplied software. DMX interface shall be integral to the system bus and shall connect and be controlled via a single Category 5, 4 twisted pair cable, providing real time response from the lighting control system to DMX commands.
 7. Direct digital interface to building automation systems using DDC protocols such as BACnet, Metasys (N2) and ModBus that accept on/off commands, time schedules and report status of all relays in all panels in real time. Interface cards shall "self populate" each individual relay and each group to the BAS. All BAS system programming required shall be the responsibility of the BAS system provider.

H. X Point

1. X Point relay modules shall be fed from an X Point router that sits on the GR 2400 Bus in the manner of a relay panel. Individual modules are fed from this panel on a separate bus. Each router may feed two strings of up to 64 modules on a 2000ft string. Each Module may be a single relay, a dual relay or a dimming (0-10Volt) module. Relays in the modules are to be capable of being separately controlled in the same manner as an individual relay or dimmer in a relay or dimmer panel. Additionally multiple relays may be collected together to act together as a single multi-pole load or dimmer for ease of programming. Graphical software shall be available that does these assignments and reassignments in a straightforward and logical manner. Relays shall have the same specifications as laid out in 2.1.C. Modules with reduced current ratings may be supplied with Quick Connect connectors for more rapid installation.

PART 3 – EXECUTION

3.1 EQUIPMENT INSTALLATION

- A. Mount relay control cabinets adjacent to respective lighting panelboard. Cabinet shall be surface or flush mount, per plans. Wiring between relay control cabinet and panelboards to be per local codes and acceptable industry standards. Under no circumstances will any extra be authorized for payment to the EC or GC due to the EC's lack of knowledge or understanding of any and all prevailing codes or specified manufacturer's installation requirements. Neatly lace and rack wiring in cabinets. During construction process, protect all interior components of each relay panel and each digital switch from dust and debris. Any damage done to electronic components due to non-protection shall be the sole responsibility of the installing contractor.
- B. Switches: Provide outlet boxes, single or multi-gang, as shown on the plans for the low voltage digital switches. Mount switches as per plans. Supply faceplates per plans and specifications. EC is specifically responsible to supply and install the required low voltage cable, Category 5, 4 twisted pair, with RJ45 connectors and snagless boots (commonly referred to as Cat 5 patch cable) between all switches and panels. Field-test all Cat 5 patch cable with a recognized cable tester.
- C. Manufacturer to provide on all systems of more than 2 panels a crimping kit with sufficient approved EZ Brand RJ 45 connectors to populate the whole system. A simple manual that shows all the pitfalls of crimping RJ 45s and how to do it right must be both provided and read by the installing contractor.
- D. Wiring
 1. Do not mix low voltage and high voltage conductors in the same conduit. No exceptions. All wiring to be installed in conduit.
 2. Ensure low voltage conduits or control wires do not run parallel to current carrying conduits.
 3. Place manufacturer supplied "terminators" at each end of the system bus per manufacturers instructions.
 4. Neatly lace and rack wiring in cabinets.

5. Plug in Category 5 patch cable that has been field-tested with a recognized cable tester, at the indicated RJ45 connector provided at each lighting control device, per manufacturers instructions.
6. Use Category 5 patch cable for all system low voltage connections. Additional conductors may be required to compensate for voltage drop with specific system designs. Contact LC&D or refer to the GR2400 manual for further information. Use shielded cable for dry contact inputs to lighting control system.
7. Do not exceed 4000ft-wire length for the system bus.
8. All items on the bus shall be connected in sequence (daisy chained). Star and spur topologies are not acceptable.
9. The specified lighting control system shall be installed by the electrical contractor who shall make all necessary wiring connections to external devices and equipment, to include photocell. EC to wire per manufacturer instructions.

3.2 INSTALLATION AND SETUP

- A. Verify 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. Refer to manufacturer's plans and approved shop drawings for location of line and low-voltage areas. It is the responsibility of the contractor to verify with lighting control manufacturer all catalog information and specific product acceptability.
- B. For approved line voltage type micro relay panel switches connected to matrixed inputs of the micro relay panel, furnish #18 AWG solid conductors. For all other digital switches provide wiring required by system manufacturer.
- C. Contractor to test all low voltage cable for integrity and proper operation prior to turn over. Verify with system manufacturer all wiring and testing requirements.
- D. Before Substantial Completion, arrange and provide a one-day Owner instruction period to designated Owner personnel. Set-up, commissioning of the lighting control system and Owner instruction includes:
 1. Confirmation of entire system operation and communication to each device.
 2. Confirmation of operation of individual relays, switches, occupancy sensors and daylight sensors
 3. Confirmation of system Programming, photocell settings, override settings, etc.
 4. Provide training to cover installation, maintenance, troubleshooting, programming, and repair and operation of the lighting control system.
- E. Panels shall be located so that they are readily accessible and not exposed to physical damage.
- F. Panel locations shall be furnished with sufficient working space around panels to comply with the National Electric Electrical Code.
- G. Panels shall be securely fastened to the mounting surface by at least 4 points.
- H. Unused openings in the cabinet shall be effectively closed.
- I. Cabinets shall be grounded as specified in the National Electrical Code.

- J. Lugs shall be suitable and listed for installation with the conductor being connected.
- K. Conductor lengths shall be maintained to a minimum within the wiring gutter space. Conductors shall be long enough to reach the terminal location in a manner that avoids strain on the connecting lugs.
- L. Maintain the required bending radius of conductors inside cabinets.
- M. Clean cabinets of foreign material such as cement, plaster and paint.
- N. Distribute and arrange conductors neatly in the wiring gutters.
- O. Follow the manufacturer's torque values to tighten lugs.
- P. Before energizing the panelboard, the following steps shall be taken:
 - 1. Retighten connections to the manufacturer's torque specifications. Verify that required connections have been furnished.
 - 2. Remove shipping blocks from component devices and the panel interior.
 - 3. Remove debris from panelboard interior.
- R. Follow manufacturers' instructions for installation and all low voltage wiring.
- S. Service and Operation Manuals:
 - 1. Submit operation and service manuals. Complete manuals shall be bound in flexible binders and data shall be typewritten or drafted.
 - 2. Manuals shall include instructions necessary for proper operation and servicing of system and shall include complete wiring circuit diagrams of system, wiring destination schedules for circuits and replacement part numbers. Manuals shall include as-built cable Project site plot plans and floor plans indicating cables, both underground and in each building with conduit, and as-built coding used on cables. Programming forms of systems shall be submitted with complete information.
- T. Comply with energy code lighting control system "Acceptance Requirements". Acceptance tests are used to verify that lighting controls were installed and calibrated correctly. These tests may require that a responsible party certify that controls are installed and calibrated properly. This is the installing contractors responsibility. Verify requirements with building authority.

3.3 DOCUMENTATION

- A. Each relay shall have an identification label indicating the originating branch circuit number and panelboard name as indicated on the drawings. Each line side branch circuit conductor shall have an identification tag indicating the branch circuit number.
- B. Provide a point-to-point wiring diagram for the entire lighting control system. Diagram must indicate exact mounting location of each system device. This accurate "as built" shall indicate the loads controlled by each relay and the identification number for that relay, placement of switches and location of photocell. Original to be given to owner, copies placed inside the door of each LCP.

C. OPERATION AND SERVICE MANUALS

1. The factory shall supply all operation and service manuals.

3.4 PRODUCT SUPPORT AND SERVICE

- A. Start Up: EC shall contact LC&D at least 7 days before turnover of project. LC&D will remotely dial into the lighting control system, run diagnostics and confirm system programming. EC shall be available at the time of dial in to perform any corrections required by LC&D. EC is responsible for coordinating with GC and the owner the installation of a dedicated telephone line or a shared phone line with A/B switch. Phone jack to be mounted within 12" of Master LCP. Label jack with phone number. EC to connect phone line from jack to Master LCP.
- B. Telephone factory support shall be available at no additional cost to the EC or Owner both during and after the warranty period. Factory to pre-program the lighting control system per plans and approved submittal, to the extent data is available. The specified manufacturer, at no added cost, shall provide additional remote programming via modem as required by the EC or Owner for the operation life of the system. Upon request manufacturer to provide remote dial up software at no added cost to system owner. No exceptions.

3.5 SYSTEM DELIVERY AND ACCEPTANCE

A. DELIVERY

1. The contractor is responsible for complete installation of the entire system according to strict factory standards and requirements. The following items shall constitute factory standards and requirements.
 - a. All system equipment shall operate in accordance with specification and industrial standard procedures.
 - b. An operational user program shall exist in the control system. The program shall execute and perform all functions required to effectively operate the site according to the requirements.
 - c. Demonstration of program integrity during normal operation and pursuant to a power outage.
 - d. A Factory technician shall provide a minimum of eight training hours on the operation and use of the control system. Additional support services shall be negotiated between the contractor and the building owner or manager.

3.4 WARRANTY

- A. Manufacturer shall supply a 1 year warranty on all hardware and software, and 3 years on the relays.

3.5 CLEANING

- A. Division 1 - Execution Requirements: Final cleaning.
- B. Clean photocell lens as recommended by manufacturer.

C. Clean all switch faceplates.

END OF SECTION

SECTION 26 24 16 - PANELBOARDS

PART 1 – GENERAL

1.1 RELATED REQUIREMENTS

- A. Applicable provisions of Division 1 shall govern work under this section.

1.2 SCOPE

- A. Provide panelboards as indicated in the panel schedule, as noted on the drawings and as specified herein.

1.3 RELATED WORK

- A. Section 26 05 00 – Common Work Results for Electrical
- B. Section 26 05 53 – Identification for Electrical Systems
- C. Plans - Panel Schedules

1.4 SUBMITTALS

- A. Shop Drawings
 - 1. Cabinet dimensions, nameplate nomenclature, electrical ratings and breaker type listing.
 - 2. Product data sheets with installation instructions.
 - 3. Field quality control test results.
 - 4. Operating and maintenance data.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Do not store panelboards exposed to weather.
- B. Protect panelboards against damage from work of other trades.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURES

- A. Use of a manufacturer's name and model or catalog number is for the purpose of establishing standard of quality and general configuration desired.
- B. Square D
- C. General Electric
- D. Cutler-Hammer

2.2 PANELBOARD RATINGS

- A. UL listed short circuit rating (integral equipment rating):

1. 208Y/120V Lighting Panels: 10,000 RMS symmetrical amperes minimum or higher as specified on the drawings. Equivalent to Square D type NQ. Panelboards with AIC ratings of 22,000 RMS symmetrical amperes or lower shall be fully rated.

2.3 PANEL CONSTRUCTION

- A. Main breaker or main lugs only, per panelboard schedule.

2.4 BUSSING

- A. Plated copper phase bussing.
- B. Plated copper neutral bus with terminals.
- C. Copper equipment grounding bus with terminals.
- D. Distributed phase sequence type.
- E. Ratings per panelboard schedule, 100 amp minimum.

2.5 PANEL CABINETS

- A. Code gauge galvanized steel.
- B. Minimum 20" wide.
- C. Minimum 5¾ " deep.
- D. Height as required to accommodate breakers and spaces indicated on plans and code required gutter space.
- E. Gutters adequate for wire size used, 4 inches minimum.

2.6 PANEL FRONTS

- A. Dead front safety type.
- B. Concealed adjustable trim clamps.
- C. Code gauge steel with rust inhibiting primer and baked enamel finish.
- D. Panel front cover shall have piano hinge to allow access to wiring gutters without removal of panel trim. Hinged trim held in place with screw fasteners. Door shall be built into trim which allows access to breakers as well as to hinged trim screw fasteners. Breakers access door shall have the following features:
 1. Concealed piano hinge.
 2. Flush stainless steel cylinder tumbler type locks with spring loaded door pulls.
 3. Locks for all job panels keyed alike.
- E. Steel frame circuit directory holder with directory cards on inside face.
 1. Suitable for complete descriptions.
 2. Clear plastic cover.

3. Typewritten descriptions.

2.7 BRANCH BREAKER DETAILS

- A. Thermal Magnetic type.
- B. UL Class A ground fault circuit protection (GFI) as indicated on drawings.
- C. UL listed terminals for type and temperature rating of wire utilized. Anti-turn solderless type.
- D. Circuit breaker construction for NQOD panels shall bolt on to panel bussing.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine area to receive panelboard to assure adequate clearance for panelboard installation.
- B. Start work only after unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation," and in accordance with recognized industry practices.
- B. Flush mount or surface mount as specified on drawings and schedules.
- C. Support panel cabinets independently to structure with no weight bearing on conduits.
- D. Install recessed panelboards to allow cover to be drawn tight against wall to provide neat appearance.
- E. Install panelboards so top breaker is not higher than 6 ft-0 in. above floor.
- F. Adjacent panel cabinets shall be of same size and mounted in horizontal alignment.
- G. Install in each panelboard a typewritten directory accurately indication rooms and/or equipment being served.
- H. Attach nameplates. Nameplates for panels in public areas shall be attached to the inside face of the cover. Nameplates for panels in equipment rooms and other nonpublic areas shall be attached to the outside face of the cover.

3.3 FIELD QUALITY CONTROL

- A. Balanced load among feeder conductors.
- B. Unbalance shall not exceed $\pm 7\frac{1}{2}$ % of computed average load per phase.
- C. Energize each circuit and check for complete and correct function.

3.4 ADJUSTMENT AND CLEANING

- A. Adjust doors and operating mechanisms for free mechanical movement.
- B. Tighten lugs and bus connections.
- C. Sand, prime and paint scratched or marred surfaces to match original finish.

END OF SECTION

SECTION 26 27 02 - EQUIPMENT WIRING SYSTEMS

PART 1 – GENERAL

1.1 RELATED REQUIREMENTS

- A. Applicable provisions of Division 1 shall govern work under this section.

1.2 SCOPE

- A. Provide connections and wiring to motors as indicated in the motor wiring and special purpose outlets schedules, as indicated on the drawings and also as indicated in other divisions of the specifications and as specified herein.

1.3 RELATED WORK

- A. Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables
- B. Section 26 27 28 – Disconnect Switch

PART 2 – PRODUCTS

Not Used.

PART 3 – EXECUTION

3.1 GENERAL

- A. Motor starters shall be furnished by the Contractor supplying the motor requiring a starter, unless otherwise noted.
- B. This Contractor shall check the drawings and specifications of the other trades to determine the requirements for motor disconnect switches. In each case, the Contractor shall install all required disconnect switches. The Electrical Contractor shall also provide all code required disconnect switches not specifically supplied by others.
- C. Unless otherwise indicated on the drawings or elsewhere in these specifications, all motors shall be furnished by others.
- D. Motors shall be set in place by others and the associated motor starters and controllers shall be turned over to the Electrical Contractor for installation.
- E. Any contractor supplying starters and controllers shall index same and provide the Electrical Contractor with written instructions as to proper location in sufficient time to permit the installation of a concealed raceway system.
- F. Control wiring, regardless of voltage, shall be the responsibility of the Contractor providing the motor. The Electrical Contractor shall extend the 120 volt circuit to the control transformers and make final 120V transformer connections. Transformers will be supplied by HVAC Contractor. Location of control transformers shall be in close proximity of the heating equipment.

- G. Review the HVAC and plumbing specifications and provide all line voltage wiring and connections to controls and auxiliary equipment specified as to be provided by the Electrical Contractor.

3.2 INSPECTION

- A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.3 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.

3.4 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 liquidtight 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.

3.5 HVAC AND PLUMBING CONNECTIONS

- A. Provide all power wiring including all circuitry carrying electrical energy from panelboard or other source through starters, variable frequency drives (VFDs), and disconnects to motors or to packaged control panels. Packaged control panels may include disconnects and starters and overcurrent protection. Provide all wiring between packaged control panels and motors.
- B. VFD Installations: Install VFD input wiring and output wiring in separate conduit systems. Do not mix VFD input power and output power, or control wiring in a common raceway.
- C. Provide 120 volts to each temperature control panel.
- D. Unless otherwise specified, all electrical motors and control devices such as aquastats, float and pressure switches, fan powered VAV boxes, switches, electro-pneumatic switches, solenoid valves and damper motors requiring mechanical connections shall be furnished and installed and wired by the Contractor supplying the devices.
- E. Each motor terminal box shall be connected with a minimum 12", maximum 36" piece of flexible conduit to a fixed junction box. Use liquidtight flexible metal conduit for connections in damp or wet locations. Conduit must be installed perpendicular to direction of equipment vibration to allow conduit to freely flex.
- F. Check for proper rotation of each motor.

END OF SECTION

SECTION 26 27 13 - METERING EQUIPMENT

PART 1 – GENERAL

1.1 RELATED REQUIREMENTS

- A. Applicable provisions of Division 1 shall govern work under this section.

1.2 SCOPE

- A. Provide a factory assembled metal enclosed metering socket, pedestal or stack for metering of power from incoming line terminals to outgoing feeder terminals, as indicated on the drawings and as specified herein.

1.3 RELATED WORK

- A. Section 26 05 29 – Hangers and Supports for Electrical Systems
- B. Section 26 05 26 – Grounding and Bonding for Electrical Systems

1.4 QUALITY ASSURANCE

- A. Equipment shall conform to the standards of the following agencies.
 - 1. National Electrical Manufacturers Association (NEMA)
 - 2. Underwriters Laboratories (UL). All components shall have been tested and listed for use as an integral part of a multi-metering system.
- B. Reference the local electrical utility's Service Rules and Regulations.

1.5 SHOP DRAWING SUBMITTALS

- A. Plan and elevation layouts showing dimensions and compartment layout with available space and conduit entrance.
- B. Electrical ratings and nameplate nomenclature.
- C. One-line diagram.
- D. Metering arrangement, bus sizes, doors and sealing provisions with written utility company approval.
- E. Submit shop drawings of service entrance equipment for approval by Electrical Utility before submitting approved drawings to Engineer.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Square D
- B. General Electric
- C. Cutler-Hammer

- D. AMP
- E. Erickson
- F. Milbank

2.2 ENCLOSURE CONSTRUCTION

- A. Enclosures shall be constructed of formed and welded code gauge steel. No device disassembly is to be required before mounting.
- B. Mounting shall be accomplished by using a separate mounting channel in conjunction with enclosure for vertical support. Final mounting shall be by the use of external mounting feet for attaching to walls.
- C. All devices must be bonded together with bolted connections.
- D. Meter units shall be provided with individual, removable covers for each meter position.
- E. All compartments containing un-metered circuits shall be provided with a sealing means.
- F. Enclosure construction shall conform to the standard of NEMA Type 3R.

2.3 INTERIOR CONSTRUCTION

- A. All components shall be factory assembled and all current carrying parts shall be plated copper bus bars.
- B. Individual units shall be constructed with an integral sliding one bolt assembly for a completely bussed meter center.

2.4 METER SOCKETS/BRANCH CIRCUIT BREAKER SECTIONS

- A. Meter sockets shall be 7-jaw without meter bypass. Socket shall be rated 200 amps continuous duty.
- B. Branch circuit breakers shall be Square D type QE-VH, 3P with ratings as indicated on the plans.
- C. Section shall be of such design to allow wiring at the top or bottom in the same assembly.
- D. Equipment shall be so arranged as to permit the installation of units with different branch ratings in the same meter section.

PART 3 – EXECUTION

3.1 PREPARATION

- A. Confirmation of electric service.

1. Consult with Electric Utility to verify service information specified herein and shown on drawing before submitting bid.
- B. Metering.
1. Consult with Electric Utility regarding service entrance requirements and metering equipment.
 2. Install metering equipment and empty conduit for metering conductors to meet standards and requirements of Electric Utility.
- C. Electric Utility Charges.
1. Include in Base Bid an allowance of \$5,000 to cover the Electric Utility charges for incoming underground electrical services. This should be clearly identified on the bid form.

3.2 INSPECTION

- A. Examine area to receive meter stack to assure adequate clearance for installation.
- B. Start work only after unsatisfactory conditions are corrected.
- C. Verify service details with the utility prior to submitting bid.

3.3 INSTALLATION

- A. Install equipment in accordance with manufacturer's written instructions and the NEC.
- B. Provide a duckbank extension from the building for incoming service lateral conductors as shown on drawings.
- C. The service installation shall comply with the latest applicable standards of the utility.
- D. The Contractor shall meet with the electric utility prior to rough-in to review and coordinate the installation of the electrical service and verify existing conditions and any special requirements.

3.4 FIELD QUALITY CONTROL

- A. Field tests prior to energization shall be as follows:
 1. Continuity
 2. Short Circuit
 3. Perform tests to meter bank manufacturer's instructions.

3.5 ADJUSTMENT AND CLEANING

- A. Adjust operating mechanisms for free mechanical movement.
- B. Tighten bus connections and mechanical fasteners.
- C. Touch-up scratched or marred surfaces to match original finish.

3.6 PRODUCT DELIVER, STORAGE AND HANDLING

- A. Lift using manufacturer supplied attachments.
- B. Physically protect against damage from work of other trades.

END OF SECTION

SECTION 26 27 26 - WIRING DEVICES

PART 1 – GENERAL

1.1 RELATED REQUIREMENTS

- A. Applicable provisions of Division 1 shall govern work under this section.

1.2 SCOPE

- A. Provide wiring devices generally consisting of switches, receptacles and occupancy sensors as indicated on the drawings and as specified herein.

1.3 RELATED WORK

- A. Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables
- B. Section 26 05 33 – Raceway and Boxes for Electrical Systems

1.4 SHOP DRAWING SUBMITTALS

- A. Listing of brand names and types of materials proposed for use.
- B. Nameplate nomenclature.
- C. Electrical ratings.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Use of a manufacturer's name and model or catalog number is for purpose of establishing standard of quality and general configuration desired only.
- B. Cooper
- C. Hubbell Wiring Device Div.
- D. Pass and Seymour, Inc.
- E. Leviton
- F. WattStopper
- G. SensorSwitch

2.2 GENERAL

- A. Provide factory-fabricated, NEMA specification grade wiring devices in type, color and electrical rating for service indicated.
- B. Provide wiring devices of one manufacturer.
- C. See Symbol Schedule on drawings for identification of device type.

- D. Wiring devices for use with stranded conductor shall have a clamping type terminal that can be physically tightened. The clamping device shall not be a spring type of clamp.

2.3 SWITCHES

- A. General use lighting switches: 20 amp toggle type. Pass and Seymour CS20AC1 Series.
- B. Switch color shall be as selected by the architect.

2.4 RECEPTACLES

- A. General use duplex receptacles: NEMA type 5-15R, grounding type, 15 amp, 120 volt rating, impact resistant face and body, side wired, commercial specification grade rated. Provide internal shutter tamper resistant type where required on plans.
- B. Where a single duplex receptacle is wired to a dedicated 20 ampere, 120 volt circuit, provide NEMA type 5-20R grounding type 20 ampere receptacles, impact resistant face and body, side wired, commercial specification grade rated. Provide internal shutter tamper resistant type where required on plans.
- C. Special purpose receptacles: As shown on drawings and schedules.
- D. Ground fault circuit interrupter duplex receptacles: Test and reset buttons shall match device color, LED trip indicator. Device shall meet UL 2003 requirements. Provide weather resistant type for outdoor locations. Provide internal shutter tamper resistant type where required on plans.
- E. Receptacle color shall be as selected by the architect.

2.5 WIRING DEVICE PLATES AND COVERS

- A. Provide wall plates for wiring devices with ganging and cutouts as indicated and with metal screws for securing plates to devices, screw heads colored to match finish of plate.
- B. Plates for flush mounted devices: Coverplates shall be smooth, hi-impact nylon material. Color of plates and screws shall match device.
- C. Device plates for surface mounted Type FS or FD boxes: Type FSK galvanized steel covers.
- D. Device plates and covers for exterior duplex receptacles shall be weatherproof-while-in-use type with lockable, cast aluminum cover (plastic covers not allowed). Use proper cover to match orientation of installed device.

2.6 OCCUPANCY SENSORS AND LIGHT SENSORS

- A. Provide occupancy sensors for the automatic control of room lighting as indicated on the drawings and as specified herein. The Contractor is to adjust the sensitivity to provide optimal operation.
- B. All low voltage wiring for this system may be installed exposed above accessible

ceilings or in wall cavities. Exposed cable shall be supported every 5 feet minimum via bridal clamps or tie wraps.

- C. Wall mounted dual technology, dual switching sensors (WD2) shall be Sensor Switch #WSX PDT 2P.
- D. High Bay ceiling mounted PIR sensors: Sensor Switch #CM-6.
- E. Standalone Light (LS) Sensors: Sensor Switch #CM-PC-DZ-LT with power pack as required.
- F. Wall mounted occupancy sensor color shall match wiring device color in respective area.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which wiring devices are to be installed and notify Engineer, in writing, of conditions detrimental to proper and timely completion of work.
- B. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation," and in accordance with recognized industry practices.
- B. Do not install devices until wiring is complete.
- C. Before installing receptacles and switches, clean electrical boxes of dirt and debris.
- D. Do not use terminals on wiring devices (hot or neutral) for feed-through connections, looped or otherwise. Make circuit connections via wire connectors and pigtails.
- E. Install gasket plates for devices or system components having light emitting features, such as switches with pilot lights. Where installed on rough textured surfaces, seal plates with black self-adhesive poly-foam.
- F. Ground receptacles with an insulated green ground wire from device ground screw to a bolted outlet box connection. Route a continuous green equipment grounding conductor with branch circuit conductors serving isolated ground receptacles. Terminate the equipment ground on the ground bus in panelboards.
- G. Stranded conductor terminating on wiring devices shall be terminated in a clamping terminal and not on the screw terminal.
- H. Provide a layer of electrical tape around the perimeter sides of each wiring device so that the terminations are insulated.
- I. Gang switches together when located at the same location.

3.3 FIELD QUALITY CONTROL

- A. Provide operational testing for all devices.
- B. Test receptacles with Hubbell 5200, Woodhead 1750 or equal, for correct polarity, proper ground connection and wiring faults.
- C. The manufacturer's representative shall verify that the specified occupancy sensors are appropriate and located correctly for their application and/or room size.
- D. Occupancy Sensor Sensitivity Test: After the sensor has been energized for at least 15 minutes, walk to the middle of the room or sit at the normal desk position. Make no motion for 20 seconds. Move one arm up and down slowly. The test LED should blink. Check all positions within a room to confirm that there are no dead areas.
- E. Occupancy Sensor Time Delay Test: Set the time delay for 10 minutes. Walk into the room to activate the sensor then leave room. Sensor must turn lights off at approximately 10 minutes. Walk into the room again to reactivate the lights. Lights should activate within 1 second.

END OF SECTION

SECTION 26 27 28 - DISCONNECT SWITCHES

PART 1 – GENERAL

1.1 RELATED REQUIREMENTS

- A. Applicable provisions of Division 1 shall govern work under this section.

1.2 SCOPE

- A. Provide disconnect switches for the safe disconnection of motorized equipment and other equipment as required by the national and state electrical codes and as specified herein.

1.3 RELATED WORK

- A. Section 26 05 53 – Identification for Electrical Systems
- B. Section 26 05 26 – Grounding and Bonding for Electrical Systems
- C. Section 26 27 02 – Equipment Wiring Systems

1.4 SHOP DRAWING SUBMITTALS

- A. Enclosure dimensions, nameplate nomenclature, electrical ratings, fuse and breaker type listing.
- B. Field quality control test results.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. General Electric
- B. Square D
- C. Cutler-Hammer

2.2 DISCONNECT RATINGS

- A. UL listed short circuit rating:
 - 1. 200,000 RMS amps with Class R fuses.

2.3 SAFETY SWITCH CONSTRUCTION

- A. NEMA heavy duty Type HD.
- B. Dual cover interlock.
- C. Visible blades.
- D. Provisions for control circuit interlock.

- E. Pin type hinges.
- F. Tin plated copper current carrying parts.
- G. Quick make and break operator mechanism.
- H. Handle attached to box, not cover.
- I. Handle position indication, ON in up position and OFF in down position.
- J. Padlock provisions for up to three padlocks in OFF position.
- K. UL listed lugs for type and size of wire specified.
- L. Spring reinforced fuse clips for Type R fuses.
- M. Provisions for insulated or grounded neutral.

2.4 ENCLOSURES

- A. Indoor: NEMA 1 code gauge steel with rust inhibiting primer and baked enamel finish.
- B. Outdoor: NEMA 3R code gauge zinc coated steel with baked enamel finish or NEMA 4 when indicated on drawings.
- C. Corrosive Area: NEMA 4X Type 304 stainless steel with brushed finish.
- D. Hazardous Area: NEMA 7/9 cast, copper free, aluminum alloy.

PART 3 – EXECUTION

3.1 GENERAL

- A. Provide disconnect switches for loads as required by code. Review HVAC and Plumbing specifications to determine what equipment is furnished with disconnect switches. Install all disconnect switches whether furnished under this contract or not. It is the Electrical Contractors responsibility to determine the need for disconnect switch requirements for each specific load. The contractors shall include in their bid all disconnect switches required whether indicated on the drawings or not.

3.2 INSPECTION

- A. Examine area to receive disconnect to assure adequate clearance for installation.
- B. Start work only after unsatisfactory conditions are corrected.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation," and in accordance with recognized industry practices.

- B. Locate disconnect switches as shown on drawings or as required by NEC.
 - C. Install on equipment support where feasible or anchor firmly to wall or structural surface.
 - D. Provide control circuit interlock as required by NEC.
- 3.4 ADJUSTMENT
- A. Adjust covers and operating mechanism for free mechanical movement.
 - B. Verify overcurrent protection to provide proper operation and compliance with NEC.
 - C. Tighten wire and cable connections.
 - D. Clean interior of enclosure.
 - E. Touch up scratched or marred surfaces to match original finish.

END OF SECTION

SECTION 26 43 13 - SURGE PROTECTION DEVICES FOR LOW-VOLTAGE
ELECTRICAL POWER CIRCUITS

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Furnish and install surge protection devices (formally known as transient voltage surge suppressors) as shown on the Drawings and herein specified.
- B. The surge protection device (SPD) shall be mounted external to the electrical distribution equipment. Integral mounting of the SPD into a switchboard/panelboard will not be accepted.

1.2 STANDARDS

- A. Underwriters Laboratories - UL 1449 3rd Edition, current Standard for Safety for Surge Protective Devices).
Underwriters Laboratories - UL 1283 listed as an electromagnetic interference filter that provides noise attenuation
Underwriters Laboratories – UL 96A 12th Edition, Standard for Installation Requirements for Lightning Protection Systems
- B. Canadian Standards Association – CAN/CSA-C22 No. 8; cUL 1449 Ed.3
- C. National Electrical Code – NEC 2008 Article 285 TVSS Installation Practice; NEC 2008 Article 250.56 Grounding
NFPA-78 and CSA - (National Fire Protection Association and Canadian Standards Associations)
ISO 9001:2000 - Quality standard / Military Standards (MIL-STD 220A)
- D. American National Standards Institute and Institute of Electrical and Electronic Engineering – ANSI/IEEE – C62.41 and C62.45
- E. The fusing elements must be capable of allowing the suppressor's maximum rated single impulse current to pass through the suppressor at least one time without failure
- F. CBEMA (ITIC) and IEC - (Computer Business Equipment Manufacturers Association or Information Technology Industry Council and International Electrotechnical Commission define clamping voltage tolerance guidelines for sensitive equipment)
- G. All manufacturers must comply with above listed standards and any additions current revisions of industry standards. All products that do not comply with current industry standards will not be accepted.

1.3 MANUFACTURERS

- A. Surge Suppressors:
 - 1. Current Technology, Inc.
 - 2. Liebert
 - 3. LEA
 - 4. ERICO/CRITEC

No other Manufacturers will be accepted.

1.4 SUBMITTALS

- A. Drawings: Electrical and mechanical drawings shall be provided by the manufacturer which show unit dimensions, weights, mounting provisions, connection notes, wire size and wiring diagram.
- B. Equipment Manual: The manufacturer shall furnish an installation manual with installation notes, start-up and operating instructions for the specified system. Installation instructions shall clearly state whether the system requires an external over current device to maintain the system's UL 1449 listing.
- C. Submit UL 1449 3rd Edition Listing/Classification page listing the Voltage Protection Ratings with corresponding model numbers
- D. Independent Testing:
 - 1. High exposure with the 10 x 1,000µs tests per IEEE C62.41.2 Section 7.2
 - 2. Life Cycle/Repetitive Testing per C62.45-2002 section B.38 minimum of 1,000 to 2,000 times
- E. National Electrical Code (NEC) 285 - Installation requirements for SPD's Surge Protection Devices that utilize fuses must have repetitive surge capability that can survive its surge rating and meet UL 1449.
2.Section 285.6, TVSS shall be marked with a short circuit current rating and shall not be installed at a point on the system (ex. service, distribution or branch panels) where the available fault current (AIC rating) is in excess of that rating.
- F. UL 1449 stipulation for SPD Type 2 product that requires over-current protection devices; the manufacturer's authorized representative is required to submit the following:
 - 1. Certify that the SPD system is UL 1449 listed (VZCA file documentation)
 - 2. Indicate the type of external over-current protection that shall be incorporated With the SPD system; and, what impact the fusing has on the performance of the device with respect to surge capacity and clamping levels.
- G. Maintenance Data: Include maintenance instructions for cleaning methods; cleaning materials recommended; component replacement, testing and adjustment.
- H. Any deviation from the specification, modification of products, models, or alternative units must be submitted to the engineer as a letter signed by the owner reflecting the requested changes. The letter should in detail outline the changes and requested product details.

PART 2 – PRODUCTS

2.1 SERVICE ENTRANCE

- A. Acceptable Manufacturers and Models:

Current Technology – TG3 series
LEA International Inc. – PV Series
Liebert – Interceptor 2 series
ERICO/CRITEC - TDXM Series

- B. The equipment's minimum surge current capacity shall be 200 kA per phase (L-N plus L-G) and 100 kA per mode (L-N, L-G, L-L and N-G)
- C. The UL 1449 Edition 3 Nominal Discharge Current Rating shall be no less than 20 kA.
- D. The system protection modules shall contain a technology that utilizes a symmetrical array of balanced metal oxide varistors (MOV). Each MOV will be individually coordinated to pass UL 1449.
- E. All primary transient paths shall utilize copper wire, aluminum bus bar and lugs of equivalent capacity to provide equal impedance interconnection between phases. No plug-in module or components shall be used in surge carrying paths.
- F. Each protection module shall have a visual indicator that signifies that the protection circuitry is on line. The unit shall not be taken off line to verify integrity system. Redundant status indicators shall be mounted on the front of the door hat monitors the system protection circuitry.
- G. The system shall be modular with field replaceable modules. Modular units shall contain a minimum of one module per phase.
- H. Filter Attenuation shall be equal to, or greater than -40 dB at 100 kHz.
- I. Protection modes: The SPD shall provide protection for all modes, L-G, L-N, N-G, L-L for WYE, L-L and L-G for Delta configurations.
- J. Service Conditions: The SPD shall operate under the following conditions, unless otherwise indicated:
 1. MCOV: Maximum Continuous Operating Voltage of 125% or greater.
 2. Operating Temperature: 30 to 120 degrees F.
 3. Humidity: 0 to 85 percent, non-condensing.
 4. Altitude: Less than 20,000 feet above sea level.
- K. Equipment shall provide the following monitoring features: N.O./N.C. Relay Contacts: Digital Surge Counter; Audible Alarm; LED Indication for each Phase.
- L. The SPD shall be rated for NEMA 4; or NEMA 4x in corrosive environments.
- M. The UL 1449 Ed. 3 Voltage Protection Ratings (VPR) shall be equal to or less than the following voltage configurations:

Voltage	Mode	UL 1449 Ed 3 VPR
120/240 (1-Phase)	L-G, N-G	700V
	L-N	1,200V
120/208 (3-Phase WYE)	L-G, N-G, L-N	700V
	L-L	1,200V
277/480 (3-Phase WYE)	L-G, N-G, L-N	1,200V
	L-L	2,000V
240 (Delta)	L-L, L-G	1,200V
	L-L, L-G	2,000V

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install surge suppressor equipment in accordance with manufacturer's recommendations.
- B. The specified service entrance/switchboard system shall be installed with the shortest lead length possible not to exceed five (5') electrical feet from the power conductor(s) it is protecting, must have a grounding of 25 Ohms (NEC Article 250.56) or less and shall avoid any unnecessary or sharp bends. Utilize a 3 pole 60 amp breaker for connection means.
- C. Provide engraved plastic nameplate.

3.2 EXAMINATION

- A. Examine areas to receive surge suppressor equipment to assure adequate working clearance for equipment installation.

3.3 WARRANTY

- A. Manufacturer shall provide a product warranty for a period of not less than five (5) years from date of installation. Warranty shall cover unlimited replacement of SPD modules during the warranty period. Those firms responding to this specification shall provide proof that they have been regularly engaged in the design, manufacturing and testing of SPD for not less than twenty (25) years.

3.4 DELIVER, STORAGE AND HANDLING

- A. Protect products from weather and moisture on site.
- B. Inspect for damage.

END OF SECTION

SECTION 26 50 00 - LIGHTING

PART 1 – GENERAL

1.1 RELATED REQUIREMENTS

- A. Applicable provisions of Division 1 shall govern work under this section.

1.2 SCOPE

- A. Provide and install lighting fixtures and related accessories as indicated on the drawings and as specified herein.
- B. Furnish and install the initial fill of lamps for all lighting fixtures. Lamps shall be of size and type as called for in the lighting fixture schedule and as recommended by the manufacturer. Where scheduled lamp types differ from that recommended by the manufacturer, the Contractor shall obtain approval from Engineer prior to furnishing lamps as recommended by the lighting fixture manufacturer.
- C. Provide ballasts for fluorescent lighting fixtures as indicated on the drawings and as specified herein.

1.3 RELATED WORK

- A. Section 26 05 26 – Grounding and Bonding for Electrical Systems
- B. Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables
- C. Section 26 05 29 – Hangers and Supports for Electrical Systems

1.4 QUALITY ASSURANCE

- A. Comply with the requirements of the following regulatory agencies:
 - 1. National Fire Protection Association (NFPA) Chapter 70 - National Electric Code (NEC) and Wisconsin Amendments thereto.
 - 2. Underwriters Laboratories (UL) Approval
- B. Conform to the standards of the following agencies:
 - 1. National Electrical Manufacturers Association (NEMA)
 - 2. Certified Ballast Manufacturers Association (CBM)
 - 3. American National Standards Institute (ANSI), ANSI C82.1.
- C. Ballasts shall have the following approvals/certifications:
 - 1. Certified Ballast Manufacturer's (CBM) Approval
 - 2. Underwriters Laboratories (UL) Approval
 - 3. Electrical Testing Laboratory (ETL) Certified

1.5 SHOP DRAWING SUBMITTALS

- A. Submit manufacturer's printed data on lighting fixtures.

- B. Submit fixture shop drawings in booklet form with index and a separate sheet for each fixture, assembled in luminaire "type" alphabetical order, with specified fixture and accessories clearly indicated on each sheet.
- C. Submit copy of UL test report if requested by Engineer.
- D. Include the following information as a minimum:
 - 1. Dimensional informational.
 - 2. Description of the fixture construction.
 - 3. Recommended lamps for use in that particular fixture.
 - 4. Photometric test reports.
 - 5. Any warnings regarding special requirements regarding the use of the lighting fixture.

1.6 WARRANTY

- A. All lamps shall be guaranteed for 50% of rated life after date of final acceptance.

PART 2 – PRODUCTS

2.1 GENERAL

- A. Provide lighting fixtures of the size, type and rating indicated in "Lighting Fixture Schedule" complete with lamps, lampholders, reflectors, ballasts, starters, wiring and other equipment required for a complete working installation.
- B. Fixture catalog numbers do not necessarily include all accessories required to complete the installation. Catalog numbers used in the Lighting Fixture Schedule are used to designate the fixture series, size and lamping requirements. Refer to the lighting fixture schedule notes for additional requirements.
- C. Gasketing material for use in lighting fixtures shall be vinyl, neoprene or other non-aging type material as approved by Engineer.
- D. Provide proper trim for each fixture as required for the various types of ceiling being installed throughout project. Provide the necessary plaster frames, fixture ends, caps, suspension units, mounting brackets, and/or other auxiliary parts required to complete the fixture installation.
- E. All outdoor ballasts and ballasts in unheated areas shall operate to -20 deg. F (0 deg. F minimum for 48" rapid start lamp ballasts).
- F. Ballasts shall comply with UL requirements with regards to thermal protection. Each ballast shall be equipped with thermal sensitive devices that will de-activate the ballast in the event higher than normal operating temperatures occur within the ballast. Internal protective devices shall be automatic resetting.

2.2 FLUORESCENT FIXTURES

- A. Fabricate of sheet steel, die-formed to provide rigidity.
- B. The color finish of each surface or pendant mounted lighting fixture is to be verified with the Architect at the time of shop drawing review.

- C. Lens panels for fluorescent troffers shall be framed and be equipped with hinge and latch. Equip frames and louvers with retaining means to support frame during relamping.
- D. Design fluorescent rapid start fixtures, 40W and smaller, to incorporate a grounded metal starting aid such as reflector, ballast channel strip, at least 1 in. wide over full length of lamp and within maximum ½ in. distance from lamp per ANSI C82.1.
- E. Design fixtures such that case temperature of ballast does not exceed 90° C.

2.3 FLUORESCENT BALLASTS

- A. All fluorescent ballasts shall be electronic type and shall meet the following specs:
 1. UL Listed (Class P) sound rating A and CSA certified.
 2. Comply with EMI and RFI limits set by the FCC (CFR 47 part 18) or NEMA and not interfere with normal electrical equipment.
 3. Meet any applicable standards set forth by ANSI.
 4. Be potted or conformal coated in a metallic case and not contain PCBs.
 5. Provide normal rated lamp life as stated by lamp manufacturers (i.e. rated life at 3 hour burn time per start).
 6. Provide independent test results from an approved testing laboratory for all of the specifications below. This is required for all submitted ballasts.
 7. Nominal power factor of .90 or higher.
 8. Total harmonic distortion of less than 10% at 120 or 277 volts (universal voltage).
 9. Ballast factor 0.87-0.88, unless noted on the plans.
 10. Frequency of operation shall be 40 kHz - 50 kHz and units shall operate without visible flicker.
 11. Ballast efficiency factor shall meet Consortium of Energy Efficiency (www.cee1.org) specifications (adopted by Focus on Energy program).
 12. Multi-lamp ballasts shall operate in parallel so that when one lamp burns out, the other lamps will continue to operate at full light output.
 13. Ballasts shall carry a minimum 5 year warranty with a \$10 replacement labor allowance.
 14. Ballasts shall not be affected by lamp failure.
 15. Ballasts shall be a standard production item.
 16. Ballasts shall be marked with manufacturer's name, part number, supply voltage, power factor, open circuit voltage, current draw for each lamp type and UL Listing.
 17. Ballasts shall withstand line transients as defined in IEEE 587, Category A.
 18. Octron T8 lamp starting temperature of -20°F.
 19. **SYSTEM PERFORMANCE:** System performance for T8 programmed-start ballasts shall be as follows:

Programmed-Start, Low Ballast Factor (BF = 0.71)

Lamps	Nominal Lamp Watts	System Input (Max. Watts @ Univ Volt)
1 – F32T8	32	25
2 – F32T8	32	47
3 – F32T8	32	73
4 – F32T8	32	93

Programmed-Start, Normal Ballast Factor (BF = 0.88)

Lamps	Nominal Lamp Watts	System Input (Max. Watts @ Univ Volt)
1 – F32T8	32	31
2 – F32T8	32	60
3 – F32T8	32	88
4 – F32T8	32	118

Programmed-Start, Normal Ballast Factor (BF = 1.15)

Lamps	Nominal Lamp Watts	System Input (Max. Watts @ Univ Volt)
1 – F32T8	32	38
2 – F32T8	32	75
3 – F32T8	32	110
4 – F32T8	32	146

Acceptable ballast manufacturer's names and product lines are as follows:
Osram Sylvania – Quicktronic High Efficiency and Quicktronic PROstart.
GE Lighting – Ultramax and UltraStart.
Maxlite – High Efficiency Ballast.
Advance – Optanium.
Universal Lighting Technologies – F32T8.

Manufacturer names are used to develop quality and performance requirements only. All manufacturers and their products shall meet the system performance requirements and this entire specification.

2.4 LAMPS

- A. Manufacturer names and catalog numbers are used to develop quality and performance requirements only. Lamps manufactured by others will be accepted provided they meet or exceed the specifications.
- B. Four Foot Fluorescent Lamps: High Performance T8 Lamps:
 - 1. Minimum 3100 initial lumens and minimum of 2914 mean lumens.
 - 2. Minimum 40,000 hour rated life at three-hour starts on programmed rapid start ballasts.
 - 3. Color Rendering Index (CRI) of 85 or higher.
 - 4. 4100°K color temperature, unless noted on plans.
 - 5. Lamps shall be suitable for use with instant start ballasts, programmed start ballasts and occupancy sensors.
 - 6. Lamps shall meet "TLCP" requirements for low mercury.
 - 7. Mean system efficiency equal to 90MLPW minimum, with instant start ballasts
 - 8. Sylvania F032/841/XPS/ECO3.
- C. All lamps shall be new.

2.5 LED DRIVERS

- A. Dimming drivers shall use constant current regulation (CCR) type dimming. Pulse Width Modulation (PWM) dimming methods will not be allowed.

2.6 LENSES

- A. Plastic fixture lenses and diffusers, 100% virgin acrylic material. Lenses minimum .125 average thickness.

2.7 SUSPENSION

- A. Fixtures identified for pendant mounted shall be provided with aircraft cable suspension, unless indicated to have rigid pendants or chain hangers.
- B. Where stems are furnished by fixture manufacturer, he shall verify length prior to releasing for shipment.
- C. Where stems are furnished by Contractor, he shall verify length prior to installation.

- D. Suspended fixtures shall have swivel type aligner hangers in ceiling outlet boxes to ensure plumb suspension.
- E. Aircraft Cable suspension shall consist of appropriate hangers compatible with fixture with galvanized steel cable by Gripple, Rize Enterprises or approved equal. Wet, hazardous or corrosive locations shall use stainless steel cable.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Install lighting fixtures of type indicated where shown on drawings and at indicated heights.
- B. Install in accordance with manufacturer's written instructions.
- C. Fasten fixtures securely to indicate structural support members.
- D. Install pendant fixtures plumb.
- E. Provide proper bushing for wire entrances. Ground fixture chassis to conduit system.
- F. Coordinate with trades so lighting fixtures are properly aligned with items such as diffusers, grilles and speakers. If necessary, relocate fixtures as directed so there will be no conflict with other equipment.
- G. Mount stem mounted fixtures with swivel aligners and stem lengths as required. Verify stem lengths.
- H. Make fixture holes for wire entrance with knock-out punches or hole saw, remove burrs. Do not cut holes with tin snip.
- I. Special care shall be taken to assure light-tight joints between recessed fixtures and ceiling.
- J. Recessed lighting fixtures which are installed in a rough textured ceiling surface whereby light may be emitted between fixture frame and ceiling surface shall have black self-adhesive polyfoam gasketing installed around inside edges of frame to prevent leaks.
- K. Care shall be taken in placement of outlets and surface-mounted fixtures to maintain alignment, spacing, layout and general arrangement shown on drawings. Contractor may vary these dimensions slightly in order to clear obstructions. Any major changes in the arrangement must be approved by Engineer.
- L. Install tandem fixtures in continuous rows providing that finished appearance conforms to appearance of individual units.
- M. Align and plumb rows of light fixtures.
- N. Provide additional trim as required for neat plumbing of recessed fluorescent lights mounted in patterns.

- O. Mount wall and ceiling fixtures independent and secure so that they are not dependent on finish for support and cannot be rotated or displaced.
- P. Maintain clearances as required in Section 410.66 of the NEC. Notify Engineer of any conflict, prior to rough-in.

3.2 FIXTURE SUPPORTS

- A. See Section 26 05 29 for fixture support items such as device procedures and retaining clips.
- B. Surface or pendant mounted lighting fixtures weighing in excess of 25 pounds shall be securely supported to the outlet box through the use of a fixture stud. The stud shall attach to the box through a knockout in the top of the box. Fixture support shall not be solely dependant on the ears of the box.
- C. Securely attach outlet boxes to the building structure either directly to the structure or through the use of a threaded rod or steel channel.
- D. The contractor is required to determine and provide all necessary mounting hardware, plates, supports, etc. as required, and finished in a color per architect's requirements to install fixtures in locations as indicated on the plans.

3.3 ADJUST, CLEAN AND LUBRICATE

- A. Clean lighting fixtures of dirt and debris prior to acceptance. Cleaning shall include lamps, reflectors, lenses, louvers and exposed trims and housing.
- B. Protect installed fixtures from damage during the construction period.
- C. Remove conspicuous trade labels.
- D. Aim adjustable fixtures to satisfaction of Engineer. Adjustable exterior lighting fixtures, such as floodlights, shall be aimed after dark.

3.4 FIELD QUALITY CONTROL

- A. All lamps shall be new and delivered to the job site in sealed cartons.
- B. At time of Substantial Completion, replace lamps in lighting fixtures which are observed to be noticeably dimmed after Contractor's use and testing, as judged by the Engineer.

3.5 PRODUCT STORAGE AND HANDLING

- A. Handle lighting fixtures carefully to prevent breakage, denting and scoring finish.
- B. Do not install damaged lighting fixtures.
- C. Do not repair damaged fixtures; replace and return damaged units to equipment manufacturer for repair.
- D. Store lighting fixtures in a clean, dry space. Store in original cartons and protect from dirt, physical damage, weather and construction traffic.

3.6 JOB CONDITIONS

- A. Contractor shall determine that ceiling suspension system is adequately supported to receive and support the lighting fixtures. Where deemed inadequate, do not install fixtures until additional support has been provided.
- B. Verify local codes and ordinances that may pertain to installation and aiming of exterior fixtures. Notify Engineer prior to Bid time if problems are encountered.

3.7 EXTRA MATERIALS

- A. Turn over to Owner all extra materials in original packaging/containers and store in a location as directed. The Contractor shall get a written confirmation from Owner that the extra materials were left at the site.

END OF SECTION

SECTION 312000 - EARTH MOVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Preparing subgrades for slabs-on-grade.
 - 2. Excavating and backfilling for buildings and structures.
 - 3. Drainage course for concrete slabs-on-grade.
- B. Related Requirements:
 - 1. Section 033000 "Cast-in-Place Concrete" for granular course if placed over vapor retarder and beneath the slab-on-grade.

1.3 DEFINITIONS

- A. Backfill: Soil material or controlled low-strength material used to fill an excavation.
- B. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.
- C. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.
- D. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
 - 1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
 - 2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.
- E. Fill: Soil materials used to raise existing grades.

1.4 QUALITY ASSURANCE

- A. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E 329 and ASTM D 3740 for testing indicated.

1.5 FIELD CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth-moving operations.
- B. Utility Locator Service: Notify utility locator service for area where Project is located before beginning earth-moving operations.
- C. Do not commence earth-moving operations until temporary site fencing and erosion- and sedimentation-control measures specified on drawings are in place.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
- B. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and CL according to ASTM D 2487, or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.
- C. Unsatisfactory Soils: Soil Classification Groups GC, SC, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.
 - 1. Unsatisfactory soils also include satisfactory soils not maintained within 3 percent of optimum moisture content at time of compaction.
- D. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940/D 2940M; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.
- E. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and zero to 5 percent passing a No. 8 sieve.
- F. Sand: ASTM C 33/C 33M; fine aggregate.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth-moving operations.
- B. Protect and maintain erosion and sedimentation controls during earth-moving operations.

- C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 DEWATERING

- A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.
- B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
 - 1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

3.3 EXCAVATION, GENERAL

- A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.
 - 1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

3.4 EXCAVATION FOR STRUCTURES

- A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
 - 1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

3.5 SUBGRADE INSPECTION

- A. Notify Architect when excavations have reached required subgrade.
- B. If Architect determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
- C. Proof-roll subgrade below the building slabs with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
 - 1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.

2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.
- D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
 - E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.6 UNAUTHORIZED EXCAVATION

- A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by Architect.

3.7 STORAGE OF SOIL MATERIALS

- A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

3.8 BACKFILL

- A. Place and compact backfill in excavations promptly, but not before completing the following:
 1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
 2. Removing concrete formwork.
 3. Removing trash and debris.
- B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.9 SOIL FILL

- A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
- B. Place and compact fill material in layers to required elevations as follows:
 1. Under building slabs, use engineered fill.
 2. Under footings and foundations, use engineered fill.
- C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.10 SOIL MOISTURE CONTROL

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 3 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 3 percent and is too wet to compact to specified dry unit weight.

3.11 COMPACTION OF SOIL BACKFILLS AND FILLS

- A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- B. Place backfill and fill soil materials evenly on all sides of structures to required elevations and uniformly along the full length of each structure.
- C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698:
 1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.

3.12 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

- A. Place drainage course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:
 1. Place drainage course 6 inches or less in compacted thickness in a single layer.
 2. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.13 FIELD QUALITY CONTROL

- A. Testing Agency: Contractor will engage a qualified geotechnical engineering testing agency to perform tests and inspections.
- B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.
- C. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.
- D. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2937, and ASTM D 6938, as applicable. Tests will be performed at the following locations and frequencies:

1. Building Slab Area: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of paved area or building slab but in no case fewer than three tests.
 2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet per 2 feet of fill or less of wall length but no fewer than two tests.
- E. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.14 PROTECTION

- A. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
1. Scarify or remove and replace soil material to depth as directed by Architect; reshape and recompact.
- B. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.15 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Transport surplus satisfactory soil to designated storage areas on Owner's property. Stockpile or spread soil as directed by Owner.
1. Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 312000